- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2 2.1 2.0**

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pgRouting extends the **PostGIS**/**PostgreSQL** geospatial database to provide geospatial routing and other network analysis functionality.

This is the manual for pgRouting v3.2.2.

General

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Introduction

pgRouting is an extension of **PostGIS** and **PostgreSQL** geospatial database and adds routing and other network analysis functionality. A predecessor of pgRouting – pgDijkstra, written by Sylvain Pasche from **Camptocamp**, was later extended by Orkney and renamed to pgRouting. The project is now supported and maintained by **Georepublic**, **Paragon Corporation** and a broad user community.

pgRouting is part of **OSGeo Community Projects** from the **OSGeo Foundation** and included on **OSGeoLive**.

Licensing

The following licenses can be found in pgRouting:

License	
GNU General Public License v2.0 or later	Most features of pgRouting are available under **GNU General Public License v2.0 or later**.
Boost Software License - Version 1.0	Some Boost extensions are available under **Boost Software License - Version 1.0**.
MIT-X License	Some code contributed by iMaptools.com is available under MIT-X license.
Creative Commons Attribution-Share Alike 3.0 License	The pgRouting Manual is licensed under a **Creative Commons Attribution-Share Alike 3.0 License**.

In general license information should be included in the header of each source file.

Contributors

This Release Contributors

Individuals (in alphabetical order)

Ashish Kumar, Cayetano Benavent, Daniel Kastl, Himanshu Raj, Martha Vergara, Regina Obe, Virginia Vergara

And all the people that give us a little of their time making comments, finding issues, making pull requests etc. in any of our products: osm2pgrouting, pgRouting, pgRoutingLayer.

Corporate Sponsors (in alphabetical order)

These are corporate entities that have contributed developer time, hosting, or direct monetary funding to the pgRouting project:

* **Georepublic**
* **Google Summer of Code**
* **Leopark**
* **Paragon Corporation**

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* Camptocamp
* CSIS (University of Tokyo)
* Georepublic
* Google Summer of Code
* iMaptools
* Leopark
* Orkney
* Paragon Corporation
* Versaterm Inc.

More Information

* The latest software, documentation and news items are available at the pgRouting web site **https://pgrouting.org**.
* PostgreSQL database server at the PostgreSQL main site **https://www.postgresql.org**.
* PostGIS extension at the PostGIS project web site **https://postgis.net**.
* Boost C++ source libraries at **https://www.boost.org**.
* The Migration guide can be found at **https://github.com/pgRouting/pgrouting/wiki/Migration-Guide**.

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Installation

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Instructions for downloading and installing binaries for different Operative systems instructions and additional notes and corrections not included in this documentation can be found in **Installation wiki**

To use pgRouting postGIS needs to be installed, please read the information about installation in this **Install Guide**

Short Version

Extracting the tar ball

```
tar xvfz pgrouting-3.2.2.tar.gz
cd pgrouting-3.2.2
```

To compile assuming you have all the dependencies in your search path:

```
mkdir build
cd build
cmake  ..
make
sudo make install
```

Once pgRouting is installed, it needs to be enabled in each individual database you want to use it in.

```
createdb routing
psql routing -c 'CREATE EXTENSION PostGIS'
psql routing -c 'CREATE EXTENSION pgRouting'
```

Get the sources

The pgRouting latest release can be found in **https://github.com/pgRouting/pgrouting/releases/latest**

wget

To download this release:

```
wget -O pgrouting-3.2.2.tar.gz https://github.com/pgRouting/pgrouting/archive/v3.2.2.tar.gz
```

Goto **Short Version** to the extract and compile instructions.

git

To download the repository

```
git clone git://github.com/pgRouting/pgrouting.git
cd pgrouting
git checkout v3.2.2
```

Goto **Short Version** to the compile instructions (there is no tar ball).

Enabling and upgrading in the database

Enabling the database

pgRouting is an extension and depends on postGIS. Enabling postGIS before enabling pgRouting in the database

```
CREATE EXTENSION postgis;
CREATE EXTENSION pgrouting;
```

Upgrading the database

To upgrade pgRouting in the database to version 3.2.2 use the following command:

```
ALTER EXTENSION pgrouting UPDATE TO "3.2.2";
```

More information can be found in **https://www.postgresql.org/docs/current/sql-createextension.html**

Dependencies

Compilation Dependencies

To be able to compile pgRouting, make sure that the following dependencies are met:

- C and C++0x compilers * Compiling with Boost 1.56 up to Boost 1.74 requires C++ Compiler with C++03 or C++11 standard support * Compiling with Boost 1.75 requires C++ Compiler with C++14 standard support
- Postgresql version = Supported versions by PostgreSQL
- The Boost Graph Library (BGL). Version >= 1.56
- CMake >= 3.2

optional dependencies

For user’s documentation

- Sphinx >= 1.1
- Latex

For developer's documentation

- Doxygen >= 1.7

For testing

- pgtap
- pg_prove

For using:

- PostGIS version >= 2.2

Example: Installing dependencies on linux

Installing the compilation dependencies

Database dependencies

```
sudo apt-get install
    postgresql-10 \
    postgresql-server-dev-10 \
    postgresql-10-postgis
```

Build dependencies

```
sudo apt-get install
    cmake \
    g++ \
    libboost-graph-dev
```

Optional dependencies

For documentation and testing

```
sudo apt-get install -y python-sphinx \
    texlive \
    doxygen \
    libtap-parser-sourcehandler-pgtap-perl \
    postgresql-10-pgtap
```

Configuring

pgRouting uses the *cmake* system to do the configuration.

The build directory is different from the source directory

Create the build directory

```
$ mkdir build
```

Configurable variables

To see the variables that can be configured

```
$ cd build
$ cmake -L ..
```

Configuring The Documentation

Most of the effort of the documentation has being on the HTML files. Some variables for the documentation:

Variable	Default	Comment
WITH_DOC	BOOL=OFF	Turn on/off building the documentation
BUILD_HTML	BOOL=ON	If ON, turn on/off building HTML for user's documentation
BUILD_DOXY	BOOL=ON	If ON, turn on/off building HTML for developer's documentation
BUILD_LATEX	BOOL=OFF	If ON, turn on/off building PDF

Variable	Default	Comment
BUILD_MAN	BOOL=OFF	If ON, turn on/off building MAN pages
DOC_USE_BOOTSTRAP	BOOL=OFF	If ON, use sphinx-bootstrap for HTML pages of the users documentation

Configuring with documentation

```
$ cmake -DWITH_DOC=ON ..
```

Note

Most of the effort of the documentation has being on the html files.

Building

Using `make` to build the code and the documentation

The following instructions start from *path/to/pgrouting/build*

```
$ make          # build the code but not the documentation
$ make doc      # build only the documentation
$ make all doc  # build both the code and the documentation
```

We have tested on several platforms, For installing or reinstalling all the steps are needed.

Warning

The sql signatures are configured and build in the `cmake` command.

MinGW on Windows

```
$ mkdir build
$ cd build
$ cmake -G"MSYS Makefiles" ..
$ make
$ make install
```

Linux

The following instructions start from *path/to/pgrouting*

```
mkdir build
cd build
cmake  ..
make
sudo make install
```

When the configuration changes:

```
rm -rf build
```

and start the build process as mentioned above.

Testing

Currently there is no `make test` and testing is done as follows

The following instructions start from *path/to/pgrouting/*

```
tools/testers/doc_queries_generator.pl
createdb  -U <user> ___pgr___test___
sh ./tools/testers/pg_prove_tests.sh <user>
dropdb  -U <user> ___pgr___test___
```

See Also

Indices and tables

- **Index**
- **Search Page**

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Support

pgRouting community support is available through the **pgRouting website**, **documentation**, tutorials, mailing lists and others. If you're looking for **commercial support**, find below a list of companies providing pgRouting development and consulting services.

Reporting Problems

Bugs are reported and managed in an **issue tracker**. Please follow these steps:

1. Search the tickets to see if your problem has already been reported. If so, add any extra context you might have found, or at least indicate that you too are having the problem. This will help us prioritize common issues.
2. If your problem is unreported, create a **new issue** for it.
3. In your report include explicit instructions to replicate your issue. The best tickets include the exact SQL necessary to replicate a problem.
4. If you can test older versions of PostGIS for your problem, please do. On your ticket, note the earliest version the problem appears.
5. For the versions where you can replicate the problem, note the operating system and version of pgRouting, PostGIS and PostgreSQL.
6. It is recommended to use the following wrapper on the problem to pin point the step that is causing the problem.

```
SET client_min_messages TO debug;
  <your code>
SET client_min_messages TO notice;
```

Mailing List and GIS StackExchange

There are two mailing lists for pgRouting hosted on OSGeo mailing list server:

- User mailing list: **https://lists.osgeo.org/mailman/listinfo/pgrouting-users**
- Developer mailing list: **https://lists.osgeo.org/mailman/listinfo/pgrouting-dev**

For general questions and topics about how to use pgRouting, please write to the user mailing list.

You can also ask at **GIS StackExchange** and tag the question with `pgrouting`. Find all questions tagged with `pgrouting` under **https://gis.stackexchange.com/questions/tagged/pgrouting** or subscribe to the **pgRouting questions feed**.

Commercial Support

For users who require professional support, development and consulting services, consider contacting any of the following organizations, which have significantly contributed to the development of pgRouting:

Company	Offices in	Website
Georepublic	Germany, Japan	**https://georepublic.info**
Paragon Corporation	United States	**https://www.paragoncorporation.com**
Camptocamp	Switzerland, France	**https://www.camptocamp.com**
Netlab	Capranica, Italy	**https://www.osgeo.org/service-providers/netlab/**

- **Sample Data** that is used in the examples of this manual.

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Sample Data

The documentation provides very simple example queries based on a small sample network. To be able to execute the sample queries, run the following SQL commands to create a table with a small network data set.

Create table

```
CREATE TABLE edge_table (
    id BIGSERIAL,
    dir character varying,
    source BIGINT,
    target BIGINT,
    cost FLOAT,
    reverse_cost FLOAT,
    capacity BIGINT,
    reverse_capacity BIGINT,
    category_id INTEGER,
    reverse_category_id INTEGER,
    x1 FLOAT,
    y1 FLOAT,
    x2 FLOAT,
    y2 FLOAT,
    the_geom geometry
);
```

Insert data

```
INSERT INTO edge_table (
    category_id, reverse_category_id,
    cost, reverse_cost,
    capacity, reverse_capacity,
    x1, y1,
    x2, y2) VALUES
(3, 1,    1,  1,  80, 130,   2,   0,    2, 1),
(3, 2,   -1,  1,  -1, 100,   2,   1,    3, 1),
(2, 1,   -1,  1,  -1, 130,   3,   1,    4, 1),
(2, 4,    1,  1, 100,  50,   2,   1,    2, 2),
(1, 4,    1, -1, 130,  -1,   3,   1,    3, 2),
(4, 2,    1,  1,  50, 100,   0,   2,    1, 2),
(4, 1,    1,  1,  50, 130,   1,   2,    2, 2),
(2, 1,    1,  1, 100, 130,   2,   2,    3, 2),
(1, 3,    1,  1, 130,  80,   3,   2,    4, 2),
(1, 4,    1,  1, 130,  50,   2,   2,    2, 3),
(1, 2,    1, -1, 130,  -1,   3,   2,    3, 3),
(2, 3,    1, -1, 100,  -1,   2,   3,    3, 3),
(2, 4,    1, -1, 100,  -1,   3,   3,    4, 3),
(3, 1,    1,  1,  80, 130,   2,   3,    2, 4),
(3, 4,    1,  1,  80,  50,   4,   2,    4, 3),
(3, 3,    1,  1,  80,  80,   4,   1,    4, 2),
(1, 2,    1,  1, 130, 100,   0.5, 3.5,  1.999999999999,3.5),
(4, 1,    1,  1,  50, 130,   3.5, 2.3,  3.5,4);
```

Updating geometry

```
UPDATE edge_table SET the_geom = st_makeline(st_point(x1,y1),st_point(x2,y2)),
dir = CASE WHEN (cost>0 AND reverse_cost>0) THEN 'B'   -- both ways
           WHEN (cost>0 AND reverse_cost<0) THEN 'FT'  -- direction of the LINESSTRING
           WHEN (cost<0 AND reverse_cost>0) THEN 'TF'  -- reverse direction of the LINESTRING
           ELSE '' END;                                -- unknown
```

Topology

- Before you test a routing function use this query to create a topology (fills the `source` and `target` columns).

```
SELECT pgr_createTopology('edge_table',0.001);
```

Combinations of start and end vertices

- Used to test the combinations_sql signature in dijkstra-like functions.

```
CREATE TABLE combinations_table (
    source BIGINT,
    target BIGINT
);

INSERT INTO combinations_table (
    source, target) VALUES
(1, 2),
(1, 4),
(2, 1),
(2, 4),
(2, 17);
```

Points of interest

- When points outside of the graph.
- Used with the **withPoints - Family of functions** functions.

```
CREATE TABLE pointsOfInterest(
    pid BIGSERIAL,
    x FLOAT,
    y FLOAT,
    edge_id BIGINT,
    side CHAR,
    fraction FLOAT,
    the_geom geometry,
    newPoint geometry
);

INSERT INTO pointsOfInterest (x, y, edge_id, side, fraction) VALUES
(1.8, 0.4,   1, 'l', 0.4),
(4.2, 2.4,  15, 'r', 0.4),
(2.6, 3.2,  12, 'l', 0.6),
(0.3, 1.8,   6, 'r', 0.3),
(2.9, 1.8,   5, 'l', 0.8),
(2.2, 1.7,   4, 'b', 0.7);
UPDATE pointsOfInterest SET the_geom = st_makePoint(x,y);

UPDATE pointsOfInterest
    SET newPoint = ST_LineInterpolatePoint(e.the_geom, fraction)
    FROM edge_table AS e WHERE edge_id = id;
```

Restrictions

- Used with the **pgr_trsp - Turn Restriction Shortest Path (TRSP)** functions.

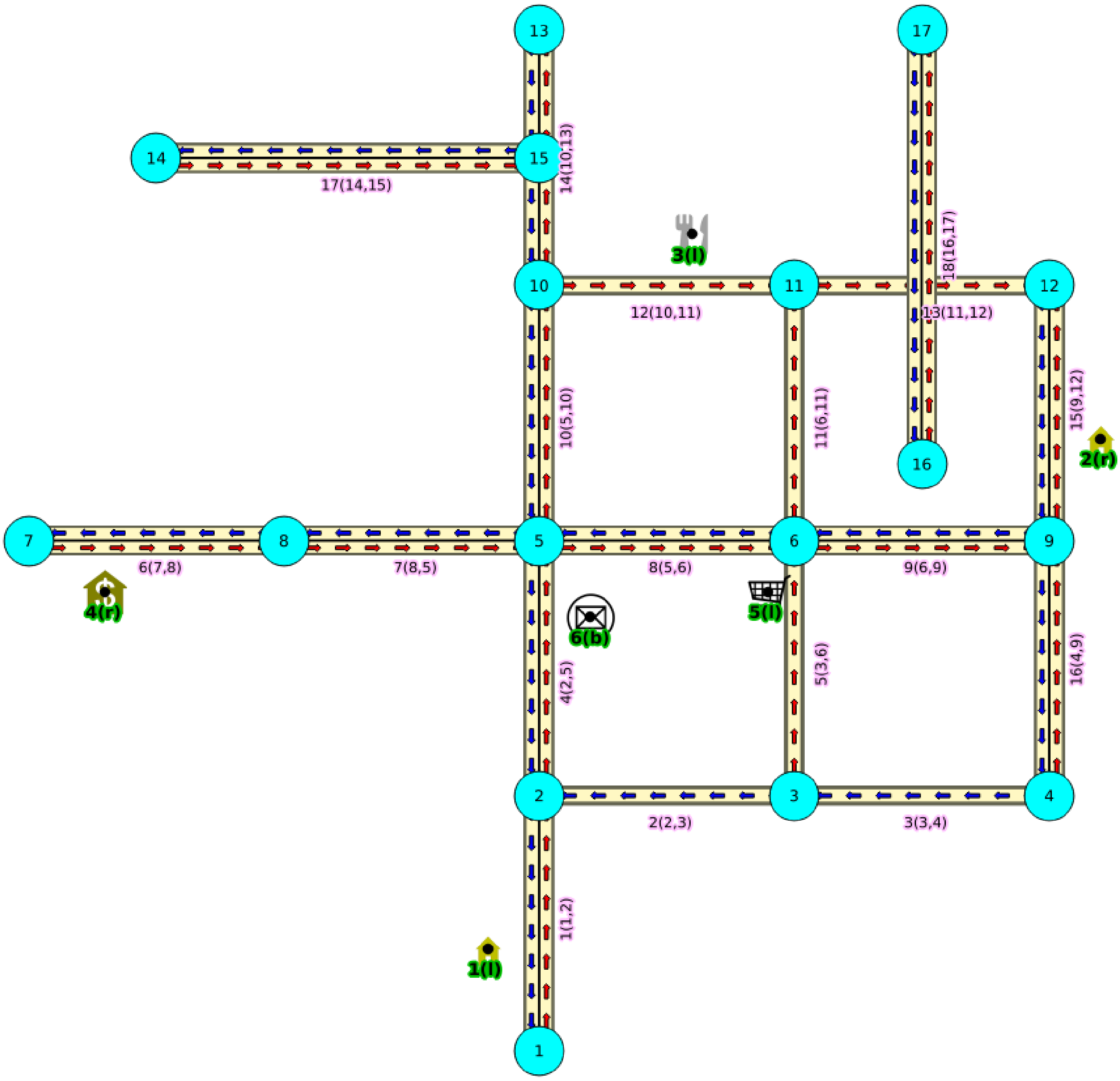
```
CREATE TABLE restrictions (
    rid BIGINT NOT NULL,
    to_cost FLOAT,
    target_id BIGINT,
    from_edge BIGINT,
    via_path TEXT
);

INSERT INTO restrictions (rid, to_cost, target_id, from_edge, via_path) VALUES
(1, 100,  7,  4, NULL),
(1, 100, 11,  8, NULL),
(1, 100, 10,  7, NULL),
(2,   4,  8,  3, 5),
(3, 100,  9, 16, NULL);

CREATE TABLE new_restrictions (
    id SERIAL PRIMARY KEY,
    path BIGINT[],
    cost float
);

INSERT INTO new_restrictions (path, cost) VALUES
(ARRAY[4, 7], 100),
(ARRAY[8, 11], 100),
(ARRAY[4, 8], 100),
(ARRAY[5, 9], 100),
(ARRAY[10, 12], 100),
(ARRAY[9, 15], 100),
(ARRAY[3, 5, 8], 100);
```

Images

- Red arrows correspond when `cost` > 0 in the edge table.
- Blue arrows correspond when `reverse_cost` > 0 in the edge table.
- Points are outside the graph.
- Click on the graph to enlarge.

Network for queries marked as `directed` and `cost` and `reverse_cost` columns are used

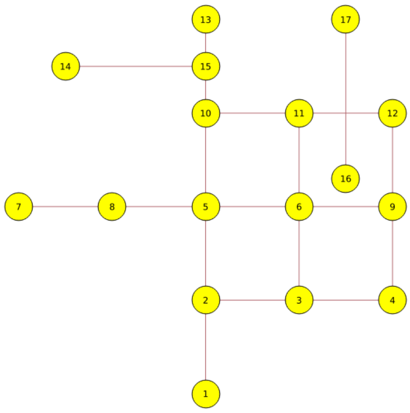
When working with city networks, this is recommended for point of view of vehicles.



Graph 1: Directed, with cost and reverse cost

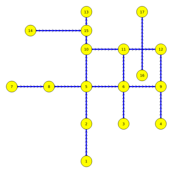
Network for queries marked as undirected **and** cost **and** reverse_cost **columns are used**

When working with city networks, this is recommended for point of view of pedestrians.



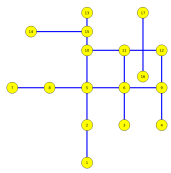
Graph 2: Undirected, with cost and reverse cost

Network for queries marked as `directed` and only `cost` column is used



Graph 3: Directed, with cost

Network for queries marked as `undirected` and only `cost` column is used



Graph 4: Undirected, with cost

Pick & Deliver Data

```
DROP TABLE IF EXISTS customer CASCADE;
CREATE table customer (
    id BIGINT not null primary key,
    x DOUBLE PRECISION,
    y DOUBLE PRECISION,
    demand INTEGER,
    opentime INTEGER,
    closetime INTEGER,
    servicetime INTEGER,
    pindex BIGINT,
    dindex BIGINT
);


INSERT INTO customer(
  id,     x,    y, demand, opentime, closetime, servicetime, pindex, dindex) VALUES
(  0,   40,   50,     0,     0,  1236,    0,    0,    0),
(  1,   45,   68,   -10,   912,   967,   90,   11,    0),
(  2,   45,   70,   -20,   825,   870,   90,    6,    0),
(  3,   42,   66,    10,    65,   146,   90,    0,   75),
(  4,   42,   68,   -10,   727,   782,   90,    9,    0),
(  5,   42,   65,    10,    15,    67,   90,    0,    7),
(  6,   40,   69,    20,   621,   702,   90,    0,    2),
(  7,   40,   66,   -10,   170,   225,   90,    5,    0),
(  8,   38,   68,    20,   255,   324,   90,    0,   10),
(  9,   38,   70,    10,   534,   605,   90,    0,    4),
( 10,   35,   66,   -20,   357,   410,   90,    8,    0),
( 11,   35,   69,    10,   448,   505,   90,    0,    1),
( 12,   25,   85,   -20,   652,   721,   90,   18,    0),
( 13,   22,   75,    30,    30,    92,   90,    0,   17),
( 14,   22,   85,   -40,   567,   620,   90,   16,    0),
( 15,   20,   80,   -10,   384,   429,   90,   19,    0),
( 16,   20,   85,    40,   475,   528,   90,    0,   14),
( 17,   18,   75,   -30,    99,   148,   90,   13,    0),
( 18,   15,   75,    20,   179,   254,   90,    0,   12),
( 19,   15,   80,    10,   278,   345,   90,    0,   15),
( 20,   30,   50,    10,    10,    73,   90,    0,   24),
( 21,   30,   52,   -10,   914,   965,   90,   30,    0),
( 22,   28,   52,   -20,   812,   883,   90,   28,    0),
( 23,   28,   55,    10,   732,   777,    0,    0,  103),
( 24,   25,   50,   -10,    65,   144,   90,   20,    0),
( 25,   25,   52,    40,   169,   224,   90,    0,   27),
( 26,   25,   55,   -10,   622,   701,   90,   29,    0),
( 27,   23,   52,   -40,   261,   316,   90,   25,    0),
( 28,   23,   55,    20,   546,   593,   90,    0,   22),
( 29,   20,   50,    10,   358,   405,   90,    0,   26),
( 30,   20,   55,    10,   449,   504,   90,    0,   21),
( 31,   10,   35,   -30,   200,   237,   90,   32,    0),
( 32,   10,   40,    30,    31,   100,   90,    0,   31),
( 33,    8,   40,    40,    87,   158,   90,    0,   37),
( 34,    8,   45,   -30,   751,   816,   90,   38,    0),
( 35,    5,   35,    10,   283,   344,   90,    0,   39),
( 36,    5,   45,    10,   665,   716,    0,    0,  105),
( 37,    2,   40,   -40,   383,   434,   90,   33,    0),
( 38,    0,   40,    30,   479,   522,   90,    0,   34),
( 39,    0,   45,   -10,   567,   624,   90,   35,    0),
( 40,   35,   30,   -20,   264,   321,   90,   42,    0),
```

```
( 40,   35,  30,  -20,  264,  321,  90,  42,   0),
( 41,   35,  32,  -10,  166,  235,  90,  43,   0),
( 42,   33,  32,   20,   68,  149,  90,   0,  40),
( 43,   33,  35,   10,   16,   80,  90,   0,  41),
( 44,   32,  30,   10,  359,  412,  90,   0,  46),
( 45,   30,  30,   10,  541,  600,  90,   0,  48),
( 46,   30,  32,  -10,  448,  509,  90,  44,   0),
( 47,   30,  35,  -10, 1054, 1127,  90,  49,   0),
( 48,   28,  30,  -10,  632,  693,  90,  45,   0),
( 49,   28,  35,   10, 1001, 1066,  90,   0,  47),
( 50,   26,  32,   10,  815,  880,  90,   0,  52),
( 51,   25,  30,   10,  725,  786,   0,   0, 101),
( 52,   25,  35,  -10,  912,  969,  90,  50,   0),
( 53,   44,   5,   20,  286,  347,  90,   0,  58),
( 54,   42,  10,   40,  186,  257,  90,   0,  60),
( 55,   42,  15,  -40,   95,  158,  90,  57,   0),
( 56,   40,   5,   30,  385,  436,  90,   0,  59),
( 57,   40,  15,   40,   35,   87,  90,   0,  55),
( 58,   38,   5,  -20,  471,  534,  90,  53,   0),
( 59,   38,  15,  -30,  651,  740,  90,  56,   0),
( 60,   35,   5,  -40,  562,  629,  90,  54,   0),
( 61,   50,  30,  -10,  531,  610,  90,  67,   0),
( 62,   50,  35,   20,  262,  317,  90,   0,  68),
( 63,   50,  40,   50,  171,  218,  90,   0,  74),
( 64,   48,  30,   10,  632,  693,   0,   0, 102),
( 65,   48,  40,   10,   76,  129,  90,   0,  72),
( 66,   47,  35,   10,  826,  875,  90,   0,  69),
( 67,   47,  40,   10,   12,   77,  90,   0,  61),
( 68,   45,  30,  -20,  734,  777,  90,  62,   0),
( 69,   45,  35,  -10,  916,  969,  90,  66,   0),
( 70,   95,  30,  -30,  387,  456,  90,  81,   0),
( 71,   95,  35,   20,  293,  360,  90,   0,  77),
( 72,   53,  30,  -10,  450,  505,  90,  65,   0),
( 73,   92,  30,  -10,  478,  551,  90,  76,   0),
( 74,   53,  35,  -50,  353,  412,  90,  63,   0),
( 75,   45,  65,  -10,  997, 1068,  90,   3,   0),
( 76,   90,  35,   10,  203,  260,  90,   0,  73),
( 77,   88,  30,  -20,  574,  643,  90,  71,   0),
( 78,   88,  35,   20,  109,  170,   0,   0, 104),
( 79,   87,  30,   10,  668,  731,  90,   0,  80),
( 80,   85,  25,  -10,  769,  820,  90,  79,   0),
( 81,   85,  35,   30,   47,  124,  90,   0,  70),
( 82,   75,  55,   20,  369,  420,  90,   0,  85),
( 83,   72,  55,  -20,  265,  338,  90,  87,   0),
( 84,   70,  58,   20,  458,  523,  90,   0,  89),
( 85,   68,  60,  -20,  555,  612,  90,  82,   0),
( 86,   66,  55,   10,  173,  238,  90,   0,  91),
( 87,   65,  55,   20,   85,  144,  90,   0,  83),
( 88,   65,  60,  -10,  645,  708,  90,  90,   0),
( 89,   63,  58,  -20,  737,  802,  90,  84,   0),
( 90,   60,  55,   10,   20,   84,  90,   0,  88),
( 91,   60,  60,  -10,  836,  889,  90,  86,   0),
( 92,   67,  85,   20,  368,  441,  90,   0,  93),
( 93,   65,  85,  -20,  475,  518,  90,  92,   0),
( 94,   65,  82,  -10,  285,  336,  90,  96,   0),
( 95,   62,  80,  -20,  196,  239,  90,  98,   0),
( 96,   60,  80,   10,   95,  156,  90,   0,  94),
( 97,   60,  85,   30,  561,  622,   0,   0, 106),
( 98,   58,  75,   20,   30,   84,  90,   0,  95),
( 99,   55,  80,  -20,  743,  820,  90, 100,   0),
( 100,  55,  85,   20,  647,  726,  90,   0,  99),
( 101,  25,  30,  -10,  725,  786,  90,  51,   0),
( 102,  48,  30,  -10,  632,  693,  90,  64,   0),
( 103,  28,  55,  -10,  732,  777,  90,  23,   0),
( 104,  88,  35,  -20,  109,  170,  90,  78,   0),
( 105,   5,  45,  -10,  665,  716,  90,  36,   0),
( 106,  60,  85,  -30,  561,  622,  90,  97,   0);
```

Pgrouting Concepts

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2 2.1 2.0**

pgRouting Concepts

Contents

Getting Started

This is a simple guide to walk you through the steps of getting started with pgRouting. In this guide we will cover:

Create a routing Database

The first thing we need to do is create a database and load pgrouting in the database. Typically you will create a database for each project. Once you have a database to work in, your can load your data and build your application in that database. This makes it easy to move your project later if you want to to say a production server.

For Postgresql 9.2 and later versions

```
createdb mydatabase
psql mydatabase -c "create extension postgis"
psql mydatabase -c "create extension pgrouting"
```

Load Data

There are several ways to load your data into pgRouting. The most direct way is to load an Open Street Maps (OSM) dataset using **osm2pgrouting**. This is a tool, integrated in pgRouting project, that loads OSM data into postgresql with pgRouting requirements, including data structure and routing topology.

If you have other requirements, you can try various OpenSource tools that can help you, like:

shp2pgsql:
- this is the postgresql shapefile loader

ogr2ogr:
- this is a vector data conversion utility

osm2pgsql:
- this is a tool for loading OSM data into postgresql

Please note that these tools will not import the data in a structure compatible with pgRouting and you might need to adapt it.

These tools and probably others will allow you to read vector data so that you may then load that data into your database as a table of some kind. At this point you need to know a little about your data structure and content. One easy way to browse your new data table is with pgAdmin or phpPgAdmin.

Build a Routing Topology

> **Note**
>
> this step is not needed if data is loaded with*osm2pgrouting*

Next we need to build a topology for our street data. What this means is that for any given edge in your street data the ends of that edge will be connected to a unique node and to other edges that are also connected to that same unique node. Once all the edges are connected to nodes we have a graph that can be used for routing with pgrouting. We provide a tool that will help with this:

```
select pgr_createTopology('myroads', 0.000001);
```

where you should replace 'myroads' with the name of your table storing the edges.

- **pgr_createTopology**

Check the Routing Topology

There are lots of possible sources for errors in a graph. The data that you started with may not have been designed with routing in mind. A graph has some very specific requirements. One is that it is *NODED*, this means that except for some very specific use cases, each road segment starts and ends at a node and that in general is does not cross another road segment that it should be connected to.

There can be other errors like the direction of a one-way street being entered in the wrong direction. We do not have tools to search for all possible errors but we have some basic tools that might help.

```
select pgr_analyzegraph('myroads', 0.000001);
select pgr_analyzeoneway('myroads',  s_in_rules, s_out_rules,
                                   t_in_rules, t_out_rules
                                   direction)
select pgr_nodeNetwork('myroads', 0.001);
```

where you should replace 'myroads' with the name of your table storing the edges ('ways', in case you used osm2pgrouting to import the data).

- **pgr_analyzeGraph**
- **pgr_analyzeOneWay**
- **pgr_nodeNetwork**

Compute a Path

Once you have all the preparation work done above, computing a route is fairly easy. We have a lot of different algorithms that can work with your prepared road network. The general form of a route query using Dijkstra algorithm is:

```
select pgr_dijkstra(`SELECT * FROM myroads', <start>, <end>)
```

This algorithm only requires *id*, *source*, *target* and *cost* as the minimal attributes, that by default will be considered to be columns in your roads table. If the column names in your roads table do not match exactly the names of these attributes, you can use aliases. For example, if you imported OSM data using **osm2pgrouting**, your id column's name would be*gid* and your roads table would be *ways*, so you would query a route from node id 1 to node id 2 by typing:

```
select pgr_dijkstra('SELECT gid AS id, source, target, cost FROM ways', 1, 2)
```

As you can see this is fairly straight forward and it also allows for great flexibility, both in terms of database structure and in defining cost functions. You can test the previous query using *length_m AS cost* to compute the shortest path in meters or *cost_s / 60 AS cost* to compute the fastest path in minutes.

You can look and the specific algorithms for the details of the signatures and how to use them. These results have information like edge id and/or the node id along with the cost or geometry for the step in the path from *start* to *end*. Using the ids you can join these result back to your edge table to get more information about each step in the path.

- **pgr_dijkstra**

Group of Functions

A function might have different overloads. Across this documentation, to indicate which overload we use the following terms:

- **One to One**
- **One to Many**
- **Many to One**

- **Many to Many**
- **Combinations**

Depending on the overload are the parameters used, keeping consistency across all functions.

One to One

When routing from:

- From **one** starting vertex
- to **one** ending vertex

One to Many

When routing from:

- From **one** starting vertex
- to **many** ending vertices

Many to One

When routing from:

- From **many** starting vertices
- to **one** ending vertex

Many to Many

When routing from:

- From **many** starting vertices
- to **many** ending vertices

Combinations

When routing from:

- From **many** different starting vertices
- to **many** different ending vertices
- Every tuple specifies a pair of a start vertex and an end vertex
- Users can define the combinations as desired.

Inner Queries

- **Description of the edges_sql query for dijkstra like functions**

There are several kinds of valid inner queries and also the columns returned are depending of the function. Which kind of inner query will depend on the function(s) requirements. To simplify variety of types, `ANY-INTEGER` and `ANY-NUMERICAL` is used.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Description of the edges_sql query for dijkstra like functions

Column	Type	Default	Description
id	`ANY-INTEGER`		Identifier of the edge.
source	`ANY-INTEGER`		Identifier of the first end point vertex of the edge.
target	`ANY-INTEGER`		Identifier of the second end point vertex of the edge.
cost	`ANY-NUMERICAL`		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it’s not part of the graph.
reverse_cost	`ANY-NUMERICAL`	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it’s not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Description of the edges_sql query (id is not necessary)

edges_sql:
an SQL query, which should return a set of rows with the following columns:

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Parameters

Parameter	Type	Default	Description
edges_sql	TEXT		SQL query as described above.
via_vertices	ARRAY[ANY-INTEGER]		Array of ordered vertices identifiers that are going to be visited.
directed	BOOLEAN	true	• When true Graph is considered *Directed* • When false the graph is considered as Undirected.
strict	BOOLEAN	false	• When false ignores missing paths returning all paths found • When true if a path is missing stops and returns *EMPTY SET*
U_turn_on_edge	BOOLEAN	true	• When true departing from a visited vertex will not try to avoid using the edge used to reach it. In other words, U turn using the edge with same *id* is allowed. • When false when a departing from a visited vertex tries to avoid using the edge used to reach it. In other words, U turn using the edge with same *id* is used when no other path is found.

edges_sql query for aStar - Family of functions and aStar - Family of functions functions

edges_sql:
an SQL query, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.
x1	ANY-NUMERICAL		X coordinate of *source* vertex.
y1	ANY-NUMERICAL		Y coordinate of *source* vertex.
x2	ANY-NUMERICAL		X coordinate of *target* vertex.
y2	ANY-NUMERICAL		Y coordinate of *target* vertex.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

For pgr_pushRelabel, pgr_edmondsKarp, pgr_boykovKolmogorov :

Edges SQL:
an SQL query of a directed graph of capacities, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
capacity	ANY-INTEGER		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_capacity	ANY-INTEGER	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

For pgr_maxFlowMinCost - Experimental and pgr_maxFlowMinCost_Cost - Experimental:

Edges SQL:
an SQL query of a directed graph of capacities, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
capacity	ANY-INTEGER		Capacity of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_capacity	ANY-INTEGER	-1	Capacity of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* if it exists.
reverse_cost	ANY-NUMERICAL	0	Weight of the edge *(target, source)* if it exists.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
smallint, int, bigint, real, float

Description of the Points SQL query

points_sql:
an SQL query, which should return a set of rows with the following columns:

Column	Type	Description
pid	ANY-INTEGER	(optional) Identifier of the point. • If column present, it can not be NULL. • If column not present, a sequential identifier will be given automatically.
edge_id	ANY-INTEGER	Identifier of the "closest" edge to the point.
fraction	ANY-NUMERICAL	Value in <0,1> that indicates the relative postition from the first end point of the edge.

Column	Type	Description
side	CHAR	(optional) Value in ['b', 'r', 'l', NULL] indicating if the point is: - In the right, left of the edge or - If it doesn't matter with 'b' or NULL. - If column not present 'b' is considered.

Where:

ANY-INTEGER:
smallint, int, bigint
ANY-NUMERICAL:
smallint, int, bigint, real, float

Description of the combinations_sql query for dijkstra like functions

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

Return columns & values

- **Return values for a path**
- **Return values for multiple paths from the same source and destination**
- **Description of the return values for a Cost Matrix - Category** function
- **Description of the Return Values**

There are several kinds of columns returned are depending of the function.

Return values for a path

Returns set of `(seq, path_seq [, start_vid] [, end_vid], node, edge, cost, agg_cost)`

Column	Type	Description
seq	INT	Sequential value starting from **1**.
path_seq	INT	Relative position in the path. Has value**1** for the beginning of a path.
start_vid	BIGINT	Identifier of the starting vertex. Returned when multiple starting vetrices are in the query. - **Many to One** - **Many to Many**
end_vid	BIGINT	Identifier of the ending vertex. Returned when multiple ending vertices are in the query. - **One to Many** - **Many to Many**
node	BIGINT	Identifier of the node in the path from `start_vid` to `end_vid`.
edge	BIGINT	Identifier of the edge used to go from `node` to the next node in the path sequence. `-1` for the last node of the path.
cost	FLOAT	Cost to traverse from `node` using `edge` to the next node in the path sequence.
agg_cost	FLOAT	Aggregate cost from `start_v` to `node`.

Return values for multiple paths from the same source and destination

Returns set of `(seq, path_id, path_seq [, start_vid] [, end_vid], node, edge, cost, agg_cost)`

Column	Type	Description
seq	INT	Sequential value starting from **1**.
path_id	INT	Path identifier. Has value **1** for the first of a path. Used when there are multiple paths for the same `start_vid` to `end_vid` combination.
path_seq	INT	Relative position in the path. Has value**1** for the beginning of a path.

Column	Type	Description
start_vid	BIGINT	Identifier of the starting vertex. Returned when multiple starting vetrices are in the query. • **Many to One** • **Many to Many**
end_vid	BIGINT	Identifier of the ending vertex. Returned when multiple ending vertices are in the query. • **One to Many** • **Many to Many**
node	BIGINT	Identifier of the node in the path from start_vid to end_vid.
edge	BIGINT	Identifier of the edge used to go from node to the next node in the path sequence. -1 for the last node of the path.
cost	FLOAT	Cost to traverse from node using edge to the next node in the path sequence.
agg_cost	FLOAT	Aggregate cost from start_v to node.

Description of the return values for a Cost Matrix - Category function

Returns SET OF (start_vid, end_vid, agg_cost)

Column	Type	Description
start_vid	BIGINT	Identifier of the starting vertex.
end_vid	BIGINT	Identifier of the ending vertex.
agg_cost	FLOAT	Aggregate cost from start_vid to end_vid.

Description of the Return Values

For pgr_pushRelabel, pgr_edmondsKarp, pgr_boykovKolmogorov :

Column	Type	Description
seq	INT	Sequential value starting from **1**.
edge	BIGINT	Identifier of the edge in the original query(edges_sql).
start_vid	BIGINT	Identifier of the first end point vertex of the edge.
end_vid	BIGINT	Identifier of the second end point vertex of the edge.
flow	BIGINT	Flow through the edge in the direction (start_vid, end_vid).
residual_capacity	BIGINT	Residual capacity of the edge in the direction (start_vid, end_vid).

For pgr_maxFlowMinCost - Experimental

Column	Type	Description
seq	INT	Sequential value starting from **1**.
edge	BIGINT	Identifier of the edge in the original query(edges_sql).
source	BIGINT	Identifier of the first end point vertex of the edge.
target	BIGINT	Identifier of the second end point vertex of the edge.
flow	BIGINT	Flow through the edge in the direction (source, target).
residual_capacity	BIGINT	Residual capacity of the edge in the direction (source, target).
cost	FLOAT	The cost of sending this flow through the edge in the direction (source, target).
agg_cost	FLOAT	The aggregate cost.

Advanced Topics

Routing Topology

Overview

Typically when GIS files are loaded into the data database for use with pgRouting they do not have topology information associated with them. To create a useful topology the data needs to be “noded”. This means that where two or more roads form an intersection there it needs to be a node at the intersection and all the road segments need to be broken at the intersection, assuming that you can navigate from any of these segments to any other segment via that intersection.

You can use the **graph analysis functions** to help you see where you might have topology problems in your data. If you need to node your data, we also have a function **pgr_nodeNetwork()** that might work for you. This function splits ALL crossing segments and nodes them. There are some cases where this might NOT be the right thing to do.

For example, when you have an overpass and underpass intersection, you do not want these noded, but pgr_nodeNetwork does not know that is the case and will node them which is not good because then the router will be able to turn off the overpass onto the underpass like it was a flat 2D intersection. To deal with this problem some data sets use z-levels at these types of intersections and other data might not node these intersection which would be ok.

For those cases where topology needs to be added the following functions may be useful. One way to prep the data for pgRouting is to add the following columns to your table and then populate them as appropriate. This example makes a lot of assumption like that you original data tables already has certain columns in it like `one_way`, `fcc`, and possibly others and that they contain specific data values. This is only to give you an idea of what you can do with your data.

```
ALTER TABLE edge_table
    ADD COLUMN source integer,
    ADD COLUMN target integer,
    ADD COLUMN cost_len double precision,
    ADD COLUMN cost_time double precision,
    ADD COLUMN rcost_len double precision,
    ADD COLUMN rcost_time double precision,
    ADD COLUMN x1 double precision,
    ADD COLUMN y1 double precision,
    ADD COLUMN x2 double precision,
    ADD COLUMN y2 double precision,
    ADD COLUMN to_cost double precision,
    ADD COLUMN rule text,
    ADD COLUMN isolated integer;

SELECT pgr_createTopology('edge_table', 0.000001, 'the_geom', 'id');
```

The function **pgr_createTopology** will create the `vertices_tmp` table and populate the `source` and `target` columns. The following example populated the remaining columns. In this example, the `fcc` column contains feature class code and the `CASE` statements converts it to an average speed.

```
UPDATE edge_table SET x1 = st_x(st_startpoint(the_geom)),
                      y1 = st_y(st_startpoint(the_geom)),
                      x2 = st_x(st_endpoint(the_geom)),
                      y2 = st_y(st_endpoint(the_geom)),
  cost_len  = st_length_spheroid(the_geom, 'SPHEROID["WGS84",6378137,298.25728]'),
  rcost_len = st_length_spheroid(the_geom, 'SPHEROID["WGS84",6378137,298.25728]'),
  len_km = st_length_spheroid(the_geom, 'SPHEROID["WGS84",6378137,298.25728]')/1000.0,
  len_miles = st_length_spheroid(the_geom, 'SPHEROID["WGS84",6378137,298.25728]')
              / 1000.0 * 0.6213712,
  speed_mph = CASE WHEN fcc='A10' THEN 65
                   WHEN fcc='A15' THEN 65
                   WHEN fcc='A20' THEN 55
                   WHEN fcc='A25' THEN 55
                   WHEN fcc='A30' THEN 45
                   WHEN fcc='A35' THEN 45
                   WHEN fcc='A40' THEN 35
                   WHEN fcc='A45' THEN 35
                   WHEN fcc='A50' THEN 25
                   WHEN fcc='A60' THEN 25
                   WHEN fcc='A61' THEN 25
                   WHEN fcc='A62' THEN 25
                   WHEN fcc='A64' THEN 25
                   WHEN fcc='A70' THEN 15
                   WHEN fcc='A69' THEN 10
                   ELSE null END,
  speed_kmh = CASE WHEN fcc='A10' THEN 104
                   WHEN fcc='A15' THEN 104
                   WHEN fcc='A20' THEN 88
                   WHEN fcc='A25' THEN 88
                   WHEN fcc='A30' THEN 72
                   WHEN fcc='A35' THEN 72
                   WHEN fcc='A40' THEN 56
                   WHEN fcc='A45' THEN 56
                   WHEN fcc='A50' THEN 40
                   WHEN fcc='A60' THEN 50
                   WHEN fcc='A61' THEN 40
                   WHEN fcc='A62' THEN 40
                   WHEN fcc='A64' THEN 40
                   WHEN fcc='A70' THEN 25
                   WHEN fcc='A69' THEN 15
                   ELSE null END;

-- UPDATE the cost information based on oneway streets

UPDATE edge_table SET
    cost_time = CASE
        WHEN one_way='TF' THEN 10000.0
        ELSE cost_len/1000.0/speed_kmh::numeric*3600.0
        END,
    rcost_time = CASE
        WHEN one_way='FT' THEN 10000.0
        ELSE cost_len/1000.0/speed_kmh::numeric*3600.0
        END;

-- clean up the database because we have updated a lot of records

VACUUM ANALYZE VERBOSE edge_table;
```

Now your database should be ready to use any (most?) of the pgRouting algorithms.

Graph Analytics

Overview

It is common to find problems with graphs that have not been constructed fully noded or in graphs with z-levels at intersection that have been entered incorrectly. An other problem is one way streets that have been entered in the wrong direction. We can not detect errors with respect to “ground” truth, but we can look for inconsistencies and some anomalies in a graph and report them for additional inspections.

We do not current have any visualization tools for these problems, but I have used mapserver to render the graph and highlight potential problem areas. Someone familiar with graphviz might contribute tools for generating images with that.

Analyze a Graph

With **pgr_analyzeGraph** the graph can be checked for errors. For example for table “mytab” that has “mytab_vertices_pgr” as the vertices table:

```
SELECT pgr_analyzeGraph('mytab', 0.000002);
NOTICE:  Performing checks, pelase wait...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 158
NOTICE:                            Dead ends: 20028
NOTICE:  Potential gaps found near dead ends: 527
NOTICE:               Intersections detected: 2560
NOTICE:                      Ring geometries: 0
pgr_analyzeGraph
----------
   OK
(1 row)
```

In the vertices table "mytab_vertices_pgr":

- Deadends are identified by `cnt=1`
- Potencial gap problems are identified with `chk=1`.

```
SELECT count(*) as deadends  FROM mytab_vertices_pgr WHERE cnt = 1;
deadends
----------
    20028
 (1 row)

SELECT count(*) as gaps  FROM mytab_vertices_pgr WHERE chk = 1;
 gaps
 -----
   527
 (1 row)
```

For isolated road segments, for example, a segment where both ends are deadends. you can find these with the following query:

```
SELECT *
    FROM mytab a, mytab_vertices_pgr b, mytab_vertices_pgr c
    WHERE a.source=b.id AND b.cnt=1 AND a.target=c.id AND c.cnt=1;
```

If you want to visualize these on a graphic image, then you can use something like mapserver to render the edges and the vertices and style based on `cnt` or if they are isolated, etc. You can also do this with a tool like graphviz, or geoserver or other similar tools.

Analyze One Way Streets

pgr_analyzeOneWay analyzes one way streets in a graph and identifies any flipped segments. Basically if you count the edges coming into a node and the edges exiting a node the number has to be greater than one.

This query will add two columns to the vertices_tmp table `ein int` and `eout int` and populate it with the appropriate counts. After running this on a graph you can identify nodes with potential problems with the following query.

The rules are defined as an array of text strings that if match the `col` value would be counted as true for the source or target in or out condition.

Example

Lets assume we have a table "st" of edges and a column "one_way" that might have values like:

- 'FT' - oneway from the source to the target node.
- 'TF' - oneway from the target to the source node.
- 'B' - two way street.
- '' - empty field, assume twoway.
- <NULL> - NULL field, use two_way_if_null flag.

Then we could form the following query to analyze the oneway streets for errors.

```
SELECT pgr_analyzeOneway('mytab',
          ARRAY['', 'B', 'TF'],
          ARRAY['', 'B', 'FT'],
          ARRAY['', 'B', 'FT'],
          ARRAY['', 'B', 'TF'],
          );

-- now we can see the problem nodes
SELECT * FROM mytab_vertices_pgr WHERE ein=0 OR eout=0;

-- and the problem edges connected to those nodes
SELECT gid FROM mytab a, mytab_vertices_pgr b WHERE a.source=b.id AND ein=0 OR eout=0
UNION
SELECT gid FROM mytab a, mytab_vertices_pgr b WHERE a.target=b.id AND ein=0 OR eout=0;
```

Typically these problems are generated by a break in the network, the one way direction set wrong, maybe an error related to z-levels or a network that is not properly noded.

The above tools do not detect all network issues, but they will identify some common problems. There are other problems that are hard to detect because they are more global in nature like multiple disconnected networks. Think of an island with a road network that is not connected to the mainland network because the bridge or ferry routes are missing.

Performance Tips

- **For the Routing functions**
- **For the topology functions:**

For the Routing functions

To get faster results bound your queries to the area of interest of routing to have, for example, no more than one million rows.

Use an inner query SQL that does not include some edges in the routing function

```
SELECT id, source, target from edge_table WHERE
      id < 17 and
      the_geom  && (select st_buffer(the_geom,1) as myarea FROM  edge_table where id = 5)
```

Integrating the inner query to the pgRouting function:

```
SELECT * FROM pgr_dijkstra(
      'SELECT id, source, target from edge_table WHERE
         id < 17 and
         the_geom  && (select st_buffer(the_geom,1) as myarea FROM  edge_table where id = 5)',
   1, 2)
```

For the topology functions:

When “you know” that you are going to remove a set of edges from the edges table, and without those edges you are going to use a routing function you can do the following:

Analize the new topology based on the actual topology:

```
pgr_analyzegraph('edge_table',rows_where:='id < 17');
```

Or create a new topology if the change is permanent:

```
pgr_createTopology('edge_table',rows_where:='id < 17');
pgr_analyzegraph('edge_table',rows_where:='id < 17');
```

How to contribute

Wiki

- Edit an existing **pgRouting Wiki** page.
- Or create a new Wiki page
  - Create a page on the **pgRouting Wiki**
  - Give the title an appropriate name
- **Example**

Adding Functionaity to pgRouting

Consult the **developer’s documentation**

Indices and tables

- **Index**
- **Search Page**

Reference

- **pgr_version** - Get pgRouting's version information.
- **pgr_full_version** - Get pgRouting's details of version.

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2 2.1 2.0**

pgr_version

`pgr_version` — Query for pgRouting version information.

Availability

- Version 3.0.0
  - Breaking change on result columns
  - Support for old signature ends
- Version 2.0.0
  - **Official** function

Description

Returns pgRouting version information.

Signature

```
TEXT pgr_version();
```

Example:
pgRouting Version for this documentatoin

```
SELECT pgr_version();
 pgr_version
-------------
 3.2.2
(1 row)
```

Result Columns

Type	Description
`TEXT`	pgRouting version

See Also

- **pgr_full_version**

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.1 3.0**

pgr_full_version

`pgr_full_version` — Get the details of pgRouting version information.

Availability

- Version 3.0.0
  - New **official** function

Description

Get the details of pgRouting version information

Signatures

```
pgr_full_version()
RETURNS RECORD OF (version, build_type, compile_date, library, system, PostgreSQL, compiler, boost, hash)
```

Example:
Information when this documentation was build

```
SELECT version, library FROM pgr_full_version();
 version |     library
---------+-----------------
 3.2.2   | pgrouting-3.2.2
(1 row)
```

Result Columns

Column	Type	Description
version	TEXT	pgRouting version
build_type	TEXT	The Build type
compile_date	TEXT	Compilation date
library	TEXT	Library name and version
system	TEXT	Operative system
postgreSQL	TEXT	pgsql used
compiler	TEXT	Compiler and version
boost	TEXT	Boost version
hash	TEXT	Git hash of pgRouting build

See Also

- **pgr_version**

Indices and tables

- **Index**
- **Search Page**

Function Families

- **Supported versions: Latest** (**3.2**) **3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2 2.1 2.0**

Function Families

All Pairs - Family of Functions

- **pgr_floydWarshall** - Floyd-Warshall’s algorithm.
- **pgr_johnson** - Johnson’s algorithm

aStar - Family of functions

- **pgr_aStar** - A* algorithm for the shortest path.
- **pgr_aStarCost** - Get the aggregate cost of the shortest paths.
- **pgr_aStarCostMatrix** - Get the cost matrix of the shortest paths.

Bidirectional A* - Family of functions

- **pgr_bdAstar** - Bidirectional A* algorithm for obtaining paths.
- **pgr_bdAstarCost** - Bidirectional A* algorithm to calculate the cost of the paths.
- **pgr_bdAstarCostMatrix** - Bidirectional A* algorithm to calculate a cost matrix of paths.

Bidirectional Dijkstra - Family of functions

- **pgr_bdDijkstra** - Bidirectional Dijkstra algorithm for the shortest paths.
- **pgr_bdDijkstraCost** - Bidirectional Dijkstra to calculate the cost of the shortest paths
- **pgr_bdDijkstraCostMatrix** - Bidirectional Dijkstra algorithm to create a matrix of costs of the shortest paths.

Components - Family of functions

- **pgr_connectedComponents** - Connected components of an undirected graph.
- **pgr_strongComponents** - Strongly connected components of a directed graph.
- **pgr_biconnectedComponents** - Biconnected components of an undirected graph.
- **pgr_articulationPoints** - Articulation points of an undirected graph.
- **pgr_bridges** - Bridges of an undirected graph.

Contraction - Family of functions

- **pgr_contraction**

Dijkstra - Family of functions

- **pgr_dijkstra** - Dijkstra's algorithm for the shortest paths.
- **pgr_dijkstraCost** - Get the aggregate cost of the shortest paths.
- **pgr_dijkstraCostMatrix** - Use pgr_dijkstra to create a costs matrix.
- **pgr_drivingDistance** - Use pgr_dijkstra to calculate catchament information.
- **pgr_KSP** - Use Yen algorithm with pgr_dijkstra to get the K shortest paths.

Flow - Family of functions

- **pgr_maxFlow** - Only the Max flow calculation using Push and Relabel algorithm.
- **pgr_boykovKolmogorov** - Boykov and Kolmogorov with details of flow on edges.
- **pgr_edmondsKarp** - Edmonds and Karp algorithm with details of flow on edges.
- **pgr_pushRelabel** - Push and relabel algorithm with details of flow on edges.
- Applications
  - **pgr_edgeDisjointPaths** - Calculates edge disjoint paths between two groups of vertices.
  - **pgr_maxCardinalityMatch** - Calculates a maximum cardinality matching in a graph.

Kruskal - Family of functions

- **pgr_kruskal**
- **pgr_kruskalBFS**
- **pgr_kruskalDD**
- **pgr_kruskalDFS**

Prim - Family of functions

- **pgr_prim**
- **pgr_primBFS**
- **pgr_primDD**
- **pgr_primDFS**

Topology - Family of Functions

- **pgr_createTopology** - to create a topology based on the geometry.
- **pgr_createVerticesTable** - to reconstruct the vertices table based on the source and target information.
- **pgr_analyzeGraph** - to analyze the edges and vertices of the edge table.
- **pgr_analyzeOneWay** - to analyze directionality of the edges.
- **pgr_nodeNetwork** -to create nodes to a not noded edge table.

Traveling Sales Person - Family of functions

- **pgr_TSP** - When input is given as matrix cell information.
- **pgr_TSPeuclidean** - When input are coordinates.

pgr_trsp - Turn Restriction Shortest Path (TRSP) - Turn Restriction Shortest Path (TRSP)

Functions by categories

Cost - Category

- **pgr_aStarCost**
- **pgr_dijkstraCost**

Cost Matrix - Category

- **pgr_aStarCostMatrix**
- **pgr_dijkstraCostMatrix**

Driving Distance - Category

- **pgr_drivingDistance** - Driving Distance based on Dijkstra's algorithm
- **pgr_primDD** - Driving Distance based on Prim's algorithm
- **pgr_kruskalDD** - Driving Distance based on Kruskal's algorithm
- Post pocessing
  - **pgr_alphaShape** - Alpha shape computation

K shortest paths - Category

- **pgr_KSP** - Yen's algorithm based on pgr_dijkstra

Spanning Tree - Category

- **Kruskal - Family of functions**
- **Prim - Family of functions**

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2**

All Pairs - Family of Functions

The following functions work on all vertices pair combinations

- **pgr_floydWarshall** - Floyd-Warshall's algorithm.
- **pgr_johnson** - Johnson's algorithm

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2 2.1 2.0**

pgr_floydWarshall

pgr_floydWarshall - Returns the sum of the costs of the shortest path for each pair of nodes in the graph using Floyd-Warshall algorithm.

Boost Graph Inside

Availability

- Version 2.2.0
  - Signature change
  - Old signature no longer supported
- Version 2.0.0
  - **Official** function

Description

The Floyd-Warshall algorithm, also known as Floyd's algorithm, is a good choice to calculate the sum of the costs of the shortest path for each pair of nodes in the graph, for *dense graphs*. We use Boost's implementation which runs in $\Theta(V^3)$ time,

The main characteristics are:

- It does not return a path.
- Returns the sum of the costs of the shortest path for each pair of nodes in the graph.
- Process is done only on edges with positive costs.
- Boost returns a $V \times V$ matrix, where the infinity values. Represent the distance between vertices for which there is no path.
  - We return only the non infinity values in form of a set of *(start_vid, end_vid, agg_cost)*.
- Let be the case the values returned are stored in a table, so the unique index would be the pair: *(start_vid, end_vid)*.
- For the undirected graph, the results are symmetric.

    - The *agg_cost* of *(u, v)* is the same as for *(v, u)*.
- When *start_vid* = *end_vid*, the *agg_cost* = 0.
- **Recommended, use a bounding box of no more than 3500 edges.**

Signatures

Summary

```
pgr floydWarshall(edges_sql [, directed])
RETURNS SET OF (start_vid, end_vid,  agg_cost)
OR EMPTY SET
```

Using defaults

```
pgr_floydWarshall(edges_sql)
RETURNS SET OF (start_vid, end_vid,  agg_cost)
OR EMPTY SET
```

Example 1:
For vertices \(\{1, 2, 3, 4\}\) on a **directed** graph

```
SELECT * FROM pgr_floydWarshall(
    'SELECT id, source, target, cost FROM edge_table where id < 5'
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         1 |       2 |        1
         1 |       5 |        2
         2 |       5 |        1
(3 rows)
```

Complete Signature

```
pgr_floydWarshall(edges_sql [, directed])
RETURNS SET OF (start_vid, end_vid,  agg_cost)
OR EMPTY SET
```

Example 2:
For vertices \(\{1, 2, 3, 4\}\) on an **undirected** graph

```
SELECT * FROM pgr_floydWarshall(
    'SELECT id, source, target, cost FROM edge_table where id < 5',
    false
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         1 |       2 |        1
         1 |       5 |        2
         2 |       1 |        1
         2 |       5 |        1
         5 |       1 |        2
         5 |       2 |        1
(6 rows)
```

Parameters

Parameter	Type	Description
edges_sql	TEXT	SQL query as described above.
directed	BOOLEAN	(optional) Default is true (is directed). When set to false the graph is considered as Undirected

Inner query

Description of the edges_sql query (id is not necessary)

edges_sql:
an SQL query, which should return a set of rows with the following columns:

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.

Column	Type	Default	Description
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns set of (start_vid, end_vid, agg_cost)

Column	Type	Description
start_vid	BIGINT	Identifier of the starting vertex.
end_vid	BIGINT	Identifier of the ending vertex.
agg_cost	FLOAT	Total cost from start_vid to end_vid.

See Also

- **pgr_johnson**
- **Boost floyd-Warshall** algorithm
- Queries uses the **Sample Data** network.

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest** (**3.2**) **3.1 3.0 2.6**
- **Unsupported versions: 2.5 2.4 2.3 2.2 2.1 2.0**

pgr_johnson

pgr_johnson - Returns the sum of the costs of the shortest path for each pair of nodes in the graph using Floyd-Warshall algorithm.

Boost Graph Inside

Availability

- Version 2.2.0
  - Signature change
  - Old signature no longer supported
- Version 2.0.0
  - **Official** function

Description

The Johnson algorithm, is a good choice to calculate the sum of the costs of the shortest path for each pair of nodes in the graph, for *sparse graphs*. It usees the Boost's implementation which runs in $O(V E \log V)$ time,

The main characteristics are:

- It does not return a path.

- Returns the sum of the costs of the shortest path for each pair of nodes in the graph.
- Process is done only on edges with positive costs.
- Boost returns a \(V \times V\) matrix, where the infinity values. Represent the distance between vertices for which there is no path.
  - We return only the non infinity values in form of a set of *(start_vid, end_vid, agg_cost)*.
- Let be the case the values returned are stored in a table, so the unique index would be the pair: *(start_vid, end_vid)*.
- For the undirected graph, the results are symmetric.
  - The *agg_cost* of *(u, v)* is the same as for *(v, u)*.
- When *start_vid* = *end_vid*, the *agg_cost* = 0.

Signatures

Summary

```
pgr_johnson(edges_sql)
pgr johnson(edges_sql [, directed])
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Using default

```
pgr_johnson(edges_sql)
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example 1:

For vertices \(\{1, 2, 3, 4\}\) on a **directed** graph

```
SELECT * FROM pgr_johnson(
    'SELECT source, target, cost FROM edge_table WHERE id < 5
        ORDER BY id'
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         1 |       2 |        1
         1 |       5 |        2
         2 |       5 |        1
(3 rows)
```

Complete Signature

```
pgr_johnson(edges_sql[, directed])
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example 2:

For vertices \(\{1, 2, 3, 4\}\) on an **undirected** graph

```
SELECT * FROM pgr_johnson(
    'SELECT source, target, cost FROM edge_table WHERE id < 5
        ORDER BY id',
    false
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         1 |       2 |        1
         1 |       5 |        2
         2 |       1 |        1
         2 |       5 |        1
         5 |       1 |        2
         5 |       2 |        1
(6 rows)
```

Parameters

Parameter	Type	Description
edges_sql	TEXT	SQL query as described above.
directed	BOOLEAN	(optional) Default is true (is directed). When set to false the graph is considered as Undirected

Inner query

Description of the edges_sql query (id is not necessary)

edges_sql:
an SQL query, which should return a set of rows with the following columns:

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns set of `(start_vid, end_vid, agg_cost)`

Column	Type	Description
start_vid	BIGINT	Identifier of the starting vertex.
end_vid	BIGINT	Identifier of the ending vertex.
agg_cost	FLOAT	Total cost from `start_vid` to `end_vid`.

See Also

- **pgr_floydWarshall**
- **Boost Johnson** algorithm implementation.
- Queries uses the **Sample Data** network.

Indices and tables

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Performance

The following tests:
- non server computer
- with AMD 64 CPU
- 4G memory
- trusty
- posgreSQL version 9.3

Data

The following data was used

```
BBOX="-122.8,45.4,-122.5,45.6"
wget --progress=dot:mega -O "sampledata.osm" "https://www.overpass-api.de/api/xapi?*[bbox=][@meta]"
```

Data processing was done with osm2pgrouting-alpha

```
createdb portland
psql -c "create extension postgis" portland
psql -c "create extension pgrouting" portland
osm2pgrouting -f sampledata.osm -d portland -s 0
```

Results

Test:
One

This test is not with a bounding box The density of the passed graph is extremely low. For each <SIZE> 30 tests were executed to get the average The tested query is:

```
SELECT count(*) FROM pgr_floydWarshall(
   'SELECT gid as id, source, target, cost, reverse_cost FROM ways where id <=  <SIZE>');

SELECT count(*) FROM pgr_johnson(
   'SELECT gid as id, source, target, cost, reverse_cost FROM ways where id <=  <SIZE>');
```

The results of this tests are presented as:

SIZE:
is the number of edges given as input.
EDGES:
is the total number of records in the query.
DENSITY:
is the density of the data\(\dfrac{E}{V \times (V-1)}\).
OUT ROWS:
is the number of records returned by the queries.
Floyd-Warshall:
is the average execution time in seconds of pgr_floydWarshall.
Johnson:
is the average execution time in seconds of pgr_johnson.

SIZE	EDGES	DENSITY	OUT ROWS	Floyd-Warshall	Johnson
500	500	0.18E-7	1346	0.14	0.13
1000	1000	0.36E-7	2655	0.23	0.18
1500	1500	0.55E-7	4110	0.37	0.34
2000	2000	0.73E-7	5676	0.56	0.37
2500	2500	0.89E-7	7177	0.84	0.51
3000	3000	1.07E-7	8778	1.28	0.68
3500	3500	1.24E-7	10526	2.08	0.95
4000	4000	1.41E-7	12484	3.16	1.24
4500	4500	1.58E-7	14354	4.49	1.47
5000	5000	1.76E-7	16503	6.05	1.78
5500	5500	1.93E-7	18623	7.53	2.03
6000	6000	2.11E-7	20710	8.47	2.37
6500	6500	2.28E-7	22752	9.99	2.68
7000	7000	2.46E-7	24687	11.82	3.12
7500	7500	2.64E-7	26861	13.94	3.60
8000	8000	2.83E-7	29050	15.61	4.09
8500	8500	3.01E-7	31693	17.43	4.63
9000	9000	3.17E-7	33879	19.19	5.34
9500	9500	3.35E-7	36287	20.77	6.24
10000	10000	3.52E-7	38491	23.26	6.51

Test:
Two

This test is with a bounding box The density of the passed graph higher than of the Test One. For each <SIZE> 30 tests were executed to get the average The tested edge query is:

```
WITH
    buffer AS (SELECT ST_Buffer(ST_Centroid(ST_Extent(the_geom)), SIZE) AS geom FROM ways),
    bbox AS (SELECT ST_Envelope(ST_Extent(geom)) as box from buffer)
SELECT gid as id, source, target, cost, reverse_cost FROM ways where the_geom && (SELECT box from bbox);
```

The tested queries

```
SELECT count(*) FROM pgr_floydWarshall(<edge query>)
SELECT count(*) FROM pgr_johnson(<edge query>)
```

The results of this tests are presented as:

SIZE:
is the size of the bounding box.
EDGES:
is the total number of records in the query.

DENSITY:
is the density of the data $\dfrac{E}{V \times (V-1)}$.
OUT ROWS:
is the number of records returned by the queries.
Floyd-Warshall:
is the average execution time in seconds of pgr_floydWarshall.
Johnson:
is the average execution time in seconds of pgr_johnson.

SIZE	EDGES	DENSITY	OUT ROWS	Floyd-Warshall	Johnson
0.001	44	0.0608	1197	0.10	0.10
0.002	99	0.0251	4330	0.10	0.10
0.003	223	0.0122	18849	0.12	0.12
0.004	358	0.0085	71834	0.16	0.16
0.005	470	0.0070	116290	0.22	0.19
0.006	639	0.0055	207030	0.37	0.27
0.007	843	0.0043	346930	0.64	0.38
0.008	996	0.0037	469936	0.90	0.49
0.009	1146	0.0032	613135	1.26	0.62
0.010	1360	0.0027	849304	1.87	0.82
0.011	1573	0.0024	1147101	2.65	1.04
0.012	1789	0.0021	1483629	3.72	1.35
0.013	1975	0.0019	1846897	4.86	1.68
0.014	2281	0.0017	2438298	7.08	2.28
0.015	2588	0.0015	3156007	10.28	2.80
0.016	2958	0.0013	4090618	14.67	3.76
0.017	3247	0.0012	4868919	18.12	4.48

See Also

- **pgr_johnson**
- **pgr_floydWarshall**
- **Boost floyd-Warshall** algorithm

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4**

aStar - Family of functions

The A* (pronounced “A Star”) algorithm is based on Dijkstra’s algorithm with a heuristic that allow it to solve most shortest path problems by evaluation only a sub-set of the overall graph.

- **pgr_aStar** - A* algorithm for the shortest path.
- **pgr_aStarCost** - Get the aggregate cost of the shortest paths.
- **pgr_aStarCostMatrix** - Get the cost matrix of the shortest paths.

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2 2.1 2.0**

pgr_aStar

`pgr_aStar` — Shortest path using A* algorithm.

Boost Graph Inside

Availability

- Version 3.2.0
  - New **proposed** function:
    - pgr_aStar(Combinations)
- Version 3.0.0
  - **Official** function
- Version 2.4.0
  - New **Proposed** functions:
    - pgr_aStar(One to Many)
    - pgr_aStar(Many to One)
    - pgr_aStar(Many to Many)
- Version 2.3.0
  - Signature change on pgr_astar(One to One)
    - Old signature no longer supported
- Version 2.0.0
  - **Official** pgr_aStar(One to One)

Description

The main characteristics are:

- Default kind of graph is **directed** when
  - `directed` flag is missing.
  - `directed` flag is set to true
- Unless specified otherwise, ordering is:
  - first by `start_vid` (if exists)
  - then by `end_vid`
- Values are returned when there is a path
- Let \(v\) and \(u\) be nodes on the graph:
  - If there is no path from \(v\) to \(u\):
    - no corresponding row is returned
    - `agg_cost` from \(v\) to \(u\) is \(\infty\)
  - There is no path when \(v = u\) therefore
    - no corresponding row is returned
    - `agg_cost` from *v* to *u* is \(0\)
- Edges with negative costs are not included in the graph.
- When (x,y) coordinates for the same vertex identifier differ:
  - A random selection of the vertex's (x,y) coordinates is used.
- Running time: \(O((E + V) * \log V)\)

- The results are equivalent to the union of the results of the *pgr_aStar(* **One to One** *)* on the:
  - *pgr_aStar(* **One to Many** *)*
  - *pgr_aStar(* **Many to One** *)*
  - *pgr_aStar(* **Many to Many** *)*
- `start_vid` and `end_vid` in the result is used to distinguish to which path it belongs.

Signatures

Summary

```
pgr_aStar(Edges SQL, from_vid,  to_vid  [, directed] [, heuristic] [, factor] [, epsilon])
pgr_aStar(Edges SQL, from_vid,  to_vids [, directed] [, heuristic] [, factor] [, epsilon])
pgr_aStar(Edges SQL, from_vids, to_vid  [, directed] [, heuristic] [, factor] [, epsilon])
pgr_aStar(Edges SQL, from_vids, to_vids [, directed] [, heuristic] [, factor] [, epsilon])
pgr_aStar(Edges SQL, Combinations SQL  [, directed] [, heuristic] [, factor] [, epsilon]) -- Proposed on v3.2

RETURNS SET OF (seq, path_seq [, start_vid] [, end_vid], node, edge, cost, agg_cost)
OR EMPTY SET
```

Optional parameters are *named parameters* and have a default value.

Using defaults

```
pgr_aStar(Edges SQL, from_vid, to_vid)
RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertex \(2\) to vertex \(12\) on a **directed** graph

```
SELECT * FROM pgr_astar(
    'SELECT id, source, target, cost, reverse_cost, x1, y1, x2, y2 FROM edge_table',
    2, 12);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    4 |    1 |        0
   2 |        2 |    5 |    8 |    1 |        1
   3 |        3 |    6 |   11 |    1 |        2
   4 |        4 |   11 |   13 |    1 |        3
   5 |        5 |   12 |   -1 |    0 |        4
(5 rows)
```

One to One

```
pgr_aStar(Edges SQL, from_vid,  to_vid  [, directed] [, heuristic] [, factor] [, epsilon])

RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertex \(2\) to vertex \(12\) on an **undirected** graph using heuristic \(2\)

```
SELECT * FROM pgr_astar(
    'SELECT id, source, target, cost, reverse_cost, x1, y1, x2, y2 FROM edge_table',
    2, 12,
    directed := false, heuristic := 2);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    2 |    1 |        0
   2 |        2 |    3 |    3 |    1 |        1
   3 |        3 |    4 |   16 |    1 |        2
   4 |        4 |    9 |   15 |    1 |        3
   5 |        5 |   12 |   -1 |    0 |        4
(5 rows)
```

One to many

```
pgr_aStar(Edges SQL, from_vid,  to_vids [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (seq, path_seq, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertex \(2\) to vertices \(\{3, 12\}\) on a **directed** graph using heuristic \(2\)

```
SELECT * FROM pgr_astar(
    'SELECT id, source, target, cost, reverse_cost, x1, y1, x2, y2 FROM edge_table',
    2, ARRAY[3, 12], heuristic := 2);
 seq | path_seq | end_vid | node | edge | cost | agg_cost
-----+----------+---------+------+------+------+----------
   1 |        1 |       3 |    2 |    4 |    1 |        0
   2 |        2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |       3 |    6 |    9 |    1 |        2
   4 |        4 |       3 |    9 |   16 |    1 |        3
   5 |        5 |       3 |    4 |    3 |    1 |        4
   6 |        6 |       3 |    3 |   -1 |    0 |        5
   7 |        1 |      12 |    2 |    4 |    1 |        0
   8 |        2 |      12 |    5 |   10 |    1 |        1
   9 |        3 |      12 |   10 |   12 |    1 |        2
  10 |        4 |      12 |   11 |   13 |    1 |        3
  11 |        5 |      12 |   12 |   -1 |    0 |        4
(11 rows)
```

Many to One

```
pgr_aStar(Edges SQL, from_vids, to_vid  [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (seq, path_seq, start_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertices \(\{7, 2\}\) to vertex \(12\) on a **directed** graph using heuristic \(0\)

```
SELECT * FROM pgr_astar(
    'SELECT id, source, target, cost, reverse_cost, x1, y1, x2, y2 FROM edge_table',
    ARRAY[7, 2], 12, heuristic := 0);
 seq | path_seq | start_vid | node | edge | cost | agg_cost
-----+----------+-----------+------+------+------+----------
   1 |        1 |         2 |    2 |    4 |    1 |        0
   2 |        2 |         2 |    5 |   10 |    1 |        1
   3 |        3 |         2 |   10 |   12 |    1 |        2
   4 |        4 |         2 |   11 |   13 |    1 |        3
   5 |        5 |         2 |   12 |   -1 |    0 |        4
   6 |        1 |         7 |    7 |    6 |    1 |        0
   7 |        2 |         7 |    8 |    7 |    1 |        1
   8 |        3 |         7 |    5 |   10 |    1 |        2
   9 |        4 |         7 |   10 |   12 |    1 |        3
  10 |        5 |         7 |   11 |   13 |    1 |        4
  11 |        6 |         7 |   12 |   -1 |    0 |        5
(11 rows)
```

Many to Many

```
pgr_aStar(Edges SQL, from_vids, to_vids [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertices \(\{7, 2\}\) to vertices \(\{3, 12\}\) on a **directed** graph using heuristic \(2\)

```
SELECT * FROM pgr_astar(
    'SELECT id, source, target, cost, reverse_cost, x1, y1, x2, y2 FROM edge_table',
    ARRAY[7, 2], ARRAY[3, 12], heuristic := 2);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    4 |    1 |        0
   2 |        2 |         2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |         2 |       3 |    6 |    9 |    1 |        2
   4 |        4 |         2 |       3 |    9 |   16 |    1 |        3
   5 |        5 |         2 |       3 |    4 |    3 |    1 |        4
   6 |        6 |         2 |       3 |    3 |   -1 |    0 |        5
   7 |        1 |         2 |      12 |    2 |    4 |    1 |        0
   8 |        2 |         2 |      12 |    5 |   10 |    1 |        1
   9 |        3 |         2 |      12 |   10 |   12 |    1 |        2
  10 |        4 |         2 |      12 |   11 |   13 |    1 |        3
  11 |        5 |         2 |      12 |   12 |   -1 |    0 |        4
  12 |        1 |         7 |       3 |    7 |    6 |    1 |        0
  13 |        2 |         7 |       3 |    8 |    7 |    1 |        1
  14 |        3 |         7 |       3 |    5 |    8 |    1 |        2
  15 |        4 |         7 |       3 |    6 |    9 |    1 |        3
  16 |        5 |         7 |       3 |    9 |   16 |    1 |        4
  17 |        6 |         7 |       3 |    4 |    3 |    1 |        5
  18 |        7 |         7 |       3 |    3 |   -1 |    0 |        6
  19 |        1 |         7 |      12 |    7 |    6 |    1 |        0
  20 |        2 |         7 |      12 |    8 |    7 |    1 |        1
  21 |        3 |         7 |      12 |    5 |   10 |    1 |        2
  22 |        4 |         7 |      12 |   10 |   12 |    1 |        3
  23 |        5 |         7 |      12 |   11 |   13 |    1 |        4
  24 |        6 |         7 |      12 |   12 |   -1 |    0 |        5
(24 rows)
```

Combinations

```
pgr_aStar(Edges SQL, Combinations SQL  [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

Using a combinations table on a **directed** graph using heuristic \(2\).

```
SELECT * FROM pgr_astar(
    'SELECT id, source, target, cost, reverse_cost, x1, y1, x2, y2 FROM edge_table',
    'SELECT * FROM ( VALUES (7, 3), (2, 12) ) AS t(source, target)',
    heuristic := 2);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |      12 |    2 |    4 |    1 |        0
   2 |        2 |         2 |      12 |    5 |   10 |    1 |        1
   3 |        3 |         2 |      12 |   10 |   12 |    1 |        2
   4 |        4 |         2 |      12 |   11 |   13 |    1 |        3
   5 |        5 |         2 |      12 |   12 |   -1 |    0 |        4
   6 |        1 |         7 |       3 |    7 |    6 |    1 |        0
   7 |        2 |         7 |       3 |    8 |    7 |    1 |        1
   8 |        3 |         7 |       3 |    5 |    8 |    1 |        2
   9 |        4 |         7 |       3 |    6 |    9 |    1 |        3
  10 |        5 |         7 |       3 |    9 |   16 |    1 |        4
  11 |        6 |         7 |       3 |    4 |    3 |    1 |        5
  12 |        7 |         7 |       3 |    3 |   -1 |    0 |        6
(12 rows)
```

Parameters

Parameter	Type	Description
Edges SQL	TEXT	*Edges query* as described below.
Combinations SQL	TEXT	*Combinations query* as described below.
from_vid	ANY-INTEGER	Starting vertex identifier. Parameter in: • **One to One** • **One to Many**
from_vids	ARRAY[ANY-INTEGER]	Array of starting vertices identifiers. Parameter in: • **Many to One** • **Many to Many**
to_vid	ANY-INTEGER	Ending vertex identifier. Parameter in: • **One to One** • **Many to One**
to_vids	ARRAY[ANY-INTEGER]	Array of ending vertices identifiers. Parameter in: • **One to Many** • **Many to Many**

Optional Parameters

Parameter	Type	Default	Description
directed	BOOLEAN	true	• When true the graph is considered as Directed. • When false the graph is considered as Undirected.
heuristic	INTEGER	5	Heuristic number. Current valid values 0~5. Default5 • 0: h(v) = 0 (Use this value to compare with pgr_dijkstra) • 1: h(v) abs(max(dx, dy)) • 2: h(v) abs(min(dx, dy)) • 3: h(v) = dx * dx + dy * dy • 4: h(v) = sqrt(dx * dx + dy * dy) • 5: h(v) = abs(dx) + abs(dy)
factor	FLOAT	1	For units manipulation.\(factor > 0\). See **Factor**
epsilon	FLOAT	1	For less restricted results.\(epsilon >= 1\).

Inner queries

Edges query

edges_sql:
an SQL query, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Column	Type	Default	Description
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.
x1	ANY-NUMERICAL		X coordinate of *source* vertex.
y1	ANY-NUMERICAL		Y coordinate of *source* vertex.
x2	ANY-NUMERICAL		X coordinate of *target* vertex.
y2	ANY-NUMERICAL		Y coordinate of *target* vertex.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Combinations query

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

Result Columns

Returns set of (seq, path_seq [, start_vid] [, end_vid], node, edge, cost, agg_cost)

Column	Type	Description
seq	INT	Sequential value starting from **1**.
path_seq	INT	Relative position in the path. Has value **1** for the beginning of a path.
start_vid	BIGINT	Identifier of the starting vertex. Returned when multiple starting vetrices are in the query. • **Many to One** • **Many to Many**
end_vid	BIGINT	Identifier of the ending vertex. Returned when multiple ending vertices are in the query. • **One to Many** • **Many to Many**
node	BIGINT	Identifier of the node in the path from start_vid to end_vid.
edge	BIGINT	Identifier of the edge used to go from node to the next node in the path sequence. -1 for the last node of the path.
cost	FLOAT	Cost to traverse from node using edge to the next node in the path sequence.
agg_cost	FLOAT	Aggregate cost from start_v to node.

See Also

- **aStar - Family of functions**
- **Sample Data**
- **https://www.boost.org/libs/graph/doc/astar_search.html**
- **https://en.wikipedia.org/wiki/A*_search_algorithm**

Indices and tables

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- **Search Page**

- **Supported versions: Latest (3.2) 3.1 3.0**

- **Unsupported versions: 2.6 2.5 2.4**

pgr_aStarCost

pgr_aStarCost — Returns the aggregate cost shortest path using **pgr_aStar** algorithm.

Boost Graph Inside

Availability

- Version 3.2.0
  - New **proposed** function:
    - pgr_aStarCost(Combinations)
- Version 3.0.0
  - **Official** function
- Version 2.4.0
  - New **proposed** function

Description

The main characteristics are:

- Default kind of graph is **directed** when
  - directed flag is missing.
  - directed flag is set to true
- Unless specified otherwise, ordering is:
  - first by start_vid (if exists)
  - then by end_vid
- Values are returned when there is a path
- Let \(v\) and \(u\) be nodes on the graph:
  - If there is no path from \(v\) to \(u\):
    - no corresponding row is returned
    - agg_cost from \(v\) to \(u\) is \(\infty\)
  - There is no path when \(v = u\) therefore
    - no corresponding row is returned
    - agg_cost from *v* to *u* is \(0\)
- Edges with negative costs are not included in the graph.
- When (x,y) coordinates for the same vertex identifier differ:
  - A random selection of the vertex's (x,y) coordinates is used.
- Running time: \(O((E + V) * \log V)\)
- The results are equivalent to the union of the results of the *pgr_aStarCost(* **One to One** *)* on the:
  - *pgr_aStarCost(* **One to Many** *)*
  - *pgr_aStarCost(* **Many to One** *)*
  - *pgr_aStarCost(* **Many to Many** *)*

Signatures

Summary

```
pgr_aStarCost(Edges SQL, from_vid,  to_vid   [, directed] [, heuristic] [, factor] [, epsilon])
pgr_aStarCost(Edges SQL, from_vid,  to_vids  [, directed] [, heuristic] [, factor] [, epsilon])
pgr_aStarCost(Edges SQL, from_vids, to_vid   [, directed] [, heuristic] [, factor] [, epsilon])
pgr_aStarCost(Edges SQL, from_vids, to_vids  [, directed] [, heuristic] [, factor] [, epsilon])
pgr_aStarCost(Edges SQL, Combinations SQL  [, directed] [, heuristic] [, factor] [, epsilon]) -- Proposed on v3.2

RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Optional parameters are *named parameters* and have a default value.

Using defaults

```
pgr_aStarCost(Edges SQL, start_vid, end_vid)
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example:

From vertex \(2\) to vertex \(12\) on a **directed** graph

```
SELECT * FROM pgr_aStarCost(
    'SELECT id, source, target, cost, reverse_cost, x1, y1, x2, y2 FROM edge_table',
    2, 12);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |      12 |        4
(1 row)
```

One to One

```
pgr_aStarCost(Edges SQL, from_vid,  to_vid   [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example:

From vertex \(2\) to vertex \(12\) on an **undirected** graph using heuristic \(2\)

```
SELECT * FROM pgr_aStarCost(
    'SELECT id, source, target, cost, reverse_cost, x1, y1, x2, y2 FROM edge_table',
    2, 12,
    directed := false, heuristic := 2);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |      12 |        4
(1 row)
```

One to many

```
pgr_aStarCost(Edges SQL, from_vid,  to_vids  [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example:

From vertex \(2\) to vertices \(\{3, 12\}\) on a **directed** graph using heuristic \(2\)

```
SELECT * FROM pgr_aStarCost(
    'SELECT id, source, target, cost, reverse_cost, x1, y1, x2, y2 FROM edge_table',
    2, ARRAY[3, 12], heuristic := 2);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |       3 |        5
         2 |      12 |        4
(2 rows)
```

Many to One

```
pgr_aStarCost(Edges SQL, from_vids, to_vid   [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example:

From vertices \(\{7, 2\}\) to vertex \(12\) on a **directed** graph using heuristic \(0\)

```
SELECT * FROM pgr_aStarCost(
    'SELECT id, source, target, cost, reverse_cost, x1, y1, x2, y2 FROM edge_table',
    ARRAY[7, 2], 12, heuristic := 0);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |      12 |        4
         7 |      12 |        5
(2 rows)
```

Many to Many

```
pgr_aStarCost(Edges SQL, from_vids, to_vids  [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example:

From vertices \(\{7, 2\}\) to vertices \(\{3, 12\}\) on a **directed** graph using heuristic \(2\)

```
SELECT * FROM pgr_aStarCost(
    'SELECT id, source, target, cost, reverse_cost, x1, y1, x2, y2 FROM edge_table',
    ARRAY[7, 2], ARRAY[3, 12], heuristic := 2);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |       3 |        5
         2 |      12 |        4
         7 |       3 |        6
         7 |      12 |        5
(4 rows)
```

Combinations

```
pgr_aStarCost(Edges SQL, Combinations SQL  [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example:

Using a combinations table on a **directed** graph using heuristic \(2\).

```
SELECT * FROM pgr_aStarCost(
    'SELECT id, source, target, cost, reverse_cost, x1, y1, x2, y2 FROM edge_table',
    'SELECT * FROM ( VALUES (7, 3), (2, 12) ) AS t(source, target)',
    heuristic := 2);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |      12 |        4
         7 |       3 |        6
(2 rows)
```

Parameters

Parameter	Type	Description
Edges SQL	TEXT	*Edges query* as described below.
Combinations SQL	TEXT	*Combinations query* as described below.
from_vid	ANY-INTEGER	Starting vertex identifier. Parameter in: • **One to One** • **One to Many**
from_vids	ARRAY[ANY-INTEGER]	Array of starting vertices identifiers. Parameter in: • **Many to One** • **Many to Many**
to_vid	ANY-INTEGER	Ending vertex identifier. Parameter in: • **One to One** • **Many to One**
to_vids	ARRAY[ANY-INTEGER]	Array of ending vertices identifiers. Parameter in: • **One to Many** • **Many to Many**

Optional Parameters

Parameter	Type	Default	Description
directed	BOOLEAN	true	• When true the graph is considered as Directed. • When false the graph is considered as Undirected.
heuristic	INTEGER	5	Heuristic number. Current valid values 0~5. Default 5 • 0: h(v) = 0 (Use this value to compare with pgr_dijkstra) • 1: h(v) abs(max(dx, dy)) • 2: h(v) abs(min(dx, dy)) • 3: h(v) = dx * dx + dy * dy • 4: h(v) = sqrt(dx * dx + dy * dy) • 5: h(v) = abs(dx) + abs(dy)
factor	FLOAT	1	For units manipulation. \(factor > 0\). See **Factor**
epsilon	FLOAT	1	For less restricted results. \(epsilon >= 1\).

Inner queries

Edges query

edges_sql:
an SQL query, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.
x1	ANY-NUMERICAL		X coordinate of *source* vertex.
y1	ANY-NUMERICAL		Y coordinate of *source* vertex.
x2	ANY-NUMERICAL		X coordinate of *target* vertex.
y2	ANY-NUMERICAL		Y coordinate of *target* vertex.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Combinations query

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

Result Columns

Returns SET OF (start_vid, end_vid, agg_cost)

Column	Type	Description
start_vid	BIGINT	Identifier of the starting vertex.
end_vid	BIGINT	Identifier of the ending vertex.
agg_cost	FLOAT	Aggregate cost from start_vid to end_vid.

See Also

- **aStar - Family of functions**
- **Cost - Category**
- **Cost Matrix - Category**
- Examples use **Sample Data** network.

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- **Search Page**

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4**

pgr_aStarCostMatrix - Calculates the a cost matrix using **pgr_aStar**.

Boost Graph Inside

Availability

- Version 3.0.0
  - **Official** function
- Version 2.4.0
  - New **proposed** function

Description

The main characteristics are:

- Using internaly the **pgr_aStar** algorithm
- Returns a cost matrix.
- No ordering is performed
- let *v* and *u* are nodes on the graph:
  - when there is no path from *v* to *u*:
    - no corresponding row is returned
    - cost from *v* to *u* is \(\inf\)
  - when \(v = u\) then
    - no corresponding row is returned
    - cost from *v* to *u* is \(0\)
- When the graph is **undirected** the cost matrix is symmetric

Signatures

Summary

```
pgr_aStarCostMatrix(edges_sql, vids [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (start_vid, end_vid, agg_cost)
```

Using defaults

```
pgr_aStarCostMatrix(edges_sql, vids)
RETURNS SET OF (start_vid, end_vid, agg_cost)
```

Example:
Cost matrix for vertices \(\{1, 2, 3, 4\}\) on a **directed** graph

```
SELECT * FROM pgr_aStarCostMatrix(
    'SELECT id, source, target, cost, reverse_cost, x1, y1, x2, y2 FROM edge_table',
    (SELECT array_agg(id) FROM edge_table_vertices_pgr WHERE id < 5)
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         1 |       2 |        1
         1 |       3 |        6
         1 |       4 |        5
         2 |       1 |        1
         2 |       3 |        5
         2 |       4 |        4
         3 |       1 |        2
         3 |       2 |        1
         3 |       4 |        3
         4 |       1 |        3
         4 |       2 |        2
         4 |       3 |        1
(12 rows)
```

Complete Signature

```
pgr_aStarCostMatrix(edges_sql, vids, [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (start_vid, end_vid, agg_cost)
```

Example:
Symmetric cost matrix for vertices \(\{1, 2, 3, 4\}\) on an **undirected** graph using heuristic \(2\)

```
SELECT * FROM pgr_aStarCostMatrix(
    'SELECT id, source, target, cost, reverse_cost, x1, y1, x2, y2 FROM edge_table',
    (SELECT array_agg(id) FROM edge_table_vertices_pgr WHERE id < 5),
    directed := false, heuristic := 2
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         1 |       2 |        1
         1 |       3 |        2
         1 |       4 |        3
         2 |       1 |        1
         2 |       3 |        1
         2 |       4 |        2
         3 |       1 |        2
         3 |       2 |        1
         3 |       4 |        1
         4 |       1 |        3
         4 |       2 |        2
         4 |       3 |        1
(12 rows)
```

Parameters

Parameter	Type	Description
edges_sql	TEXT	**edges_sql** inner query.
vids	ARRAY[ANY-INTEGER]	Array of vertices identifiers.

Optional Parameters

Parameter	Type	Default	Description
directed	BOOLEAN	true	• When true the graph is considered as Directed. • When false the graph is considered as Undirected.
heuristic	INTEGER	5	Heuristic number. Current valid values 0~5. Default5 • 0: h(v) = 0 (Use this value to compare with pgr_dijkstra) • 1: h(v) abs(max(dx, dy)) • 2: h(v) abs(min(dx, dy)) • 3: h(v) = dx * dx + dy * dy • 4: h(v) = sqrt(dx * dx + dy * dy) • 5: h(v) = abs(dx) + abs(dy)
factor	FLOAT	1	For units manipulation. \(factor > 0\). See **Factor**
epsilon	FLOAT	1	For less restricted results. \(epsilon >= 1\).

Inner query

edges_sql

edges_sql:
an SQL query, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it’s not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it’s not part of the graph.
x1	ANY-NUMERICAL		X coordinate of *source* vertex.
y1	ANY-NUMERICAL		Y coordinate of *source* vertex.
x2	ANY-NUMERICAL		X coordinate of *target* vertex.
y2	ANY-NUMERICAL		Y coordinate of *target* vertex.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns SET OF (start_vid, end_vid, agg_cost)

Column	Type	Description
start_vid	BIGINT	Identifier of the starting vertex.
end_vid	BIGINT	Identifier of the ending vertex.
agg_cost	FLOAT	Aggregate cost from start_vid to end_vid.

Additional Examples

Example:
Use with **pgr_TSP**

```
SELECT * FROM pgr_TSP(
    $$
    SELECT * FROM pgr_aStarCostMatrix(
        'SELECT id, source, target, cost, reverse_cost, x1, y1, x2, y2 FROM edge_table',
        (SELECT array_agg(id) FROM edge_table_vertices_pgr WHERE id < 5),
        directed:= false, heuristic := 2
    )
    $$,
    randomize := false
);
 seq | node | cost | agg_cost
-----+------+------+----------
   1 |    1 |    1 |        0
   2 |    2 |    1 |        1
   3 |    3 |    1 |        2
   4 |    4 |    3 |        3
   5 |    1 |    0 |        6
(5 rows)
```

See Also

- **aStar - Family of functions**
- **Cost - Category**
- **Cost Matrix - Category**
- **Traveling Sales Person - Family of functions**
- The queries use the **Sample Data** network.

Indices and tables

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General Information

The main Characteristics are:

- Default kind of graph is **directed** when
  - directed flag is missing.
  - directed flag is set to true
- Unless specified otherwise, ordering is:
  - first by start_vid (if exists)
  - then by end_vid
- Values are returned when there is a path
- Let \(v\) and \(u\) be nodes on the graph:
  - If there is no path from \(v\) to \(u\):
    - no corresponding row is returned
    - agg_cost from \(v\) to \(u\) is \(\infty\)
  - There is no path when \(v = u\) therefore
    - no corresponding row is returned
    - agg_cost from *v* to *u* is \(0\)
- Edges with negative costs are not included in the graph.

- When (x,y) coordinates for the same vertex identifier differ:
  - A random selection of the vertex's (x,y) coordinates is used.
- Running time: \(O((E + V) * \log V)\)

Advanced documentation

The A* (pronounced "A Star") algorithm is based on Dijkstra's algorithm with a heuristic, that is an estimation of the remaining cost from the vertex to the goal, that allows to solve most shortest path problems by evaluation only a sub-set of the overall graph. Running time: \(O((E + V) * \log V)\)

Heuristic

Currently the heuristic functions available are:

- 0: \(h(v) = 0\) (Use this value to compare with pgr_dijkstra)
- 1: \(h(v) = abs(max(\Delta x, \Delta y))\)
- 2: \(h(v) = abs(min(\Delta x, \Delta y))\)
- 3: \(h(v) = \Delta x * \Delta x + \Delta y * \Delta y\)
- 4: \(h(v) = sqrt(\Delta x * \Delta x + \Delta y * \Delta y)\)
- 5: \(h(v) = abs(\Delta x) + abs(\Delta y)\)

where \(\Delta x = x_1 - x_0\) and \(\Delta y = y_1 - y_0\)

Factor

Analysis 1

Working with cost/reverse_cost as length in degrees, x/y in lat/lon: Factor = 1 (no need to change units)

Analysis 2

Working with cost/reverse_cost as length in meters, x/y in lat/lon: Factor = would depend on the location of the points:

Latitude	Conversion	Factor
45	1 longitude degree is 78846.81 m	78846
0	1 longitude degree is 111319.46 m	111319

Analysis 3

Working with cost/reverse_cost as time in seconds, x/y in lat/lon: Factor: would depend on the location of the points and on the average speed say 25m/s is the speed.

Latitude	Conversion	Factor
45	1 longitude degree is (78846.81m)/(25m/s)	3153 s
0	1 longitude degree is (111319.46 m)/(25m/s)	4452 s

See Also

- **pgr_aStar**
- **pgr_aStarCost**
- **pgr_aStarCostMatrix**
- **https://www.boost.org/libs/graph/doc/astar_search.html**
- **https://en.wikipedia.org/wiki/A*_search_algorithm**

Indices and tables

- **Index**
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- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.5 2.6**

Bidirectional A* - Family of functions

- **pgr_bdAstar** - Bidirectional A* algorithm for obtaining paths.
- **pgr_bdAstarCost** - Bidirectional A* algorithm to calculate the cost of the paths.

- **pgr_bdAstarCostMatrix** - Bidirectional A* algorithm to calculate a cost matrix of paths.

- **Supported versions: Latest** (**3.2**) **3.1** **3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2 2.1 2.0**

pgr_bdAstar

`pgr_bdAstar` — Returns the shortest path using Bidirectional A* algorithm.

Boost Graph Inside

Availability:

- Version 3.2.0
  - New **proposed** function:
    - pgr_bdAstar(Combinations)
- Version 3.0.0
  - **Official** function
- Version 2.5.0
  - Signature change on pgr_bdAstar(One to One)
    - Old signature no longer supported
  - New **Proposed** functions:
    - pgr_bdAstar(One to Many)
    - pgr_bdAstar(Many to One)
    - pgr_bdAstar(Many to Many)
- Version 2.0.0
  - **Official** pgr_bdAstar(One to One)

Description

The main characteristics are:

- Default kind of graph is **directed** when
  - `directed` flag is missing.
  - `directed` flag is set to true
- Unless specified otherwise, ordering is:
  - first by `start_vid` (if exists)
  - then by `end_vid`
- Values are returned when there is a path
- Let v and u be nodes on the graph:
  - If there is no path from v to u:
    - no corresponding row is returned
    - `agg_cost` from v to u is ∞
  - There is no path when $v = u$ therefore
    - no corresponding row is returned
    - `agg_cost` from *v* to *u* is 0
- Edges with negative costs are not included in the graph.
- When (x,y) coordinates for the same vertex identifier differ:
  - A random selection of the vertex's (x,y) coordinates is used.
- Running time: $O((E + V) * \log V)$

- The results are equivalent to the union of the results of the *pgr_bdAStar(* **One to One** *)* on the:
  - *pgr_bdAstar(* **One to Many** *)*
  - *pgr_bdAstar(* **Many to One** *)*
  - *pgr_bdAstar(* **Many to Many** *)*
- `start_vid` and `end_vid` in the result is used to distinguish to which path it belongs.

Signature

Summary

```
pgr_bdAstar(Edges SQL, from_vid,  to_vid,  [, directed] [, heuristic] [, factor] [, epsilon])
pgr_bdAstar(Edges SQL, from_vid,  to_vids  [, directed] [, heuristic] [, factor] [, epsilon])
pgr_bdAstar(Edges SQL, from_vids, to_vid   [, directed] [, heuristic] [, factor] [, epsilon])
pgr_bdAstar(Edges SQL, from_vids, to_vids  [, directed] [, heuristic] [, factor] [, epsilon])
pgr_bdAstar(Edges SQL, Combinations SQL  [, directed] [, heuristic] [, factor] [, epsilon]) -- Proposed on v3.2

RETURNS SET OF (seq, path_seq [, start_vid] [, end_vid], node, edge, cost, agg_cost)
OR EMPTY SET
```

Optional parameters are *named parameters* and have a default value.

Using defaults

```
pgr_bdAstar(Edges SQL, start_vid, end_vid)
RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost)
```

Example:
From vertex \(2\) to vertex \(3\) on a **directed** graph

```
SELECT * FROM pgr_bdAstar(
    'SELECT id, source, target, cost, reverse_cost, x1,y1,x2,y2
    FROM edge_table',
    2, 3
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    4 |    1 |        0
   2 |        2 |    5 |    8 |    1 |        1
   3 |        3 |    6 |    9 |    1 |        2
   4 |        4 |    9 |   16 |    1 |        3
   5 |        5 |    4 |    3 |    1 |        4
   6 |        6 |    3 |   -1 |    0 |        5
(6 rows)
```

One to One

```
pgr_bdAstar(Edges SQL, from_vid,  to_vid,  [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost)
```

Example:
From vertex \(2\) to vertex \(3\) on a **directed** graph using heuristic \(2\)

```
SELECT * FROM pgr_bdAstar(
    'SELECT id, source, target, cost, reverse_cost, x1,y1,x2,y2
    FROM edge_table',
    2, 3,
    true, heuristic := 2
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    4 |    1 |        0
   2 |        2 |    5 |    8 |    1 |        1
   3 |        3 |    6 |    9 |    1 |        2
   4 |        4 |    9 |   16 |    1 |        3
   5 |        5 |    4 |    3 |    1 |        4
   6 |        6 |    3 |   -1 |    0 |        5
(6 rows)
```

One to many

```
pgr_bdAstar(Edges SQL, from_vid,  to_vids  [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (seq, path_seq, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertex \(2\) to vertices \(\{3, 11\}\) on a **directed** graph using heuristic \(3\) and factor \(3.5\)

```
SELECT * FROM pgr_bdAstar(
    'SELECT id, source, target, cost, reverse_cost, x1,y1,x2,y2
    FROM edge_table',
    2, ARRAY[3, 11],
    heuristic := 3, factor := 3.5
);
 seq | path_seq | end_vid | node | edge | cost | agg_cost
-----+----------+---------+------+------+------+----------
   1 |        1 |       3 |    2 |    4 |    1 |        0
   2 |        2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |       3 |    6 |    9 |    1 |        2
   4 |        4 |       3 |    9 |   16 |    1 |        3
   5 |        5 |       3 |    4 |    3 |    1 |        4
   6 |        6 |       3 |    3 |   -1 |    0 |        5
   7 |        1 |      11 |    2 |    4 |    1 |        0
   8 |        2 |      11 |    5 |    8 |    1 |        1
   9 |        3 |      11 |    6 |   11 |    1 |        2
  10 |        4 |      11 |   11 |   -1 |    0 |        3
(10 rows)
```

Many to One

```
pgr_bdAstar(Edges SQL, from_vids, to_vid   [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (seq, path_seq, start_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertices \(\{2, 7\}\) to vertex \(3\) on an **undirected** graph using heuristic \(4\)

```
SELECT * FROM pgr_bdAstar(
    'SELECT id, source, target, cost, reverse_cost, x1,y1,x2,y2
    FROM edge_table',
    ARRAY[2, 7], 3,
    false, heuristic := 4
);
 seq | path_seq | start_vid | node | edge | cost | agg_cost
-----+----------+-----------+------+------+------+----------
   1 |        1 |         2 |    2 |    2 |    1 |        0
   2 |        2 |         2 |    3 |   -1 |    0 |        1
   3 |        1 |         7 |    7 |    6 |    1 |        0
   4 |        2 |         7 |    8 |    7 |    1 |        1
   5 |        3 |         7 |    5 |    8 |    1 |        2
   6 |        4 |         7 |    6 |    5 |    1 |        3
   7 |        5 |         7 |    3 |   -1 |    0 |        4
(7 rows)
```

Many to Many

```
pgr_bdAstar(Edges SQL, from_vids, to_vids  [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertices \(\{2, 7\}\) to vertices \(\{3, 11\}\) on a **directed** graph using factor \(0.5\)

```
SELECT * FROM pgr_bdAstar(
    'SELECT id, source, target, cost, reverse_cost, x1,y1,x2,y2
    FROM edge_table',
    ARRAY[2, 7], ARRAY[3, 11],
    factor := 0.5
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    4 |    1 |        0
   2 |        2 |         2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |         2 |       3 |    6 |    9 |    1 |        2
   4 |        4 |         2 |       3 |    9 |   16 |    1 |        3
   5 |        5 |         2 |       3 |    4 |    3 |    1 |        4
   6 |        6 |         2 |       3 |    3 |   -1 |    0 |        5
   7 |        1 |         2 |      11 |    2 |    4 |    1 |        0
   8 |        2 |         2 |      11 |    5 |    8 |    1 |        1
   9 |        3 |         2 |      11 |    6 |   11 |    1 |        2
  10 |        4 |         2 |      11 |   11 |   -1 |    0 |        3
  11 |        1 |         7 |       3 |    7 |    6 |    1 |        0
  12 |        2 |         7 |       3 |    8 |    7 |    1 |        1
  13 |        3 |         7 |       3 |    5 |    8 |    1 |        2
  14 |        4 |         7 |       3 |    6 |    9 |    1 |        3
  15 |        5 |         7 |       3 |    9 |   16 |    1 |        4
  16 |        6 |         7 |       3 |    4 |    3 |    1 |        5
  17 |        7 |         7 |       3 |    3 |   -1 |    0 |        6
  18 |        1 |         7 |      11 |    7 |    6 |    1 |        0
  19 |        2 |         7 |      11 |    8 |    7 |    1 |        1
  20 |        3 |         7 |      11 |    5 |    8 |    1 |        2
  21 |        4 |         7 |      11 |    6 |   11 |    1 |        3
  22 |        5 |         7 |      11 |   11 |   -1 |    0 |        4
(22 rows)
```

Combinations

```
pgr_bdAstar(Edges SQL, Combinations SQL  [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

Using a combinations table on a **directed** graph using factor \(0.5\).

```
SELECT * FROM pgr_bdAstar(
    'SELECT id, source, target, cost, reverse_cost, x1,y1,x2,y2
    FROM edge_table',
    'SELECT * FROM ( VALUES (2, 3), (7, 11) ) AS t(source, target)',
    factor := 0.5
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    4 |    1 |        0
   2 |        2 |         2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |         2 |       3 |    6 |    9 |    1 |        2
   4 |        4 |         2 |       3 |    9 |   16 |    1 |        3
   5 |        5 |         2 |       3 |    4 |    3 |    1 |        4
   6 |        6 |         2 |       3 |    3 |   -1 |    0 |        5
   7 |        1 |         7 |      11 |    7 |    6 |    1 |        0
   8 |        2 |         7 |      11 |    8 |    7 |    1 |        1
   9 |        3 |         7 |      11 |    5 |    8 |    1 |        2
  10 |        4 |         7 |      11 |    6 |   11 |    1 |        3
  11 |        5 |         7 |      11 |   11 |   -1 |    0 |        4
(11 rows)
```

Parameters

Parameter	Type	Description
Edges SQL	TEXT	*Edges query* as described below.
Combinations SQL	TEXT	*Combinations query* as described below.
from_vid	ANY-INTEGER	Starting vertex identifier. Parameter in: • **One to One** • **One to Many**
from_vids	ARRAY[ANY-INTEGER]	Array of starting vertices identifiers. Parameter in: • **Many to One** • **Many to Many**

Parameter	Type	Description
to_vid	ANY-INTEGER	Ending vertex identifier. Parameter in: - **One to One** - **Many to One**
to_vids	ARRAY[ANY-INTEGER]	Array of ending vertices identifiers. Parameter in: - **One to Many** - **Many to Many**

Optional Parameters

Parameter	Type	Default	Description
directed	BOOLEAN	true	- When true the graph is considered as Directed. - When false the graph is considered as Undirected.
heuristic	INTEGER	5	Heuristic number. Current valid values 0~5. Default5 - 0: h(v) = 0 (Use this value to compare with pgr_dijkstra) - 1: h(v) abs(max(dx, dy)) - 2: h(v) abs(min(dx, dy)) - 3: h(v) = dx * dx + dy * dy - 4: h(v) = sqrt(dx * dx + dy * dy) - 5: h(v) = abs(dx) + abs(dy)
factor	FLOAT	1	For units manipulation.\(factor > 0\). See **Factor**
epsilon	FLOAT	1	For less restricted results.\(epsilon >= 1\).

Inner queries

Edges query

edges_sql:
an SQL query, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* - When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, - When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.
x1	ANY-NUMERICAL		X coordinate of *source* vertex.
y1	ANY-NUMERICAL		Y coordinate of *source* vertex.
x2	ANY-NUMERICAL		X coordinate of *target* vertex.
y2	ANY-NUMERICAL		Y coordinate of *target* vertex.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Combinations query

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

Result Columns

Returns set of (seq, path_id, path_seq [, start_vid] [, end_vid], node, edge, cost, agg_cost)

Column	Type	Description
seq	INT	Sequential value starting from **1**.
path_id	INT	Path identifier. Has value **1** for the first of a path. Used when there are multiple paths for the same start_vid to end_vid combination.
path_seq	INT	Relative position in the path. Has value **1** for the beginning of a path.
start_vid	BIGINT	Identifier of the starting vertex. Returned when multiple starting vetrices are in the query. • **Many to One** • **Many to Many**
end_vid	BIGINT	Identifier of the ending vertex. Returned when multiple ending vertices are in the query. • **One to Many** • **Many to Many**
node	BIGINT	Identifier of the node in the path from start_vid to end_vid.
edge	BIGINT	Identifier of the edge used to go from node to the next node in the path sequence. -1 for the last node of the path.
cost	FLOAT	Cost to traverse from node using edge to the next node in the path sequence.
agg_cost	FLOAT	Aggregate cost from start_v to node.

See Also

- **aStar - Family of functions**
- **Bidirectional A* - Family of functions**
- **Sample Data** network.
- **https://www.boost.org/libs/graph/doc/astar_search.html**
- **https://en.wikipedia.org/wiki/A*_search_algorithm**

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- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5**

pgr_bdAstarCost

pgr_bdAstarCost — Returns the aggregate cost shortest path using **pgr_aStar** algorithm.

Boost Graph Inside

Availability

- Version 3.2.0
  - New **proposed** function:
    - pgr_bdAstarCost(Combinations)
- Version 3.0.0
  - **Official** function
- Version 2.5.0
  - New **Proposed** function

Description

- Default kind of graph is **directed** when
  - directed flag is missing.
  - directed flag is set to true
- Unless specified otherwise, ordering is:

        - first by start_vid (if exists)
        - then by end_vid
- Values are returned when there is a path
- Let \(v\) and \(u\) be nodes on the graph:
    - If there is no path from \(v\) to \(u\):
        - no corresponding row is returned
        - agg_cost from \(v\) to \(u\) is \(\infty\)
    - There is no path when \(v = u\) therefore
        - no corresponding row is returned
        - agg_cost from *v* to *u* is \(0\)
- Edges with negative costs are not included in the graph.
- When (x,y) coordinates for the same vertex identifier differ:
    - A random selection of the vertex's (x,y) coordinates is used.
- Running time: \(O((E + V) * \log V)\)

- The results are equivalent to the union of the results of the *pgr_bdAstarCost(* **One to One** *)* on the:
    - *pgr_bdAstarCost(* **One to Many** *)*
    - *pgr_bdAstarCost(* **Many to One** *)*
    - *pgr_bdAstarCost(* **Many to Many** *)*

Signatures

Summary

```
pgr_bdAstarCost(Edges SQL, from_vid,  to_vid  [, directed] [, heuristic] [, factor] [, epsilon])
pgr_bdAstarCost(Edges SQL, from_vid,  to_vids [, directed] [, heuristic] [, factor] [, epsilon])
pgr_bdAstarCost(Edges SQL, from_vids, to_vid  [, directed] [, heuristic] [, factor] [, epsilon])
pgr_bdAstarCost(Edges SQL, from_vids, to_vids [, directed] [, heuristic] [, factor] [, epsilon])
pgr_bdAstarCost(Edges SQL, Combinations SQL [, directed] [, heuristic] [, factor] [, epsilon]) -- Proposed on v3.2

RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Optional parameters are *named parameters* and have a default value.

Using defaults

```
pgr_bdAstarCost(Edges SQL, from_vid,  to_vid)
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example:
From vertex \(2\) to vertex \(3\) on a **directed** graph

```
SELECT * FROM pgr_bdAstarCost(
    'SELECT id, source, target, cost, reverse_cost, x1,y1,x2,y2
    FROM edge_table',
    2, 3
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |       3 |        5
(1 row)
```

One to One

```
pgr_bdAstarCost(Edges SQL, from_vid,  to_vid  [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example:
From vertex \(2\) to vertex \(3\) on an **directed** graph using heuristic \(2\)

```
SELECT * FROM pgr_bdAstarCost(
    'SELECT id, source, target, cost, reverse_cost, x1,y1,x2,y2
    FROM edge_table',
    2, 3,
    true, heuristic := 2
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |       3 |        5
(1 row)
```

One to many

```
pgr_bdAstarCost(Edges SQL, from_vid,  to_vids [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example:
From vertex *2* to vertices \(\{3, 11\}\) on a **directed** graph using heuristic *3* and factor \(3.5\)

```
SELECT * FROM pgr_bdAstarCost(
    'SELECT id, source, target, cost, reverse_cost, x1,y1,x2,y2
    FROM edge_table',
    2, ARRAY[3, 11],
    heuristic := 3, factor := 3.5
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |       3 |        5
         2 |      11 |        3
(2 rows)
```

Many to One

```
pgr_bdAstarCost(Edges SQL, from_vids, to_vid  [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example:
From vertices \(\{7, 2\}\) to vertex \(3\) on a **undirected** graph using heuristic \(4\)

```
SELECT * FROM pgr_bdAstarCost(
    'SELECT id, source, target, cost, reverse_cost, x1,y1,x2,y2
    FROM edge_table',
    ARRAY[2, 7], 3,
    false, heuristic := 4
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |       3 |        1
         7 |       3 |        4
(2 rows)
```

Many to Many

```
pgr_bdAstarCost(Edges SQL, from_vids, to_vids [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example:
From vertices \(\{7, 2\}\) to vertices \(\{3, 11\}\) on a **directed** using heuristic \(5\) and factor \(0.5\)

```
SELECT * FROM pgr_bdAstarCost(
    'SELECT id, source, target, cost, reverse_cost, x1,y1,x2,y2
    FROM edge_table',
    ARRAY[2, 7], ARRAY[3, 11],
    factor := 0.5
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |       3 |        5
         2 |      11 |        3
         7 |       3 |        6
         7 |      11 |        4
(4 rows)
```

Combinations

```
pgr_bdAstarCost(Edges SQL, Combinations SQL  [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example:
Using a combinations table on a **directed** graph using factor \(0.5\).

```
SELECT * FROM pgr_bdAstarCost(
    'SELECT id, source, target, cost, reverse_cost, x1,y1,x2,y2
    FROM edge_table',
    'SELECT * FROM ( VALUES (2, 3), (7, 11) ) AS t(source, target)',
    factor := 0.5
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |       3 |        5
         7 |      11 |        4
(2 rows)
```

Parameters

Parameter	Type	Description
Edges SQL	TEXT	*Edges query* as described below.
Combinations SQL	TEXT	*Combinations query* as described below.
from_vid	ANY-INTEGER	Starting vertex identifier. Parameter in: • **One to One** • **One to Many**
from_vids	ARRAY[ANY-INTEGER]	Array of starting vertices identifiers. Parameter in: • **Many to One** • **Many to Many**
to_vid	ANY-INTEGER	Ending vertex identifier. Parameter in: • **One to One** • **Many to One**
to_vids	ARRAY[ANY-INTEGER]	Array of ending vertices identifiers. Parameter in: • **One to Many** • **Many to Many**

Optional Parameters

Parameter	Type	Default	Description
directed	BOOLEAN	true	• When true the graph is considered as Directed. • When false the graph is considered as Undirected.
heuristic	INTEGER	5	Heuristic number. Current valid values 0~5. Default5 • 0: h(v) = 0 (Use this value to compare with pgr_dijkstra) • 1: h(v) abs(max(dx, dy)) • 2: h(v) abs(min(dx, dy)) • 3: h(v) = dx * dx + dy * dy • 4: h(v) = sqrt(dx * dx + dy * dy) • 5: h(v) = abs(dx) + abs(dy)
factor	FLOAT	1	For units manipulation. \(factor > 0\). See **Factor**
epsilon	FLOAT	1	For less restricted results. \(epsilon >= 1\).

Inner queries

Edges query

edges_sql:
an SQL query, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.

Column	Type	Default	Description
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.
x1	ANY-NUMERICAL		X coordinate of *source* vertex.
y1	ANY-NUMERICAL		Y coordinate of *source* vertex.
x2	ANY-NUMERICAL		X coordinate of *target* vertex.
y2	ANY-NUMERICAL		Y coordinate of *target* vertex.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Combinations query

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

Result Columns

Returns SET OF (start_vid, end_vid, agg_cost)

Column	Type	Description
start_vid	BIGINT	Identifier of the starting vertex.
end_vid	BIGINT	Identifier of the ending vertex.
agg_cost	FLOAT	Aggregate cost from start_vid to end_vid.

See Also

- **Bidirectional A* - Family of functions**
- **Cost - Category**
- **Cost Matrix - Category**
- Examples use **Sample Data** network.

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest** (**3.2**) **3.1 3.0**
- **Unsupported versions: 2.6 2.5**

pgr_bdAstarCostMatrix

pgr_bdAstarCostMatrix - Calculates the a cost matrix using **pgr_aStar**.

Boost Graph Inside

Availability

- Version 3.0.0

    - **Official** function
- Version 2.5.0
    - New **Proposed** function

Description

The main characteristics are:

- Using internaly the **pgr_bdAstar** algorithm
- Returns a cost matrix.
- No ordering is performed
- let *v* and *u* are nodes on the graph:
    - when there is no path from *v* to *u*:
        - no corresponding row is returned
        - cost from *v* to *u* is \(\inf\)
    - when \(v = u\) then
        - no corresponding row is returned
        - cost from *v* to *u* is \(0\)
- When the graph is **undirected** the cost matrix is symmetric

Signatures

Summary

```
pgr_bdAstarCostMatrix(edges_sql, vids [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (start_vid, end_vid, agg_cost)
```

Using defaults

```
pgr_bdAstarCostMatrix(edges_sql, vids)
RETURNS SET OF (start_vid, end_vid, agg_cost)
```

Example:
Cost matrix for vertices \(\{1, 2, 3, 4\}\) on a **directed** graph

```
SELECT * FROM pgr_bdAstarCostMatrix(
    'SELECT id, source, target, cost, reverse_cost, x1, y1, x2, y2 FROM edge_table',
    (SELECT array_agg(id) FROM edge_table_vertices_pgr WHERE id < 5)
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         1 |       2 |        1
         1 |       3 |        6
         1 |       4 |        5
         2 |       1 |        1
         2 |       3 |        5
         2 |       4 |        4
         3 |       1 |        2
         3 |       2 |        1
         3 |       4 |        3
         4 |       1 |        3
         4 |       2 |        2
         4 |       3 |        1
(12 rows)
```

Complete Signature

```
pgr_bdAstarCostMatrix(edges_sql, vids [, directed] [, heuristic] [, factor] [, epsilon])
RETURNS SET OF (start_vid, end_vid, agg_cost)
```

Example:
Symmetric cost matrix for vertices \(\{1, 2, 3, 4\}\) on an **undirected** graph using heuristic \(2\)

```
SELECT * FROM pgr_bdAstarCostMatrix(
    'SELECT id, source, target, cost, reverse_cost, x1, y1, x2, y2 FROM edge_table',
    (SELECT array_agg(id) FROM edge_table_vertices_pgr WHERE id < 5),
    false
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         1 |       2 |        1
         1 |       3 |        2
         1 |       4 |        3
         2 |       1 |        1
         2 |       3 |        1
         2 |       4 |        2
         3 |       1 |        2
         3 |       2 |        1
         3 |       4 |        1
         4 |       1 |        3
         4 |       2 |        2
         4 |       3 |        1
(12 rows)
```

Parameters

Parameter	Type	Description
edges_sql	TEXT	**edges_sql** inner query.
vids	ARRAY[ANY-INTEGER]	Array of vertices identifiers.

Optional Parameters

Parameter	Type	Default	Description
directed	BOOLEAN	true	• When true the graph is considered as Directed. • When false the graph is considered as Undirected.
heuristic	INTEGER	5	Heuristic number. Current valid values 0~5. Default5 • 0: h(v) = 0 (Use this value to compare with pgr_dijkstra) • 1: h(v) abs(max(dx, dy)) • 2: h(v) abs(min(dx, dy)) • 3: h(v) = dx * dx + dy * dy • 4: h(v) = sqrt(dx * dx + dy * dy) • 5: h(v) = abs(dx) + abs(dy)
factor	FLOAT	1	For units manipulation. \(factor > 0\). See **Factor**
epsilon	FLOAT	1	For less restricted results. \(epsilon >= 1\).

Inner query

edges_sql

edges_sql:
an SQL query, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.
x1	ANY-NUMERICAL		X coordinate of *source* vertex.
y1	ANY-NUMERICAL		Y coordinate of *source* vertex.
x2	ANY-NUMERICAL		X coordinate of *target* vertex.
y2	ANY-NUMERICAL		Y coordinate of *target* vertex.

Where:

ANY-INTEGER:

SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns SET OF (start_vid, end_vid, agg_cost)

Column	Type	Description
start_vid	BIGINT	Identifier of the starting vertex.
end_vid	BIGINT	Identifier of the ending vertex.
agg_cost	FLOAT	Aggregate cost from start_vid to end_vid.

Additional Examples

Example:
Use with **pgr_TSP**

```
SELECT * FROM pgr_TSP(
    $$
    SELECT * FROM pgr_bdAstarCostMatrix(
        'SELECT id, source, target, cost, reverse_cost, x1, y1, x2, y2 FROM edge_table',
        (SELECT array_agg(id) FROM edge_table_vertices_pgr WHERE id < 5),
        false
    )
    $$,
    randomize := false
);
 seq | node | cost | agg_cost
-----+------+------+----------
   1 |    1 |    0 |        0
   2 |    2 |    1 |        1
   3 |    3 |    1 |        2
   4 |    4 |    1 |        3
   5 |    1 |    3 |        6
(5 rows)
```

See Also

- **aStar - Family of functions**
- **Bidirectional A* - Family of functions**
- **Cost - Category**
- **Cost Matrix - Category**
- **Traveling Sales Person - Family of functions**
- The queries use the **Sample Data** network.

Indices and tables

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Description

Based on A* algorithm, the bidirectional search finds a shortest path from a starting vertex (start_vid) to an ending vertex (end_vid). It runs two simultaneous searches: one forward from the start_vid, and one backward from the end_vid, stopping when the two meet in the middle. This implementation can be used with a directed graph and an undirected graph.

The main Characteristics are:

- Process is done only on edges with positive costs.
- Values are returned when there is a path.
- When the starting vertex and ending vertex are the same, there is no path.
    - The *agg_cost* the non included values *(v, v)* is *0*
- When the starting vertex and ending vertex are the different and there is no path:
    - The *agg_cost* the non included values *(u, v)* is ∞
- Running time (worse case scenario): $O((E + V) * \log V)$
- For large graphs where there is a path bewtween the starting vertex and ending vertex:
    - It is expected to terminate faster than pgr_astar

Signatures

Edges query

edges_sql:
an SQL query, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.
x1	ANY-NUMERICAL		X coordinate of *source* vertex.
y1	ANY-NUMERICAL		Y coordinate of *source* vertex.
x2	ANY-NUMERICAL		X coordinate of *target* vertex.
y2	ANY-NUMERICAL		Y coordinate of *target* vertex.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Combinations query

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

Parameters

Parameter	Type	Description
Edges SQL	TEXT	Edges query as described above.
Combinations SQL	TEXT	Combinations query as described above.
start_vid	ANY-INTEGER	Starting vertex identifier.
start_vids	ARRAY[ANY-INTEGER]	Starting vertices identifierers.
end_vid	ANY-INTEGER	Ending vertex identifier.
end_vids	ARRAY[ANY-INTEGER]	Ending vertices identifiers.

directed	BOOLEAN	• Optional.
		  ◦ When `false` the graph is considered as Undirected.
		  ◦ Default is `true` which considers the graph as Directed.

heuristic	INTEGER	(optional). Heuristic number. Current valid values 0~5. Default `5` • 0: h(v) = 0 (Use this value to compare with pgr_dijkstra) • 1: h(v) abs(max(dx, dy)) • 2: h(v) abs(min(dx, dy)) • 3: h(v) = dx * dx + dy * dy • 4: h(v) = sqrt(dx * dx + dy * dy) • 5: h(v) = abs(dx) + abs(dy)
factor	FLOAT	(optional). For units manipulation. \(factor > 0\). Default `1`. see **Factor**
epsilon	FLOAT	(optional). For less restricted results. \(epsilon >= 1\). Default `1`.

See Also

Indices and tables

- Index
- Search Page

Previous versions of this page

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5**

Bidirectional Dijkstra - Family of functions

- **pgr_bdDijkstra** - Bidirectional Dijkstra algorithm for the shortest paths.
- **pgr_bdDijkstraCost** - Bidirectional Dijkstra to calculate the cost of the shortest paths
- **pgr_bdDijkstraCostMatrix** - Bidirectional Dijkstra algorithm to create a matrix of costs of the shortest paths.

- **Supported versions: Latest (3.2) 3.1 3.0 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2 2.1 2.0**

pgr_bdDijkstra

`pgr_bdDijkstra` — Returns the shortest path(s) using Bidirectional Dijkstra algorithm.

Boost Graph Inside

Availability:

- Version 3.2.0
  - New **proposed** function:
    - pgr_bdDijkstra(Combinations)
- Version 3.0.0
  - **Official** function
- Version 2.5.0
  - New **Proposed** functions:
    - pgr_bdDijkstra(One to Many)
    - pgr_bdDijkstra(Many to One)
    - pgr_bdDijkstra(Many to Many)
- Version 2.4.0
  - Signature change on pgr_bdDijsktra(One to One)
    - Old signature no longer supported
- Version 2.0.0
  - **Official** pgr_bdDijkstra(One to One)

Description

The main characteristics are:

- Process is done only on edges with positive costs.
- Values are returned when there is a path.
- When the starting vertex and ending vertex are the same, there is no path.
  - The *agg_cost* the non included values *(v, v)* is *0*
- When the starting vertex and ending vertex are the different and there is no path:
  - The *agg_cost* the non included values *(u, v)* is ∞
- Running time (worse case scenario): $O((V \log V + E))$
- For large graphs where there is a path bewtween the starting vertex and ending vertex:
  - It is expected to terminate faster than pgr_dijkstra

Signatures

Summary

```
pgr_bdDijkstra(Edges SQL, start_vid,  end_vid  [, directed])
pgr_bdDijkstra(Edges SQL, start_vid,  end_vids [, directed])
pgr_bdDijkstra(Edges SQL, start_vids, end_vid  [, directed])
pgr_bdDijkstra(Edges SQL, start_vids, end_vids [, directed])
pgr_bdDijkstra(Edges SQL, Combinations SQL [, directed]) -- Proposed on v3.2

RETURNS SET OF (seq, path_seq [, start_vid] [, end_vid], node, edge, cost, agg_cost)
OR EMPTY SET
```

Using defaults

```
pgr_bdDijkstra(Edges SQL, start_vid, end_vid)
RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertex \(2\) to vertex \(3\)

```
SELECT * FROM pgr_bdDijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, 3
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    4 |    1 |        0
   2 |        2 |    5 |    8 |    1 |        1
   3 |        3 |    6 |    9 |    1 |        2
   4 |        4 |    9 |   16 |    1 |        3
   5 |        5 |    4 |    3 |    1 |        4
   6 |        6 |    3 |   -1 |    0 |        5
(6 rows)
```

One to One

```
pgr_bdDijkstra(Edges SQL, start_vid, end_vid [, directed])
RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertex \(2\) to vertex \(3\) on an **undirected** graph

```
SELECT * FROM pgr_bdDijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, 3,
    false
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    2 |    1 |        0
   2 |        2 |    3 |   -1 |    0 |        1
(2 rows)
```

One to many

```
pgr_bdDijkstra(Edges SQL, start_vid, end_vids [, directed])
RETURNS SET OF (seq, path_seq, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertex \(2\) to vertices \(\{3, 11\}\) on a **directed** graph

```
SELECT * FROM pgr_bdDijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, ARRAY[3, 11]);
 seq | path_seq | end_vid | node | edge | cost | agg_cost
-----+----------+---------+------+------+------+----------
   1 |        1 |       3 |    2 |    4 |    1 |        0
   2 |        2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |       3 |    6 |    9 |    1 |        2
   4 |        4 |       3 |    9 |   16 |    1 |        3
   5 |        5 |       3 |    4 |    3 |    1 |        4
   6 |        6 |       3 |    3 |   -1 |    0 |        5
   7 |        1 |      11 |    2 |    4 |    1 |        0
   8 |        2 |      11 |    5 |    8 |    1 |        1
   9 |        3 |      11 |    6 |   11 |    1 |        2
  10 |        4 |      11 |   11 |   -1 |    0 |        3
(10 rows)
```

Many to One

```
pgr_bdDijkstra(Edges SQL, start_vids, end_vid [, directed])
RETURNS SET OF (seq, path_seq, start_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertices \(\{2, 7\}\) to vertex \(3\) on a **directed** graph

```
SELECT * FROM pgr_bdDijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[2, 7], 3);
 seq | path_seq | start_vid | node | edge | cost | agg_cost
-----+----------+-----------+------+------+------+----------
   1 |        1 |         2 |    2 |    4 |    1 |        0
   2 |        2 |         2 |    5 |    8 |    1 |        1
   3 |        3 |         2 |    6 |    9 |    1 |        2
   4 |        4 |         2 |    9 |   16 |    1 |        3
   5 |        5 |         2 |    4 |    3 |    1 |        4
   6 |        6 |         2 |    3 |   -1 |    0 |        5
   7 |        1 |         7 |    7 |    6 |    1 |        0
   8 |        2 |         7 |    8 |    7 |    1 |        1
   9 |        3 |         7 |    5 |    8 |    1 |        2
  10 |        4 |         7 |    6 |    9 |    1 |        3
  11 |        5 |         7 |    9 |   16 |    1 |        4
  12 |        6 |         7 |    4 |    3 |    1 |        5
  13 |        7 |         7 |    3 |   -1 |    0 |        6
(13 rows)
```

Many to Many

```
pgr_bdDijkstra(Edges SQL, start_vids, end_vids [, directed])
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertices \(\{2, 7\}\) to vertices \(\{3, 11\}\) on a **directed** graph

```
SELECT * FROM pgr_bdDijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[2, 7], ARRAY[3, 11]);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    4 |    1 |        0
   2 |        2 |         2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |         2 |       3 |    6 |    9 |    1 |        2
   4 |        4 |         2 |       3 |    9 |   16 |    1 |        3
   5 |        5 |         2 |       3 |    4 |    3 |    1 |        4
   6 |        6 |         2 |       3 |    3 |   -1 |    0 |        5
   7 |        1 |         2 |      11 |    2 |    4 |    1 |        0
   8 |        2 |         2 |      11 |    5 |    8 |    1 |        1
   9 |        3 |         2 |      11 |    6 |   11 |    1 |        2
  10 |        4 |         2 |      11 |   11 |   -1 |    0 |        3
  11 |        1 |         7 |       3 |    7 |    6 |    1 |        0
  12 |        2 |         7 |       3 |    8 |    7 |    1 |        1
  13 |        3 |         7 |       3 |    5 |    8 |    1 |        2
  14 |        4 |         7 |       3 |    6 |    9 |    1 |        3
  15 |        5 |         7 |       3 |    9 |   16 |    1 |        4
  16 |        6 |         7 |       3 |    4 |    3 |    1 |        5
  17 |        7 |         7 |       3 |    3 |   -1 |    0 |        6
  18 |        1 |         7 |      11 |    7 |    6 |    1 |        0
  19 |        2 |         7 |      11 |    8 |    7 |    1 |        1
  20 |        3 |         7 |      11 |    5 |   10 |    1 |        2
  21 |        4 |         7 |      11 |   10 |   12 |    1 |        3
  22 |        5 |         7 |      11 |   11 |   -1 |    0 |        4
(22 rows)
```

Combinations

```
pgr_bdDijkstra(Edges SQL, Combinations SQL [, directed])
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
Using a combinations table on a **directed** graph.

```
SELECT * FROM pgr_bdDijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    'SELECT * FROM ( VALUES (2, 3), (7, 11) ) AS t(source, target)');
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    4 |    1 |        0
   2 |        2 |         2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |         2 |       3 |    6 |    9 |    1 |        2
   4 |        4 |         2 |       3 |    9 |   16 |    1 |        3
   5 |        5 |         2 |       3 |    4 |    3 |    1 |        4
   6 |        6 |         2 |       3 |    3 |   -1 |    0 |        5
   7 |        1 |         7 |      11 |    7 |    6 |    1 |        0
   8 |        2 |         7 |      11 |    8 |    7 |    1 |        1
   9 |        3 |         7 |      11 |    5 |   10 |    1 |        2
  10 |        4 |         7 |      11 |   10 |   12 |    1 |        3
  11 |        5 |         7 |      11 |   11 |   -1 |    0 |        4
(11 rows)
```

Parameters

Parameter	Type	Default	Description
Edges SQL	TEXT		*Edges query* as described below
Combinations SQL	TEXT		*Combinations query* as described below
start_vid	BIGINT		Identifier of the starting vertex of the path.
start_vids	ARRAY[BIGINT]		Array of identifiers of starting vertices.
end_vid	BIGINT		Identifier of the ending vertex of the path.
end_vids	ARRAY[BIGINT]		Array of identifiers of ending vertices.
directed	BOOLEAN	true	• When true Graph is considered *Directed* • When false the graph is considered as *Undirected*.

Inner queries

Edges query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Combinations query

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

Result Columns

Returns set of (seq, path_id, path_seq [, start_vid] [, end_vid], node, edge, cost, agg_cost)

Column	Type	Description
seq	INT	Sequential value starting from **1**.
path_id	INT	Path identifier. Has value **1** for the first of a path. Used when there are multiple paths for the same start_vid to end_vid combination.
path_seq	INT	Relative position in the path. Has value **1** for the beginning of a path.
start_vid	BIGINT	Identifier of the starting vertex. Returned when multiple starting vetrices are in the query. • **Many to One** • **Many to Many**
end_vid	BIGINT	Identifier of the ending vertex. Returned when multiple ending vertices are in the query. • **One to Many** • **Many to Many**
node	BIGINT	Identifier of the node in the path from start_vid to end_vid.
edge	BIGINT	Identifier of the edge used to go from node to the next node in the path sequence. -1 for the last node of the path.
cost	FLOAT	Cost to traverse from node using edge to the next node in the path sequence.
agg_cost	FLOAT	Aggregate cost from start_v to node.

See Also

- The queries use the **Sample Data** network.
- **Bidirectional Dijkstra - Family of functions**
- **https://www.cs.princeton.edu/courses/archive/spr06/cos423/Handouts/EPP%20shortest%20path%20algorithms.pdf**
- **https://en.wikipedia.org/wiki/Bidirectional_search**

Indices and tables

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- **Supported versions: Latest** (**3.2**) **3.1 3.0**
- **Unsupported versions: 2.6 2.5**

pgr_bdDijkstraCost

pgr_bdDijkstraCost — Returns the shortest path(s)'s cost using Bidirectional Dijkstra algorithm.

Boost Graph Inside

Availability:

- Version 3.2.0
  - New **proposed** function:
    - pgr_bdDijkstraCost(Combinations)
- Version 3.0.0
  - **Official** function
- Version 2.5.0
  - New **proposed** function

Description

The main characteristics are:

- Process is done only on edges with positive costs.
- Values are returned when there is a path.
- When the starting vertex and ending vertex are the same, there is no path.
  - The *agg_cost* the non included values *(v, v)* is *0*
- When the starting vertex and ending vertex are the different and there is no path:
  - The *agg_cost* the non included values *(u, v)* is ∞
- Running time (worse case scenario): $O((V \log V + E))$

- For large graphs where there is a path bewtween the starting vertex and ending vertex:
  - It is expected to terminate faster than pgr_dijkstra

Signatures

Summary

```
pgr_bdDijkstraCost(Edges SQL, from_vid,  to_vid  [, directed])
pgr_bdDijkstraCost(Edges SQL, from_vid,  to_vids [, directed])
pgr_bdDijkstraCost(Edges SQL, from_vids, to_vid  [, directed])
pgr_bdDijkstraCost(Edges SQL, from_vids, to_vids [, directed])
pgr_bdDijkstraCost(Edges SQL, Combinations SQL [, directed]) -- Proposed on v3.2

RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Using default

```
pgr_bdDijkstraCost(Edges SQL, from_vid,  to_vid)
RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertex \(2\) to vertex \(3\) on a **directed** graph

```
SELECT * FROM pgr_bdDijkstraCost(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, 3
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |       3 |        5
(1 row)
```

One to One

```
pgr_bdDijkstraCost(Edges SQL, from_vid,  to_vid  [, directed])
RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertex \(2\) to vertex \(3\) on an **undirected** graph

```
SELECT * FROM pgr_bdDijkstraCost(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, 3,
    false
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |       3 |        1
(1 row)
```

One to Many

```
pgr_bdDijkstraCost(Edges SQL, from_vid,  to_vids [, directed])
RETURNS SET OF (seq, path_seq, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertex \(2\) to vertices \(\{3, 11\}\) on a **directed** graph

```
SELECT * FROM pgr_bdDijkstraCost(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, ARRAY[3, 11]);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |       3 |        5
         2 |      11 |        3
(2 rows)
```

Many to One

```
pgr_bdDijkstraCost(Edges SQL, from_vids, to_vids [, directed])
RETURNS SET OF (seq, path_seq, start_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertices \(\{2, 7\}\) to vertex \(3\) on a **directed** graph

```
SELECT * FROM pgr_bdDijkstraCost(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[2, 7], 3);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |       3 |        5
         7 |       3 |        6
(2 rows)
```

Many to Many

```
pgr_bdDijkstraCost(Edges SQL, start_vids, end_vids [, directed])
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertices \(\{2, 7\}\) to vertices \(\{3, 11\}\) on a **directed** graph

```
SELECT * FROM pgr_bdDijkstraCost(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[2, 7], ARRAY[3, 11]);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |       3 |        5
         2 |      11 |        3
         7 |       3 |        6
         7 |      11 |        4
(4 rows)
```

Combinations

```
pgr_bdDijkstra(Edges SQL, Combinations SQL [, directed])
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

Using a combinations table on a **directed** graph.

```
SELECT * FROM pgr_bdDijkstraCost(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    'SELECT * FROM ( VALUES (2, 3), (7, 11) ) AS t(source, target)');
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |       3 |        5
         7 |      11 |        4
(2 rows)
```

Parameters

Parameter	Type	Default	Description
Edges SQL	`TEXT`		*Edges query* as described below
Combinations SQL	`TEXT`		*Combinations query* as described below
start_vid	`BIGINT`		Identifier of the starting vertex of the path.
start_vids	`ARRAY[BIGINT]`		Array of identifiers of starting vertices.
end_vid	`BIGINT`		Identifier of the ending vertex of the path.
end_vids	`ARRAY[BIGINT]`		Array of identifiers of ending vertices.
directed	`BOOLEAN`	`true`	• When `true` Graph is considered *Directed* • When `false` the graph is considered as *Undirected*.

Inner queries

Edges query

Column	Type	Default	Description
id	`ANY-INTEGER`		Identifier of the edge.
source	`ANY-INTEGER`		Identifier of the first end point vertex of the edge.
target	`ANY-INTEGER`		Identifier of the second end point vertex of the edge.
cost	`ANY-NUMERICAL`		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	`ANY-NUMERICAL`	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Combinations query

Column	Type	Default	Description
source	`ANY-INTEGER`		Identifier of the first end point vertex of the edge.
target	`ANY-INTEGER`		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

Result Columns

Returns SET OF `(start_vid, end_vid, agg_cost)`

Column	Type	Description
start_vid	`BIGINT`	Identifier of the starting vertex.
end_vid	`BIGINT`	Identifier of the ending vertex.
agg_cost	`FLOAT`	Aggregate cost from `start_vid` to `end_vid`.

See Also

- The queries use the **Sample Data** network.
- **pgr_bdDijkstra**
- **https://www.cs.princeton.edu/courses/archive/spr06/cos423/Handouts/EPP%20shortest%20path%20algorithms.pdf**
- **https://en.wikipedia.org/wiki/Bidirectional_search**

Indices and tables

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- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5**

pgr_bdDijkstraCostMatrix

`pgr_bdDijkstraCostMatrix` - Calculates the a cost matrix using **pgr_bdDijkstra**.

Boost Graph Inside

Availability:

- Version 3.0.0
  - **Official** function
- Version 2.5.0
  - New **proposed** function

Description

The main characteristics are:

- Process is done only on edges with positive costs.
- Values are returned when there is a path.
- When the starting vertex and ending vertex are the same, there is no path.
  - The *agg_cost* the non included values *(v, v)* is *0*
- When the starting vertex and ending vertex are the different and there is no path:
  - The *agg_cost* the non included values *(u, v)* is ∞
- Running time (worse case scenario): $O((V \log V + E))$
- For large graphs where there is a path bewtween the starting vertex and ending vertex:
  - It is expected to terminate faster than pgr_dijkstra
- Returns a cost matrix.

Signatures

Summary

```
pgr_bdDijkstraCostMatrix(edges_sql, start_vids [, directed])
RETURNS SET OF (start_vid, end_vid, agg_cost)
```

Using default

```
pgr_bdDijkstraCostMatrix(edges_sql, start_vid)
RETURNS SET OF (start_vid, end_vid, agg_cost)
```

Example:
Cost matrix for vertices $\{1, 2, 3, 4\}$ on a **directed** graph

```
SELECT * FROM pgr_bdDijkstraCostMatrix(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    (SELECT array_agg(id) FROM edge_table_vertices_pgr WHERE id < 5)
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         1 |       2 |        1
         1 |       3 |        6
         1 |       4 |        5
         2 |       1 |        1
         2 |       3 |        5
         2 |       4 |        4
         3 |       1 |        2
         3 |       2 |        1
         3 |       4 |        3
         4 |       1 |        3
         4 |       2 |        2
         4 |       3 |        1
(12 rows)
```

Complete Signature

```
pgr_bdDijkstraCostMatrix(edges_sql, start_vids [, directed])
RETURNS SET OF (start_vid, end_vid, agg_cost)
```

Example:
Symmetric cost matrix for vertices $\{1, 2, 3, 4\}$ on an **undirected** graph

```
SELECT * FROM pgr_bdDijkstraCostMatrix(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    (SELECT array_agg(id) FROM edge_table_vertices_pgr WHERE id < 5),
    false
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         1 |       2 |        1
         1 |       3 |        2
         1 |       4 |        3
         2 |       1 |        1
         2 |       3 |        1
         2 |       4 |        2
         3 |       1 |        2
         3 |       2 |        1
         3 |       4 |        1
         4 |       1 |        3
         4 |       2 |        2
         4 |       3 |        1
(12 rows)
```

Parameters

Parameter	Type	Description
edges_sql	TEXT	Edges SQL query as described above.
start_vids	ARRAY[ANY-INTEGER]	Array of identifiers of the vertices.
directed	BOOLEAN	(optional). When false the graph is considered as Undirected. Default is true which considers the graph as Directed.

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns SET OF (start_vid, end_vid, agg_cost)

Column	Type	Description
start_vid	BIGINT	Identifier of the starting vertex.
end_vid	BIGINT	Identifier of the ending vertex.
agg_cost	FLOAT	Aggregate cost from start_vid to end_vid.

Additional Examples

Example:
Use with tsp

```
SELECT * FROM pgr_TSP(
    $$
    SELECT * FROM pgr_bdDijkstraCostMatrix(
        'SELECT id, source, target, cost, reverse_cost FROM edge_table',
        (SELECT array_agg(id) FROM edge_table_vertices_pgr WHERE id < 5),
        false
    )
    $$,
    randomize := false
);
 seq | node | cost | agg_cost
-----+------+------+----------
   1 |    1 |    0 |        0
   2 |    2 |    1 |        1
   3 |    3 |    1 |        2
   4 |    4 |    1 |        3
   5 |    1 |    3 |        6
(5 rows)
```

See Also

- **pgr_bdDijkstra**
- **Cost Matrix - Category**
- **pgr_TSP**
- The queries use the **Sample Data** network.

Indices and tables

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Synopsis

Based on Dijkstra's algorithm, the bidirectional search finds a shortest path a starting vertex (`start_vid`) to an ending vertex (`end_vid`). It runs two simultaneous searches: one forward from the source, and one backward from the target, stopping when the two meet in the middle. This implementation can be used with a directed graph and an undirected graph.

Characteristics

The main Characteristics are:

- Process is done only on edges with positive costs.
- Values are returned when there is a path.
- When the starting vertex and ending vertex are the same, there is no path.
  - The *agg_cost* the non included values *(v, v)* is *0*
- When the starting vertex and ending vertex are the different and there is no path:
  - The *agg_cost* the non included values *(u, v)* is \(\infty\)
- Running time (worse case scenario): \(O((V \log V + E))\)
- For large graphs where there is a path bewtween the starting vertex and ending vertex:
  - It is expected to terminate faster than pgr_dijkstra

See Also

Indices and tables

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- **Supported versions: Latest** (**3.2**) **3.1** **3.0**
- **Unsupported versions: 2.6** **2.5**

Components - Family of functions

- **pgr_connectedComponents** - Connected components of an undirected graph.
- **pgr_strongComponents** - Strongly connected components of a directed graph.
- **pgr_biconnectedComponents** - Biconnected components of an undirected graph.
- **pgr_articulationPoints** - Articulation points of an undirected graph.
- **pgr_bridges** - Bridges of an undirected graph.

Experimental

Warning

Possible server crash

- These functions might create a server crash

Warning

Experimental functions

- They are not officially of the current release.
- They likely will not be officially be part of the next release:
  - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
  - Name might change.
  - Signature might change.
  - Functionality might change.
  - pgTap tests might be missing.
  - Might need c/c++ coding.
  - May lack documentation.
  - Documentation if any might need to be rewritten.
  - Documentation examples might need to be automatically generated.
  - Might need a lot of feedback from the comunity.
  - Might depend on a proposed function of pgRouting
  - Might depend on a deprecated function of pgRouting

- **pgr_makeConnected - Experimental** - Details of edges to make graph connected.

- **Supported versions: Latest** (**3.2**) **3.1 3.0**
- **Unsupported versions: 2.6 2.5**

pgr_connectedComponents

`pgr_connectedComponents` — Connected components of an undirected graph using a DFS-based approach.

Boost Graph Inside

Availability

- Version 3.0.0
  - Return columns change:
    - `n_seq` is removed
    - `seq` changed type to `BIGINT`
  - **Official** function
- Version 2.5.0
  - New **experimental** function

Description

A connected component of an undirected graph is a set of vertices that are all reachable from each other.

The main characteristics are:

- The signature is for an **undirected** graph.
- Components are described by vertices
- The returned values are ordered:
  - *component* ascending
  - *node* ascending
- Running time: \(O(V + E)\)

Signatures

```
pgr_connectedComponents(edges_sql)

RETURNS SET OF (seq, component, node)
OR EMPTY SET
```

Example:
The connected components of the graph

```
SELECT * FROM pgr_connectedComponents(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table'
);
 seq | component | node
-----+-----------+------
   1 |         1 |    1
   2 |         1 |    2
   3 |         1 |    3
   4 |         1 |    4
   5 |         1 |    5
   6 |         1 |    6
   7 |         1 |    7
   8 |         1 |    8
   9 |         1 |    9
  10 |         1 |   10
  11 |         1 |   11
  12 |         1 |   12
  13 |         1 |   13
  14 |        14 |   14
  15 |        14 |   15
  16 |        16 |   16
  17 |        16 |   17
(17 rows)
```

Parameters

Parameter	Type	Default	Description
Edges SQL	TEXT		Inner query as described below.

Inner query

edges SQL:
an SQL query of an **undirected** graph, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns set of (seq, component, node)

Column	Type	Description
seq	BIGINT	Sequential value starting from **1**.
component	BIGINT	Component identifier. It is equal to the minimum node identifier in the component.
node	BIGINT	Identifier of the vertex that belongs to **component**.

See Also

- **Components - Family of functions**
- The queries use the **Sample Data** network.
- Boost: **Connected components**
- wikipedia: **Connected component**

Indices and tables

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- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5**

pgr_strongComponents

`pgr_strongComponents` — Strongly connected components of a directed graph using Tarjan's algorithm based on DFS.

Boost Graph Inside

Availability

- Version 3.0.0
  - Return columns change:
    - `n_seq` is removed
    - `seq` changed type to `BIGINT`
  - **Official** function
- Version 2.5.0
  - New **experimental** function

Description

A strongly connected component of a directed graph is a set of vertices that are all reachable from each other.

The main characteristics are:

- The signature is for a **directed** graph.
- Components are described by vertices
- The returned values are ordered:
  - *component* ascending
  - *node* ascending
- Running time: $O(V + E)$

Signatures

```
pgr_strongComponents(Edges SQL)

RETURNS SET OF (seq, component, node)
OR EMPTY SET
```

Example:
The strong components of the graph

```
SELECT * FROM pgr_strongComponents(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table'
);
 seq | component | node
-----+-----------+------
   1 |         1 |    1
   2 |         1 |    2
   3 |         1 |    3
   4 |         1 |    4
   5 |         1 |    5
   6 |         1 |    6
   7 |         1 |    7
   8 |         1 |    8
   9 |         1 |    9
  10 |         1 |   10
  11 |         1 |   11
  12 |         1 |   12
  13 |         1 |   13
  14 |        14 |   14
  15 |        14 |   15
  16 |        16 |   16
  17 |        16 |   17
(17 rows)
```

Parameters

Parameter	Type	Default	Description
Edges SQL	TEXT		Inner query as described below.

Inner query

edges SQL:
an SQL query of a **directed** graph, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns set of (seq, component, node)

Column	Type	Description
seq	BIGINT	Sequential value starting from **1**.
component	BIGINT	Component identifier. It is equal to the minimum node identifier in the component.
node	BIGINT	Identifier of the vertex that belongs to **component**.

See Also

- **Components - Family of functions**
- The queries use the **Sample Data** network.
- Boost: **Strong components**
- wikipedia: **Strongly connected component**

Indices and tables

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5**

pgr_biconnectedComponents

`pgr_biconnectedComponents` — Return the biconnected components of an undirected graph. In particular, the algorithm implemented by Boost.Graph.

Boost Graph Inside

Availability

- Version 3.0.0
  - Return columns change:
    - `n_seq` is removed
    - `seq` changed type to `BIGINT`
  - **Official** function
- Version 2.5.0
  - New **experimental** function

Description

The biconnected components of an undirected graph are the maximal subsets of vertices such that the removal of a vertex from particular component will not disconnect the component. Unlike connected components, vertices may belong to multiple biconnected components. Vertices can be present in multiple biconnected components, but each edge can only be contained in a single biconnected component.

The main characteristics are:

- The signature is for an **undirected** graph.
- Components are described by edges.
- The returned values are ordered:
  - *component* ascending.
  - *edge* ascending.
- Running time: \(O(V + E)\)

Signatures

```
pgr_biconnectedComponents(Edges SQL)

RETURNS SET OF (seq, component, edge)
OR EMPTY SET
```

Example:
The biconnected components of the graph

```
SELECT * FROM pgr_biconnectedComponents(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table'
);
 seq | component | edge
-----+-----------+------
   1 |         1 |    1
   2 |         2 |    2
   3 |         2 |    3
   4 |         2 |    4
   5 |         2 |    5
   6 |         2 |    8
   7 |         2 |    9
   8 |         2 |   10
   9 |         2 |   11
  10 |         2 |   12
  11 |         2 |   13
  12 |         2 |   15
  13 |         2 |   16
  14 |         6 |    6
  15 |         7 |    7
  16 |        14 |   14
  17 |        17 |   17
  18 |        18 |   18
(18 rows)
```

Parameters

Parameter	Type	Default	Description
Edges SQL	TEXT		Inner query as described below.

Inner query

edges SQL:
an SQL query of an **undirected** graph, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns set of `(seq, component, edge)`

Column	Type	Description
seq	BIGINT	Sequential value starting from **1**.
component	BIGINT	Component identifier. It is equal to the minimum edge identifier in the component.
edge	BIGINT	Identifier of the edge.

See Also

- **Components - Family of functions**
- The queries use the **Sample Data** network.
- Boost: **Biconnected components**
- wikipedia: **Biconnected component**

Indices and tables

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- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5**

pgr_articulationPoints

`pgr_articulationPoints` - Return the articulation points of an undirected graph.

Boost Graph Inside

Availability

- Version 3.0.0
  - Return columns change: `seq` is removed
  - **Official** function
- Version 2.5.0
  - New **experimental** function

Description

Those vertices that belong to more than one biconnected component are called articulation points or, equivalently, cut vertices. Articulation points are vertices whose removal would increase the number of connected components in the graph. This implementation can only be used with an undirected graph.

The main characteristics are:

- The signature is for an **undirected** graph.
- The returned values are ordered:
  - *node* ascending
- Running time: $O(V + E)$

Signatures

```
pgr_articulationPoints(Edges SQL)

RETURNS SET OF (node)
OR EMPTY SET
```

Example:
The articulation points of the graph

```
SELECT * FROM pgr_articulationPoints(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table'
);
 node
------
    2
    5
    8
   10
(4 rows)
```

Parameters

Parameter	Type	Default	Description
Edges SQL	`TEXT`		Inner query as described below.

Inner query

edges SQL:

an SQL query of an **undirected** graph, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns set of (node)

Column	Type	Description
node	BIGINT	Identifier of the vertex.

See Also

- **Components - Family of functions**
- The queries use the **Sample Data** network.
- Boost: **Biconnected components & articulation points**
- wikipedia: **Biconnected component**

Indices and tables

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- **Supported versions: Latest** (**3.2**) **3.1 3.0**
- **Unsupported versions: 2.6 2.5**

pgr_bridges

pgr_bridges - Return the bridges of an undirected graph.

Boost Graph Inside

Availability

- Version 3.0.0
  - Return columns change: seq is removed
  - **Official** function
- Version 2.5.0
  - New **experimental** function

Description

A bridge is an edge of an undirected graph whose deletion increases its number of connected components. This implementation can only be used with an undirected graph.

The main characteristics are:

- The signature is for an **undirected** graph.
- The returned values are ordered:
  - *edge* ascending
- Running time: \(O(E * (V + E))\)

Signatures

```
pgr_bridges(Edges SQL)

RETURNS SET OF (edge)
OR EMPTY SET
```

Example:
The bridges of the graph

```
SELECT * FROM pgr_bridges(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table'
);
 edge
------
    1
    6
    7
   14
   17
   18
(6 rows)
```

Parameters

Parameter	Type	Default	Description
Edges SQL	TEXT		Inner query as described below.

Inner query

edges SQL:
an SQL query of an **undirected** graph, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* - When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, - When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns set of `(edge)`

Column	Type	Description
edge	BIGINT	Identifier of the edge that is a bridge.

See Also

- **https://en.wikipedia.org/wiki/Bridge_%28graph_theory%29**

- The queries use the **Sample Data** network.

Indices and tables

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- **Supported versions: Latest (3.2)**

pgr_makeConnected - Experimental

pgr_makeConnected — Returns the set of edges that will make the graph connected.

Boost Graph Inside

> **Warning**
>
> Possible server crash
>
> - These functions might create a server crash

> **Warning**
>
> Experimental functions
>
> - They are not officially of the current release.
> - They likely will not be officially be part of the next release:
>   - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
>   - Name might change.
>   - Signature might change.
>   - Functionality might change.
>   - pgTap tests might be missing.
>   - Might need c/c++ coding.
>   - May lack documentation.
>   - Documentation if any might need to be rewritten.
>   - Documentation examples might need to be automatically generated.
>   - Might need a lot of feedback from the comunity.
>   - Might depend on a proposed function of pgRouting
>   - Might depend on a deprecated function of pgRouting

Availability

- Version 3.2.0
  - New **experimental** function

Description

Adds the minimum number of edges needed to make the input graph connected. The algorithm first identifies all of the connected components in the graph, then adds edges to connect those components together in a path. For example, if a graph contains three connected components A, B, and C, make_connected will add two edges. The two edges added might consist of one connecting a vertex in A with a vertex in B and one connecting a vertex in B with a vertex in C.

The main characteristics are:

- It will give the minimum list of all edges which are needed in the graph to make the graph connected.
- Applicable only for **undirected** graphs.
- The algorithm does not considers traversal costs in the calculations.
- Running time: $O(V + E)$

Signatures

Summary

```
pgr_makeConnected(Edges SQL)

RETURNS SET OF (seq, start_vid, end_vid)
OR EMPTY SET
```

Example:

Query done on **Sample Data** network gives the list of edges that are needed in the graph to make it connected.

```
SELECT * FROM pgr_makeConnected(
    'SELECT id, source, target, cost, reverse_cost
     FROM edge_table'
);
 seq | start_vid | end_vid
-----+-----------+---------
   1 |        13 |      14
   2 |        15 |      16
(2 rows)
```

Parameters

Parameter	Type	Default	Description
Edges SQL	TEXT		SQL query as described below.

Inner query

Edges SQL:

an SQL query, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		• When positive: edge *(target, source)* is part of the graph. • When negative: edge *(target, source)* is not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	• When positive: edge *(target, source)* is part of the graph. • When negative: edge *(target, source)* is not part of the graph.

Where:

ANY-INTEGER:

SMALLINT, INTEGER, BIGINT

ANY-NUMERICAL:

SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns set of `(seq, start_vid, end_vid)`

Column	Type	Description
seq	INT	Sequential value starting from **1**.
start_vid	BIGINT	Identifier of the first end point vertex of the edge.
end_vid	BIGINT	Identifier of the second end point vertex of the edge.

See Also

- **https://www.boost.org/libs/graph/doc/make_connected.html**
- The queries use the **Sample Data** network.

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Parameters

Parameter	Type	Default	Description

Parameter	Type	Default	Description
Edges SQL	TEXT		Inner query as described below.

Inner query

Edges SQL:
an SQL query which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

pgr_connectedComponents & pgr_strongComponents

Returns set of (seq, component, node)

Column	Type	Description
seq	BIGINT	Sequential value starting from **1**.
component	BIGINT	Component identifier. It is equal to the minimum node identifier in the component.
node	BIGINT	Identifier of the vertex that belongs to**component**.

pgr_biconnectedComponents

Returns set of (seq, component, edge)

Column	Type	Description
seq	BIGINT	Sequential value starting from **1**.
component	BIGINT	Component identifier. It is equal to the minimum edge identifier in the component.
edge	BIGINT	Identifier of the edge.

pgr_articulationPoints

Returns set of (node)

Column	Type	Description
node	BIGINT	Identifier of the vertex.

pgr_bridges

Returns set of (edge)

Column	Type	Description
edge	BIGINT	Identifier of the edge that is a bridge.

pgr_makeConnected - Experimental

Returns set of `(seq, start_vid, end_vid)`

Column	Type	Description
seq	INT	Sequential value starting from **1**.
start_vid	BIGINT	Identifier of the first end point vertex of the edge.
end_vid	BIGINT	Identifier of the second end point vertex of the edge.

See Also

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- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2**

Contraction - Family of functions

- **pgr_contraction**

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3**

pgr_contraction

`pgr_contraction` — Performs graph contraction and returns the contracted vertices and edges.

Boost Graph Inside

Availability

- Version 3.0.0
  - Return columns change: `seq` is removed
  - Name change from `pgr_contractGraph`
  - Bug fixes
  - **Official** function
- Version 2.3.0
  - New **experimental** function

Description

Contraction reduces the size of the graph by removing some of the vertices and edges and, for example, might add edges that represent a sequence of original edges decreasing the total time and space used in graph algorithms.

The main Characteristics are:

- Process is done only on edges with positive costs.
- Does not return the full contracted graph
  - Only changes on the graph are returned
- Currnetly there are two types of contraction methods
  - Dead End Contraction
  - Linear Contraction
- The returned values include
  - the added edges by linear contraction.
  - the modified vertices by dead end contraction.
- The returned values are ordered as follows:
  - column *id* ascending when type = *v*
  - column *id* descending when type = *e*

Signatures

Summary

The pgr_contraction function has the following signature:

```
pgr_contraction(Edges SQL, Contraction order [, max_cycles] [, forbidden_vertices] [, directed])
RETURNS SETOF (type, id, contracted_vertices, source, target, cost)
```

Example:
Making a dead end contraction and a linear contraction with vertex 2 forbidden from being contracted

```
SELECT * FROM pgr_contraction(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
ARRAY[1, 2], forbidden_vertices:=ARRAY[2]);
 type | id | contracted_vertices | source | target | cost
------+----+---------------------+--------+--------+------
 v    |  2 | {1}                 |     -1 |     -1 |   -1
 v    |  5 | {7,8}               |     -1 |     -1 |   -1
 v    | 10 | {13}                |     -1 |     -1 |   -1
 v    | 15 | {14}                |     -1 |     -1 |   -1
 v    | 17 | {16}                |     -1 |     -1 |   -1
(5 rows)
```

Parameters

Column	Type	Description
Edges SQL	TEXT	SQL query as described in **Inner query**
Ccontraction Order	ARRAY[ANY-INTEGER]	Ordered contraction operations. • 1 = Dead end contraction • 2 = Linear contraction

Optional Parameters

Column	Type	Default	Description
forbidden_vertices	ARRAY[ANY-INTEGER]	Empty	Identifiers of vertices forbidden from contraction.
max_cycles	INTEGER	\(1\)	Number of times the contraction operations on*contraction_order* will be performed.
directed	BOOLEAN	true	• When true the graph is considered as *Directed*. • When false the graph is considered as *Undirected*.

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

RETURNS SETOF (type, id, contracted_vertices, source, target, cost)

The function returns a single row. The columns of the row are:

Column	Type	Description

Column	Type	Description
type	TEXT	Type of the *id*. • **'v'** when the row is a vertex. • **'e'** when the row is an edge.

id	BIGINT	All numbers on this column are DISTINCT
		• When type = **'v'**.
		  ◦ Identifier of the modified vertex.
		• When type = **'e'**.
		  ◦ Decreasing sequence starting from **-1**.
		  ◦ Representing a pseudo *id* as is not incorporated in the set of original edges.

contracted_vertices	ARRAY[BIGINT]	Array of contracted vertex identifiers.
source	BIGINT	• When type = **'v'**: \(-1\) • When type = **'e'**: Identifier of the source vertex of the current edge (source, target).
target	BIGINT	• When type = **'v'**: \(-1\) • When type = **'e'**: Identifier of the target vertex of the current edge (source, target).
cost	FLOAT	• When type = **'v'**: \(-1\) • When type = **'e'**: Weight of the current edge (source, target).

Additional Examples

Example:
Only dead end contraction

```
SELECT * FROM pgr_contraction(
   'SELECT id, source, target, cost, reverse_cost FROM edge_table',
ARRAY[1]);
 type | id | contracted_vertices | source | target | cost
------+----+---------------------+--------+--------+------
 v    |  2 | {1}                 |     -1 |     -1 |   -1
 v    |  5 | {7,8}               |     -1 |     -1 |   -1
 v    | 10 | {13}                |     -1 |     -1 |   -1
 v    | 15 | {14}                |     -1 |     -1 |   -1
 v    | 17 | {16}                |     -1 |     -1 |   -1
(5 rows)
```

Example:
Only linear contraction

```
SELECT * FROM pgr_contraction(
   'SELECT id, source, target, cost, reverse_cost FROM edge_table',
ARRAY[2]);
 type | id | contracted_vertices | source | target | cost
------+----+---------------------+--------+--------+------
 e    | -1 | {8}                 |      5 |      7 |    2
 e    | -2 | {8}                 |      7 |      5 |    2
(2 rows)
```

See Also

- **Contraction - Family of functions**

Indices and tables

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Introduction

In large graphs, like the road graphs, or electric networks, graph contraction can be used to speed up some graph algorithms. Contraction reduces the size of the graph by removing some of the vertices and edges and, for example, might add edges that represent a sequence of original edges decreasing the total time and space used in graph algorithms.

This implementation gives a flexible framework for adding contraction algorithms in the future, currently, it supports two algorithms:

1. Dead end contraction
2. Linear contraction

Allowing the user to:

- Forbid contraction on a set of nodes.
- Decide the order of the contraction algorithms and set the maximum number of times they are to be executed.

Dead end contraction

In the algorithm, dead end contraction is represented by 1.

Dead end

In case of an undirected graph, a node is considered a *dead end* node when

- **The number of adjacent vertices is 1.**

In case of a directed graph, a node is considered a *dead end* node when

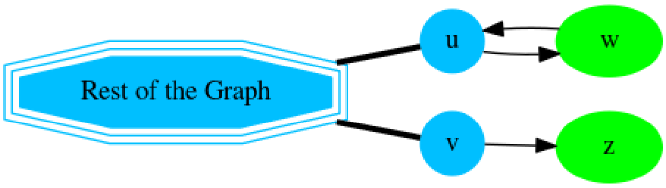
- **The number of adjacent vertices is 1.**
  - **There are no outgoing edges and has at least one incoming edge.**
  - **There are no incoming edges and has at least one outgoing edge.**

When the conditions are true then the **Operation: Dead End Contraction** can be done.

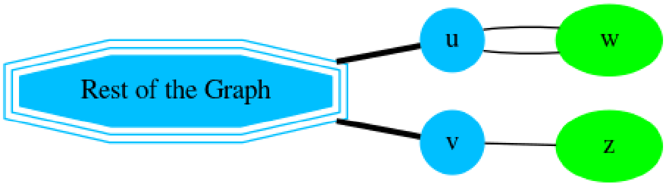
The number of adjacent vertices is 1.

- The green nodes are **dead end** nodes
- The blue nodes have an unlimited number of incoming and outgoing edges.

Directed graph



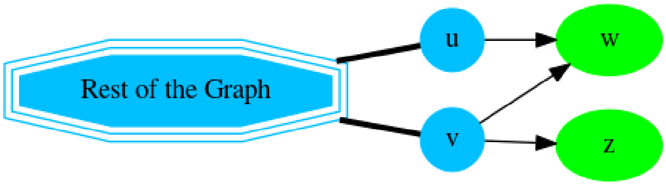
Undirected graph



There are no outgoing edges and has at least one incoming edge.

- The green nodes are **dead end** nodes
- The blue nodes have an unlimited number of incoming and outgoing edges.

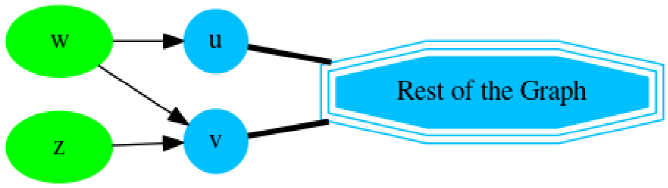
Directed graph



There are no incoming edges and has at least one outgoing edge.

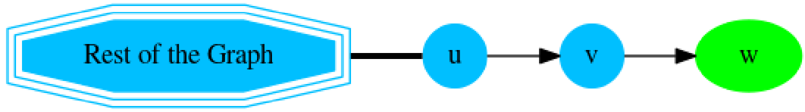
- The green nodes are **dead end** nodes
- The blue nodes have an unlimited number of incoming and outgoing edges.
- Considering that the nodes are *dead starts* nodes

Directed graph

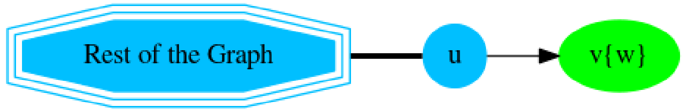


Operation: Dead End Contraction

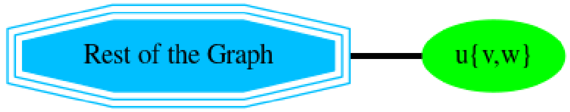
The dead end contraction will stop until there are no more dead end nodes. For example from the following graph where `w` is the **dead end** node:



After contracting `w`, node `v` is now a **dead end** node and is contracted:



After contracting `v`, stop. Node `u` has the information of nodes that were contrcted.



Node `u` has the information of nodes that were contracted.

Linear contraction

In the algorithm, linear contraction is represented by 2.

Linear

In case of an undirected graph, a node is considered a *linear* node when

- **The number of adjacent vertices is 2.**

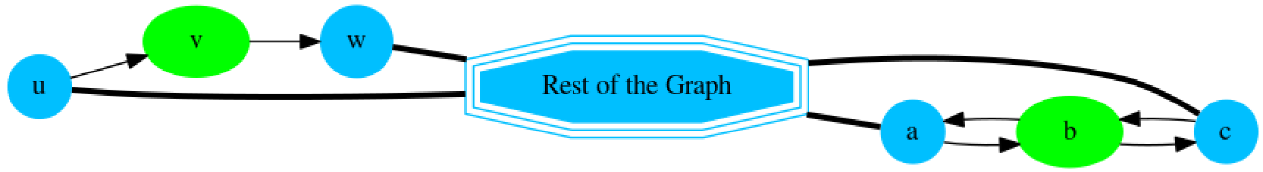
In case of a directed graph, a node is considered a *linear* node when

- **The number of adjacent vertices is 2.**
  - **Linearity is symmetrical**

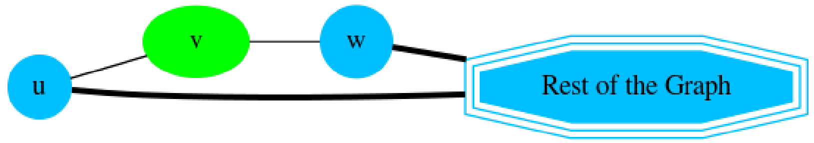
The number of adjacent vertices is 2.

- The green nodes are **linear** nodes
- The blue nodes have an unlimited number of incoming and outgoing edges.

Directed

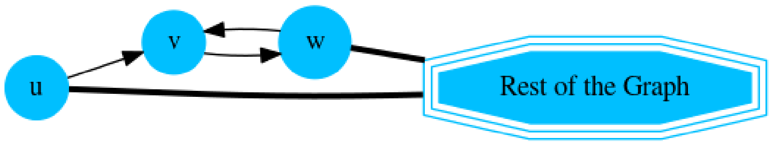


Undirected



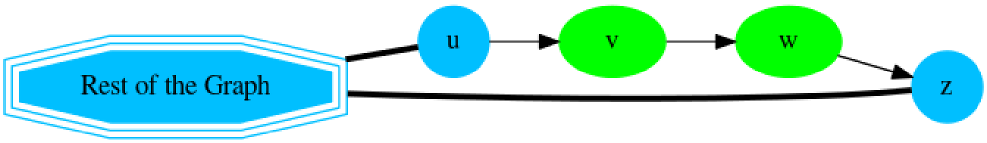
Linearity is symmetrical

Using a contra example, vertex `v` is not linear because it's not possible to go from `w` to `u` via `v`.



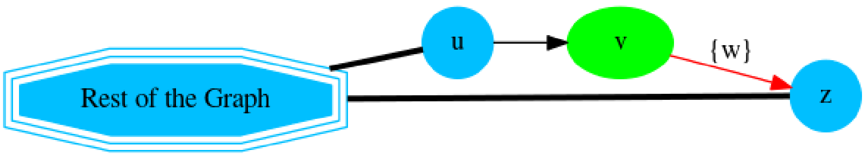
Operation: Linear Contraction

The linear contraction will stop until there are no more linear nodes. For example from the following graph where `v` and `w` are **linear** nodes:



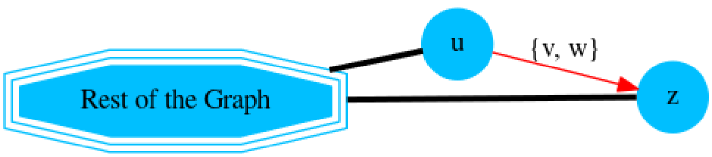
After contracting `w`,

- The vertex `w` is removed from the graph
  - The edges $v \rightarrow w$ and $w \rightarrow z$ are removed from the graph.
- A new edge $v \rightarrow z$ is inserted represented with red color.



Contracting `v`:

- The vertex `v` is removed from the graph
  - The edges $u \rightarrow v$ and $v \rightarrow z$ are removed from the graph.
- A new edge $u \rightarrow z$ is inserted represented with red color.



Edge $u \rightarrow z$ has the information of nodes that were contracted.

The cycle

Contracting a graph, can be done with more than one operation. The order of the operations affect the resulting contracted graph, after applying one operation, the set of vertices that can be contracted by another operation changes.

This implementation, cycles `max_cycles` times through `operations_order` .

```
<input>
do max_cycles times {
    for (operation in operations_order)
     { do operation }
}
<output>
```

Contracting Sample Data

In this section, building and using a contracted graph will be shown by example.

- The **Sample Data** for an undirected graph is used
- a dead end operation first followed by a linear operation.

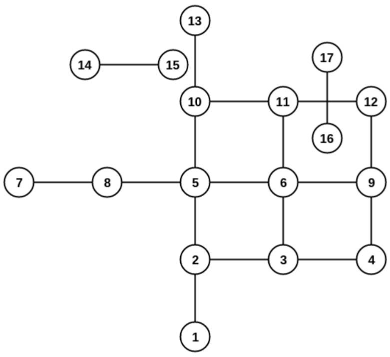
Construction of the graph in the database

Original Data

The following query shows the original data involved in the contraction operation.

```
SELECT id, source, target, cost, reverse_cost FROM edge_table;
 id | source | target | cost | reverse_cost
----+--------+--------+------+--------------
  1 |      1 |      2 |    1 |            1
  2 |      2 |      3 |   -1 |            1
  3 |      3 |      4 |   -1 |            1
  4 |      2 |      5 |    1 |            1
  5 |      3 |      6 |    1 |           -1
  6 |      7 |      8 |    1 |            1
  7 |      8 |      5 |    1 |            1
  8 |      5 |      6 |    1 |            1
  9 |      6 |      9 |    1 |            1
 10 |      5 |     10 |    1 |            1
 11 |      6 |     11 |    1 |           -1
 12 |     10 |     11 |    1 |           -1
 13 |     11 |     12 |    1 |           -1
 14 |     10 |     13 |    1 |            1
 15 |      9 |     12 |    1 |            1
 16 |      4 |      9 |    1 |            1
 17 |     14 |     15 |    1 |            1
 18 |     16 |     17 |    1 |            1
(18 rows)
```

The original graph:



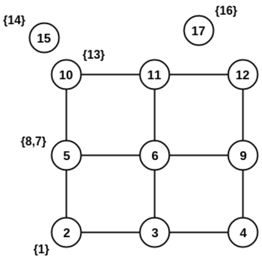
Contraction Results

The results do not represent the contracted graph. They represent the changes done to the graph after applying the contraction algorithm.

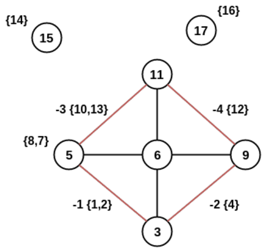
Observe that vertices, for example,\(6\) do not appear in the results because it was not affected by the contraction algorithm.

```
SELECT * FROM pgr_contraction(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    array[1,2], directed:=false);
 type | id | contracted_vertices | source | target | cost
------+----+---------------------+--------+--------+------
 v    |  5 | {7,8}               |     -1 |     -1 |   -1
 v    | 15 | {14}                |     -1 |     -1 |   -1
 v    | 17 | {16}                |     -1 |     -1 |   -1
 e    | -1 | {1,2}               |      3 |      5 |    2
 e    | -2 | {4}                 |      3 |      9 |    2
 e    | -3 | {10,13}             |      5 |     11 |    2
 e    | -4 | {12}                |      9 |     11 |    2
(7 rows)
```

After doing the dead end contraction operation:



After doing the linear contraction operation to the graph above:



The process to create the contraction graph on the database:

- **Add additional columns**
- **Store contraction information**
- **Update the vertices and edge tables**

Add additional columns

Adding extra columns to the `edge_table` and `edge_table_vertices_pgr` tables, where:

Column	Description
contracted_vertices	The vertices set belonging to the vertex/edge
is_contracted	On the *vertex* table - when `true` the vertex is contracted, its not part of the contracted graph. - when `false` the vertex is not contracted, its part of the contracted graph.
is_new	On the *edge* table: - when `true` the edge was generated by the contraction algorithm. its part of the contracted graph. - when `false` the edge is an original edge, might be or not part of the contracted graph.

```
ALTER TABLE edge_table_vertices_pgr ADD is_contracted BOOLEAN DEFAULT false;
ALTER TABLE
ALTER TABLE edge_table_vertices_pgr ADD contracted_vertices BIGINT[];
ALTER TABLE
ALTER TABLE edge_table ADD is_new BOOLEAN DEFAULT false;
ALTER TABLE
ALTER TABLE edge_table ADD contracted_vertices BIGINT[];
ALTER TABLE
```

Store contraction information

Store the **contraction results** in a table

```
SELECT * INTO contraction_results
FROM pgr_contraction(
   'SELECT id, source, target, cost, reverse_cost FROM edge_table',
   array[1,2], directed:=false);
SELECT 7
```

Update the vertices and edge tables

Update the *vertex* table using the contraction information

Use `edge_table_vertices_pgr.is_contracted` to indicate the vertices that are contracted.

```
UPDATE edge_table_vertices_pgr
SET is_contracted = true
WHERE id IN (SELECT  unnest(contracted_vertices) FROM  contraction_results);
UPDATE 10
```

Add to `edge_table_vertices_pgr.contracted_vertices` the contracted vertices belonging to the vertices.

```
UPDATE edge_table_vertices_pgr
SET contracted_vertices = contraction_results.contracted_vertices
FROM contraction_results
WHERE type = 'v' AND edge_table_vertices_pgr.id = contraction_results.id;
UPDATE 3
```

The modified `edge_table_vertices_pgr`.

```
SELECT id, contracted_vertices, is_contracted
FROM edge_table_vertices_pgr
ORDER BY id;
 id | contracted_vertices | is_contracted
----+---------------------+---------------
  1 |                     | t
  2 |                     | t
  3 |                     | f
  4 |                     | t
  5 | {7,8}               | f
  6 |                     | f
  7 |                     | t
  8 |                     | t
  9 |                     | f
 10 |                     | t
 11 |                     | f
 12 |                     | t
 13 |                     | t
 14 |                     | t
 15 | {14}                | f
 16 |                     | t
 17 | {16}                | f
(17 rows)
```

Update the *edge* table using the contraction information

Insert the new edges generated by pgr_contraction.

```
INSERT INTO edge_table(source, target, cost, reverse_cost, contracted_vertices, is_new)
SELECT source, target, cost, -1, contracted_vertices, true
FROM contraction_results
WHERE type = 'e';
INSERT 0 4
```

The modified `edge_table`.

```
SELECT id, source, target, cost, reverse_cost, contracted_vertices, is_new
FROM edge_table
ORDER BY id;
 id | source | target | cost | reverse_cost | contracted_vertices | is_new
----+--------+--------+------+--------------+---------------------+--------
  1 |      1 |      2 |    1 |            1 |                     | f
  2 |      2 |      3 |   -1 |            1 |                     | f
  3 |      3 |      4 |   -1 |            1 |                     | f
  4 |      2 |      5 |    1 |            1 |                     | f
  5 |      3 |      6 |    1 |           -1 |                     | f
  6 |      7 |      8 |    1 |            1 |                     | f
  7 |      8 |      5 |    1 |            1 |                     | f
  8 |      5 |      6 |    1 |            1 |                     | f
  9 |      6 |      9 |    1 |            1 |                     | f
 10 |      5 |     10 |    1 |            1 |                     | f
 11 |      6 |     11 |    1 |           -1 |                     | f
 12 |     10 |     11 |    1 |           -1 |                     | f
 13 |     11 |     12 |    1 |           -1 |                     | f
 14 |     10 |     13 |    1 |            1 |                     | f
 15 |      9 |     12 |    1 |            1 |                     | f
 16 |      4 |      9 |    1 |            1 |                     | f
 17 |     14 |     15 |    1 |            1 |                     | f
 18 |     16 |     17 |    1 |            1 |                     | f
 19 |      3 |      5 |    2 |           -1 | {1,2}               | t
 20 |      3 |      9 |    2 |           -1 | {4}                 | t
 21 |      5 |     11 |    2 |           -1 | {10,13}             | t
 22 |      9 |     11 |    2 |           -1 | {12}                | t
(22 rows)
```

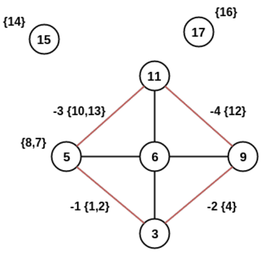
The contracted graph

Vertices that belong to the contracted graph.

```
SELECT id
FROM edge_table_vertices_pgr
WHERE is_contracted = false
ORDER BY id;
 id
----
  3
  5
  6
  9
 11
 15
 17
(7 rows)
```

Edges that belong to the contracted graph.

```
WITH
vertices_in_graph AS (
    SELECT id
    FROM edge_table_vertices_pgr
    WHERE is_contracted = false
)
SELECT id, source, target, cost, reverse_cost, contracted_vertices
FROM edge_table
WHERE source IN (SELECT * FROM vertices_in_graph)
AND target IN (SELECT * FROM vertices_in_graph)
ORDER BY id;
 id | source | target | cost | reverse_cost | contracted_vertices
----+--------+--------+------+--------------+--------------------
  5 |      3 |      6 |    1 |           -1 |
  8 |      5 |      6 |    1 |            1 |
  9 |      6 |      9 |    1 |            1 |
 11 |      6 |     11 |    1 |           -1 |
 19 |      3 |      5 |    2 |           -1 | {1,2}
 20 |      3 |      9 |    2 |           -1 | {4}
 21 |      5 |     11 |    2 |           -1 | {10,13}
 22 |      9 |     11 |    2 |           -1 | {12}
(8 rows)
```



Using the contracted graph

Using the contracted graph with `pgr_dijkstra`

There are three cases when calculating the shortest path between a given source and target in a contracted graph:

- Case 1: Both source and target belong to the contracted graph.
- Case 2: Source and/or target belong to an edge subgraph.
- Case 3: Source and/or target belong to a vertex.

Case 1: Both source and target belong to the contracted graph.

Using the **Edges that belong to the contracted graph.** on lines 10 to 19.

```
1 CREATE OR REPLACE FUNCTION my_dijkstra(
2     departure BIGINT, destination BIGINT,
3     OUT seq INTEGER, OUT path_seq INTEGER,
4     OUT node BIGINT, OUT edge BIGINT,
5     OUT cost FLOAT, OUT agg_cost FLOAT)
6 RETURNS SETOF RECORD AS
7 $BODY$
8 SELECT * FROM pgr_dijkstra(
9     $$
10     WITH
11     vertices_in_graph AS (
12         SELECT id
13         FROM edge_table_vertices_pgr
14         WHERE is_contracted = false
15     )
16     SELECT id, source, target, cost, reverse_cost
17     FROM edge_table
18     WHERE source IN (SELECT * FROM vertices_in_graph)
19     AND target IN (SELECT * FROM vertices_in_graph)
20     $$,
21     departure, destination, false);
22 $BODY$
23 LANGUAGE SQL VOLATILE;
24 CREATE FUNCTION
```

Case 1

When both source and target belong to the contracted graph, a path is found.

```
SELECT * FROM my_dijkstra(3, 11);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    3 |    5 |    1 |        0
   2 |        2 |    6 |   11 |    1 |        1
   3 |        3 |   11 |   -1 |    0 |        2
(3 rows)
```

Case 2

When source and/or target belong to an edge subgraph then a path is not found.

In this case, the contracted graph do not have an edge connecting with node\(4\).

```
SELECT * FROM my_dijkstra(4, 11);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
(0 rows)
```

Case 3

When source and/or target belong to a vertex then a path is not found.

In this case, the contracted graph do not have an edge connecting with node\(7\) and of node\(4\) of the second case.

```
SELECT * FROM my_dijkstra(4, 7);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
(0 rows)
```

Case 2: Source and/or target belong to an edge subgraph.

Refining the above function to include nodes that belong to an edge.

- The vertices that need to be expanded are calculated on lines 10 to 16.
- Adding to the contracted graph that additional section on lines 25 to 27.

```
1 CREATE OR REPLACE FUNCTION my_dijkstra(
2     departure BIGINT, destination BIGINT,
3     OUT seq INTEGER, OUT path_seq INTEGER,
4     OUT node BIGINT, OUT edge BIGINT,
5     OUT cost FLOAT, OUT agg_cost FLOAT)
6 RETURNS SETOF RECORD AS
7 $BODY$
8 SELECT * FROM pgr_dijkstra(
9     $$
10     WITH
11     edges_to_expand AS (
12         SELECT id
13         FROM edge_table
14         WHERE ARRAY[$$ || departure || $$]::BIGINT[] <@ contracted_vertices
15            OR ARRAY[$$ || destination || $$]::BIGINT[] <@ contracted_vertices
16     ),
17
18     vertices_in_graph AS (
19         SELECT id
20         FROM edge_table_vertices_pgr
21         WHERE is_contracted = false
22
23         UNION
24
25         SELECT unnest(contracted_vertices)
26         FROM edge_table
27         WHERE id IN (SELECT id FROM edges_to_expand)
28     )
29
30     SELECT id, source, target, cost, reverse_cost
31     FROM edge_table
32     WHERE source IN (SELECT * FROM vertices_in_graph)
33     AND target IN (SELECT * FROM vertices_in_graph)
34     $$,
35     departure, destination, false);
36 $BODY$
37 LANGUAGE SQL VOLATILE;
38 CREATE FUNCTION
```

Case 1

When both source and target belong to the contracted graph, a path is found.

```
SELECT * FROM my_dijkstra(3, 11);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    3 |    5 |    1 |        0
   2 |        2 |    6 |   11 |    1 |        1
   3 |        3 |   11 |   -1 |    0 |        2
(3 rows)
```

Case 2

When source and/or target belong to an edge subgraph, now, a path is found.

The routing graph now has an edge connecting with node\(4\).

```
SELECT * FROM my_dijkstra(4, 11);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    4 |   16 |    1 |        0
   2 |        2 |    9 |   22 |    2 |        1
   3 |        3 |   11 |   -1 |    0 |        3
(3 rows)
```

Case 3

When source and/or target belong to a vertex then a path is not found.

In this case, the contracted graph do not have an edge connecting with node\(7\).

```
SELECT * FROM my_dijkstra(4, 7);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
(0 rows)
```

Case 3: Source and/or target belong to a vertex.

Refining the above function to include nodes that belong to an edge.

- The vertices that need to be expanded are calculated on lines 18 to 23.
- Adding to the contracted graph that additional section on lines 38 to 40.

```
CREATE OR REPLACE FUNCTION my_dijkstra(
    departure BIGINT, destination BIGINT,
    OUT seq INTEGER, OUT path_seq INTEGER,
    OUT node BIGINT, OUT edge BIGINT,
    OUT cost FLOAT, OUT agg_cost FLOAT)
RETURNS SETOF RECORD AS
$BODY$
SELECT * FROM pgr_dijkstra(
    $$
     WITH
     edges_to_expand AS (
         SELECT id
         FROM edge_table
         WHERE ARRAY[$$ || departure || $$]::BIGINT[] <@ contracted_vertices
            OR ARRAY[$$ || destination || $$]::BIGINT[] <@ contracted_vertices
     ),

     vertices_to_expand AS (
         SELECT id
         FROM edge_table_vertices_pgr
         WHERE ARRAY[$$ || departure || $$]::BIGINT[] <@ contracted_vertices
            OR ARRAY[$$ || destination || $$]::BIGINT[] <@ contracted_vertices
     ),

     vertices_in_graph AS (
         SELECT id
         FROM edge_table_vertices_pgr
         WHERE is_contracted = false

         UNION

         SELECT unnest(contracted_vertices)
         FROM edge_table
         WHERE id IN (SELECT id FROM edges_to_expand)

         UNION

         SELECT unnest(contracted_vertices)
         FROM edge_table_vertices_pgr
         WHERE id IN (SELECT id FROM vertices_to_expand)
     )

     SELECT id, source, target, cost, reverse_cost
     FROM edge_table
     WHERE source IN (SELECT * FROM vertices_in_graph)
     AND target IN (SELECT * FROM vertices_in_graph)
     $$,
     departure, destination, false);
$BODY$
LANGUAGE SQL VOLATILE;
CREATE FUNCTION
```

Case 1

When both source and target belong to the contracted graph, a path is found.

```
SELECT * FROM my_dijkstra(3, 11);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    3 |    5 |    1 |        0
   2 |        2 |    6 |   11 |    1 |        1
   3 |        3 |   11 |   -1 |    0 |        2
(3 rows)
```

Case 2

The code change do not affect this case so when source and/or target belong to an edge subgraph, a path is still found.

```
SELECT * FROM my_dijkstra(4, 11);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    4 |   16 |    1 |        0
   2 |        2 |    9 |   22 |    2 |        1
   3 |        3 |   11 |   -1 |    0 |        3
(3 rows)
```

Case 3

When source and/or target belong to a vertex, now, a path is found.

Now, the routing graph has an edge connecting with node\(7\).

```
SELECT * FROM my_dijkstra(4, 7);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    4 |    3 |    1 |        0
   2 |        2 |    3 |   19 |    2 |        1
   3 |        3 |    5 |    7 |    1 |        3
   4 |        4 |    8 |    6 |    1 |        4
   5 |        5 |    7 |   -1 |    0 |        5
(5 rows)
```

See Also

- **https://www.cs.cmu.edu/afs/cs/academic/class/15210-f12/www/lectures/lecture16.pdf**
- **https://algo2.iti.kit.edu/documents/routeplanning/geisberger_dipl.pdf**
- The queries use **pgr_contraction** function and the **Sample Data** network.

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2**

Dijkstra - Family of functions

- **pgr_dijkstra** - Dijkstra's algorithm for the shortest paths.
- **pgr_dijkstraCost** - Get the aggregate cost of the shortest paths.
- **pgr_dijkstraCostMatrix** - Use pgr_dijkstra to create a costs matrix.
- **pgr_drivingDistance** - Use pgr_dijkstra to calculate catchament information.
- **pgr_KSP** - Use Yen algorithm with pgr_dijkstra to get the K shortest paths.

Proposed

Warning

Proposed functions for next mayor release.

- They are not officially in the current release.
- They will likely officially be part of the next mayor release:
  - The functions make use of ANY-INTEGER and ANY-NUMERICAL
  - Name might not change. (But still can)
  - Signature might not change. (But still can)
  - Functionality might not change. (But still can)
  - pgTap tests have being done. But might need more.
  - Documentation might need refinement.

- **pgr_dijkstraVia - Proposed** - Get a route of a seuence of vertices.

Experimental

Warning

Proposed functions for next mayor release.

- They are not officially in the current release.
- They will likely officially be part of the next mayor release:
  - The functions make use of ANY-INTEGER and ANY-NUMERICAL
  - Name might not change. (But still can)
  - Signature might not change. (But still can)
  - Functionality might not change. (But still can)
  - pgTap tests have being done. But might need more.
  - Documentation might need refinement.

- **pgr_dijkstraNear - Experimental** - Get the route to the nearest vertex.
- **pgr_dijkstraNearCost - Experimental** - Get the cost to the nearest vertex.

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2 2.1 2.0**

pgr_dijkstra

`pgr_dijkstra` — Returns the shortest path(s) using Dijkstra algorithm. In particular, the Dijkstra algorithm implemented by Boost.Graph.

Boost Graph Inside

Availability

- Version 3.1.0
  - New **Proposed** functions:
    - pgr_dijkstra(combinations)
- Version 3.0.0
  - **Official** functions
- Version 2.2.0
  - New **proposed** functions:
    - pgr_dijkstra(One to Many)
    - pgr_dijkstra(Many to One)
    - pgr_dijkstra(Many to Many)
- Version 2.1.0
  - Signature change on pgr_dijkstra(One to One)
- Version 2.0.0
  - **Official** pgr_dijkstra(One to One)

Description

Dijkstra's algorithm, conceived by Dutch computer scientist Edsger Dijkstra in 1956. It is a graph search algorithm that solves the shortest path problem for a graph with non-negative edge path costs, producing a shortest path from a starting vertex (`start_vid`) to an ending vertex (`end_vid`). This implementation can be used with a directed graph and an undirected graph.

The main characteristics are:

- Process is done only on edges with positive costs.
- Values are returned when there is a path.
  - When the starting vertex and ending vertex are the same, there is no path.
    - The *agg_cost* the non included values *(v, v)* is *0*
  - When the starting vertex and ending vertex are the different and there is no path:
    - The *agg_cost* the non included values *(u, v)* is ∞
- For optimization purposes, any duplicated value in the *start_vids* or *end_vids* are ignored.
- The returned values are ordered:
  - *start_vid* ascending
  - *end_vid* ascending
- Running time: $O(| start\_vids | * (V \log V + E))$

Signatures

Summary

```
pgr_dijkstra(Edges SQL, start_vid,  end_vid  [, directed])
pgr_dijkstra(Edges SQL, start_vid,  end_vids [, directed])
pgr_dijkstra(Edges SQL, start_vids, end_vid  [, directed])
pgr_dijkstra(Edges SQL, start_vids, end_vids [, directed])
pgr_dijkstra(Edges SQL, Combinations SQL [, directed]) -- Proposed on v3.1
RETURNS SET OF (seq, path_seq [, start_vid] [, end_vid], node, edge, cost, agg_cost)
OR EMPTY SET
```

Using defaults

```
pgr_dijkstra(Edges SQL, start_vid, end_vid)
RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost) or EMPTY SET
```

Example:

From vertex \(2\) to vertex \(3\) on a **directed** graph

```
SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, 3
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    4 |    1 |        0
   2 |        2 |    5 |    8 |    1 |        1
   3 |        3 |    6 |    9 |    1 |        2
   4 |        4 |    9 |   16 |    1 |        3
   5 |        5 |    4 |    3 |    1 |        4
   6 |        6 |    3 |   -1 |    0 |        5
(6 rows)
```

One to One

```
pgr_dijkstra(Edges SQL, start_vid,  end_vid  [, directed])
RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertex \(2\) to vertex \(3\) on an **undirected** graph

```
SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, 3,
    FALSE
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    2 |    1 |        0
   2 |        2 |    3 |   -1 |    0 |        1
(2 rows)
```

One to many

```
pgr_dijkstra(Edges SQL, start_vid, end_vids, [, directed])
RETURNS SET OF (seq, path_seq, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertex \(2\) to vertices \(\{3, 5\}\) on an **undirected** graph

```
SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost FROM edge_table',
    2, ARRAY[3,5],
    FALSE
);
 seq | path_seq | end_vid | node | edge | cost | agg_cost
-----+----------+---------+------+------+------+----------
   1 |        1 |       3 |    2 |    4 |    1 |        0
   2 |        2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |       3 |    6 |    5 |    1 |        2
   4 |        4 |       3 |    3 |   -1 |    0 |        3
   5 |        1 |       5 |    2 |    4 |    1 |        0
   6 |        2 |       5 |    5 |   -1 |    0 |        1
(6 rows)
```

Many to One

```
pgr_dijkstra(Edges SQL, start_vids, end_vid, [, directed])
RETURNS SET OF (seq, path_seq, start_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertices \(\{2, 11\}\) to vertex \(5\) on a **directed** graph

```
SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[2,11], 5
);
 seq | path_seq | start_vid | node | edge | cost | agg_cost
-----+----------+-----------+------+------+------+----------
   1 |        1 |         2 |    2 |    4 |    1 |        0
   2 |        2 |         2 |    5 |   -1 |    0 |        1
   3 |        1 |        11 |   11 |   13 |    1 |        0
   4 |        2 |        11 |   12 |   15 |    1 |        1
   5 |        3 |        11 |    9 |    9 |    1 |        2
   6 |        4 |        11 |    6 |    8 |    1 |        3
   7 |        5 |        11 |    5 |   -1 |    0 |        4
(7 rows)
```

Many to Many

```
pgr_dijkstra(Edges SQL, start_vids, end_vids, [, directed])
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertices \(\{2, 11\}\) to vertices \(\{3, 5\}\) on an **undirected** graph

```
SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[2,11], ARRAY[3,5],
    FALSE
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    2 |    1 |        0
   2 |        2 |         2 |       3 |    3 |   -1 |    0 |        1
   3 |        1 |         2 |       5 |    2 |    4 |    1 |        0
   4 |        2 |         2 |       5 |    5 |   -1 |    0 |        1
   5 |        1 |        11 |       3 |   11 |   11 |    1 |        0
   6 |        2 |        11 |       3 |    6 |    5 |    1 |        1
   7 |        3 |        11 |       3 |    3 |   -1 |    0 |        2
   8 |        1 |        11 |       5 |   11 |   11 |    1 |        0
   9 |        2 |        11 |       5 |    6 |    8 |    1 |        1
  10 |        3 |        11 |       5 |    5 |   -1 |    0 |        2
(10 rows)
```

Combinations

```
pgr_dijkstra(Edges SQL, Combinations SQL, end_vids, [, directed])
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
Using a combinations table on an **undirected** graph

```
SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    'SELECT * FROM combinations_table',
    FALSE
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         1 |       2 |    1 |    1 |    1 |        0
   2 |        2 |         1 |       2 |    2 |   -1 |    0 |        1
   3 |        1 |         1 |       4 |    1 |    1 |    1 |        0
   4 |        2 |         1 |       4 |    2 |    2 |    1 |        1
   5 |        3 |         1 |       4 |    3 |    3 |    1 |        2
   6 |        4 |         1 |       4 |    4 |   -1 |    0 |        3
   7 |        1 |         2 |       1 |    2 |    1 |    1 |        0
   8 |        2 |         2 |       1 |    1 |   -1 |    0 |        1
   9 |        1 |         2 |       4 |    2 |    2 |    1 |        0
  10 |        2 |         2 |       4 |    3 |    3 |    1 |        1
  11 |        3 |         2 |       4 |    4 |   -1 |    0 |        2
(11 rows)
```

Parameters

Parameter	Type	Default	Description
Edges SQL	TEXT		**Edges query** as described below
Combinations SQL	TEXT		**Combinations query** as described below
start_vid	BIGINT		Identifier of the starting vertex of the path.

Parameter	Type	Default	Description
start_vids	ARRAY[BIGINT]		Array of identifiers of starting vertices.
end_vid	BIGINT		Identifier of the ending vertex of the path.
end_vids	ARRAY[BIGINT]		Array of identifiers of ending vertices.
directed	BOOLEAN	true	• When true Graph is considered *Directed* • When false the graph is considered as *Undirected*.

Inner queries

Edges query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Combinations query

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

Return Columns

Returns set of (seq, path_id, path_seq [, start_vid] [, end_vid], node, edge, cost, agg_cost)

Column	Type	Description
seq	INT	Sequential value starting from **1**.
path_id	INT	Path identifier. Has value **1** for the first of a path. Used when there are multiple paths for the same start_vid to end_vid combination.
path_seq	INT	Relative position in the path. Has value **1** for the beginning of a path.
start_vid	BIGINT	Identifier of the starting vertex. Returned when multiple starting vetrices are in the query. • **Many to One** • **Many to Many**
end_vid	BIGINT	Identifier of the ending vertex. Returned when multiple ending vertices are in the query. • **One to Many** • **Many to Many**
node	BIGINT	Identifier of the node in the path from start_vid to end_vid.
edge	BIGINT	Identifier of the edge used to go from node to the next node in the path sequence. -1 for the last node of the path.
cost	FLOAT	Cost to traverse from node using edge to the next node in the path sequence.
agg_cost	FLOAT	Aggregate cost from start_v to node.

Additional Examples

The examples of this section are based on the **Sample Data** network.

The examples include combinations from starting vertices 2 and 11 to ending vertices 3 and 5 in a directed and undirected graph with and with out reverse_cost.

Examples:
For queries marked as `directed` with `cost` and `reverse_cost` columns

The examples in this section use the following **Network for queries marked as directed and cost and reverse_cost columns are used**

```
SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, 3
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    4 |    1 |        0
   2 |        2 |    5 |    8 |    1 |        1
   3 |        3 |    6 |    9 |    1 |        2
   4 |        4 |    9 |   16 |    1 |        3
   5 |        5 |    4 |    3 |    1 |        4
   6 |        6 |    3 |   -1 |    0 |        5
(6 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, 5
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    4 |    1 |        0
   2 |        2 |    5 |   -1 |    0 |        1
(2 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, ARRAY[3,5]
);
 seq | path_seq | end_vid | node | edge | cost | agg_cost
-----+----------+---------+------+------+------+----------
   1 |        1 |       3 |    2 |    4 |    1 |        0
   2 |        2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |       3 |    6 |    9 |    1 |        2
   4 |        4 |       3 |    9 |   16 |    1 |        3
   5 |        5 |       3 |    4 |    3 |    1 |        4
   6 |        6 |       3 |    3 |   -1 |    0 |        5
   7 |        1 |       5 |    2 |    4 |    1 |        0
   8 |        2 |       5 |    5 |   -1 |    0 |        1
(8 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    11, 3
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |   11 |   13 |    1 |        0
   2 |        2 |   12 |   15 |    1 |        1
   3 |        3 |    9 |   16 |    1 |        2
   4 |        4 |    4 |    3 |    1 |        3
   5 |        5 |    3 |   -1 |    0 |        4
(5 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    11, 5
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |   11 |   13 |    1 |        0
   2 |        2 |   12 |   15 |    1 |        1
   3 |        3 |    9 |    9 |    1 |        2
   4 |        4 |    6 |    8 |    1 |        3
   5 |        5 |    5 |   -1 |    0 |        4
(5 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[2,11], 5
);
 seq | path_seq | start_vid | node | edge | cost | agg_cost
-----+----------+-----------+------+------+------+----------
   1 |        1 |         2 |    2 |    4 |    1 |        0
   2 |        2 |         2 |    5 |   -1 |    0 |        1
   3 |        1 |        11 |   11 |   13 |    1 |        0
   4 |        2 |        11 |   12 |   15 |    1 |        1
   5 |        3 |        11 |    9 |    9 |    1 |        2
   6 |        4 |        11 |    6 |    8 |    1 |        3
   7 |        5 |        11 |    5 |   -1 |    0 |        4
```

```
  7 |        5 |        11 |       5 |   -1 |    0 |        4
(7 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[2, 11], ARRAY[3,5]
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    4 |    1 |        0
   2 |        2 |         2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |         2 |       3 |    6 |    9 |    1 |        2
   4 |        4 |         2 |       3 |    9 |   16 |    1 |        3
   5 |        5 |         2 |       3 |    4 |    3 |    1 |        4
   6 |        6 |         2 |       3 |    3 |   -1 |    0 |        5
   7 |        1 |         2 |       5 |    2 |    4 |    1 |        0
   8 |        2 |         2 |       5 |    5 |   -1 |    0 |        1
   9 |        1 |        11 |       3 |   11 |   13 |    1 |        0
  10 |        2 |        11 |       3 |   12 |   15 |    1 |        1
  11 |        3 |        11 |       3 |    9 |   16 |    1 |        2
  12 |        4 |        11 |       3 |    4 |    3 |    1 |        3
  13 |        5 |        11 |       3 |    3 |   -1 |    0 |        4
  14 |        1 |        11 |       5 |   11 |   13 |    1 |        0
  15 |        2 |        11 |       5 |   12 |   15 |    1 |        1
  16 |        3 |        11 |       5 |    9 |    9 |    1 |        2
  17 |        4 |        11 |       5 |    6 |    8 |    1 |        3
  18 |        5 |        11 |       5 |    5 |   -1 |    0 |        4
(18 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    'SELECT * FROM (VALUES (2, 3), (2, 5), (11, 3), (11, 5)) AS combinations (source, target)'
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    4 |    1 |        0
   2 |        2 |         2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |         2 |       3 |    6 |    9 |    1 |        2
   4 |        4 |         2 |       3 |    9 |   16 |    1 |        3
   5 |        5 |         2 |       3 |    4 |    3 |    1 |        4
   6 |        6 |         2 |       3 |    3 |   -1 |    0 |        5
   7 |        1 |         2 |       5 |    2 |    4 |    1 |        0
   8 |        2 |         2 |       5 |    5 |   -1 |    0 |        1
   9 |        1 |        11 |       3 |   11 |   13 |    1 |        0
  10 |        2 |        11 |       3 |   12 |   15 |    1 |        1
  11 |        3 |        11 |       3 |    9 |   16 |    1 |        2
  12 |        4 |        11 |       3 |    4 |    3 |    1 |        3
  13 |        5 |        11 |       3 |    3 |   -1 |    0 |        4
  14 |        1 |        11 |       5 |   11 |   13 |    1 |        0
  15 |        2 |        11 |       5 |   12 |   15 |    1 |        1
  16 |        3 |        11 |       5 |    9 |    9 |    1 |        2
  17 |        4 |        11 |       5 |    6 |    8 |    1 |        3
  18 |        5 |        11 |       5 |    5 |   -1 |    0 |        4
(18 rows)
```

Examples:

For queries marked as `undirected` with `cost` and `reverse_cost` columns

The examples in this section use the following **Network for queries marked as undirected and cost and reverse_cost columns are used**

```
SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, 3,
    FALSE
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    2 |    1 |        0
   2 |        2 |    3 |   -1 |    0 |        1
(2 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, 5,
    FALSE
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    4 |    1 |        0
   2 |        2 |    5 |   -1 |    0 |        1
(2 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    11, 3,
    FALSE
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |   11 |   11 |    1 |        0
   2 |        2 |    6 |    5 |    1 |        1
```

```
  2 |        2 |    6 |    5 |    1 |        1
  3 |        3 |    3 |   -1 |    0 |        2
(3 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    11, 5,
    FALSE
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |   11 |   11 |    1 |        0
   2 |        2 |    6 |    8 |    1 |        1
   3 |        3 |    5 |   -1 |    0 |        2
(3 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[2,11], 5,
    FALSE
);
 seq | path_seq | start_vid | node | edge | cost | agg_cost
-----+----------+-----------+------+------+------+----------
   1 |        1 |         2 |    2 |    4 |    1 |        0
   2 |        2 |         2 |    5 |   -1 |    0 |        1
   3 |        1 |        11 |   11 |   12 |    1 |        0
   4 |        2 |        11 |   10 |   10 |    1 |        1
   5 |        3 |        11 |    5 |   -1 |    0 |        2
(5 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, ARRAY[3,5],
    FALSE
);
 seq | path_seq | end_vid | node | edge | cost | agg_cost
-----+----------+---------+------+------+------+----------
   1 |        1 |       3 |    2 |    2 |    1 |        0
   2 |        2 |       3 |    3 |   -1 |    0 |        1
   3 |        1 |       5 |    2 |    4 |    1 |        0
   4 |        2 |       5 |    5 |   -1 |    0 |        1
(4 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[2, 11], ARRAY[3,5],
    FALSE
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    2 |    1 |        0
   2 |        2 |         2 |       3 |    3 |   -1 |    0 |        1
   3 |        1 |         2 |       5 |    2 |    4 |    1 |        0
   4 |        2 |         2 |       5 |    5 |   -1 |    0 |        1
   5 |        1 |        11 |       3 |   11 |   11 |    1 |        0
   6 |        2 |        11 |       3 |    6 |    5 |    1 |        1
   7 |        3 |        11 |       3 |    3 |   -1 |    0 |        2
   8 |        1 |        11 |       5 |   11 |   11 |    1 |        0
   9 |        2 |        11 |       5 |    6 |    8 |    1 |        1
  10 |        3 |        11 |       5 |    5 |   -1 |    0 |        2
(10 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    'SELECT * FROM (VALUES (2, 3), (2, 5), (11, 3), (11, 5)) AS combinations (source, target)',
    FALSE
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    2 |    1 |        0
   2 |        2 |         2 |       3 |    3 |   -1 |    0 |        1
   3 |        1 |         2 |       5 |    2 |    4 |    1 |        0
   4 |        2 |         2 |       5 |    5 |   -1 |    0 |        1
   5 |        1 |        11 |       3 |   11 |   11 |    1 |        0
   6 |        2 |        11 |       3 |    6 |    5 |    1 |        1
   7 |        3 |        11 |       3 |    3 |   -1 |    0 |        2
   8 |        1 |        11 |       5 |   11 |   11 |    1 |        0
   9 |        2 |        11 |       5 |    6 |    8 |    1 |        1
  10 |        3 |        11 |       5 |    5 |   -1 |    0 |        2
(10 rows)
```

Examples:
For queries marked as `directed` with `cost` column

The examples in this section use the following **Network for queries marked as directed and only cost column is used**

```
SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost FROM edge_table',
    2, 3
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
(0 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost FROM edge_table',
    2, 5
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    4 |    1 |        0
   2 |        2 |    5 |   -1 |    0 |        1
(2 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost FROM edge_table',
    11, 3
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
(0 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost FROM edge_table',
    11, 5
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
(0 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost FROM edge_table',
    ARRAY[2,11], 5
);
 seq | path_seq | start_vid | node | edge | cost | agg_cost
-----+----------+-----------+------+------+------+----------
   1 |        1 |         2 |    2 |    4 |    1 |        0
   2 |        2 |         2 |    5 |   -1 |    0 |        1
(2 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost FROM edge_table',
    2, ARRAY[3,5]
);
 seq | path_seq | end_vid | node | edge | cost | agg_cost
-----+----------+---------+------+------+------+----------
   1 |        1 |       5 |    2 |    4 |    1 |        0
   2 |        2 |       5 |    5 |   -1 |    0 |        1
(2 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost FROM edge_table',
    ARRAY[2, 11], ARRAY[3,5]
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       5 |    2 |    4 |    1 |        0
   2 |        2 |         2 |       5 |    5 |   -1 |    0 |        1
(2 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost FROM edge_table',
    'SELECT * FROM (VALUES (2, 3), (2, 5), (11, 3), (11, 5)) AS combinations (source, target)'
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       5 |    2 |    4 |    1 |        0
   2 |        2 |         2 |       5 |    5 |   -1 |    0 |        1
(2 rows)
```

Examples:
For queries marked as `undirected` with `cost` column

The examples in this section use the following **Network for queries marked as undirected and only cost column is used**

```
SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost FROM edge_table',
    2, 3,
    FALSE
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    4 |    1 |        0
   2 |        2 |    5 |    8 |    1 |        1
   3 |        3 |    6 |    5 |    1 |        2
   4 |        4 |    3 |   -1 |    0 |        3
(4 rows)
```

```
SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost FROM edge_table',
    2, 5,
    FALSE
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    4 |    1 |        0
   2 |        2 |    5 |   -1 |    0 |        1
(2 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost FROM edge_table',
    11, 3,
    FALSE
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |   11 |   11 |    1 |        0
   2 |        2 |    6 |    5 |    1 |        1
   3 |        3 |    3 |   -1 |    0 |        2
(3 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost FROM edge_table',
    11, 5,
    FALSE
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |   11 |   11 |    1 |        0
   2 |        2 |    6 |    8 |    1 |        1
   3 |        3 |    5 |   -1 |    0 |        2
(3 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost FROM edge_table',
    ARRAY[2,11], 5,
    FALSE
);
 seq | path_seq | start_vid | node | edge | cost | agg_cost
-----+----------+-----------+------+------+------+----------
   1 |        1 |         2 |    2 |    4 |    1 |        0
   2 |        2 |         2 |    5 |   -1 |    0 |        1
   3 |        1 |        11 |   11 |   12 |    1 |        0
   4 |        2 |        11 |   10 |   10 |    1 |        1
   5 |        3 |        11 |    5 |   -1 |    0 |        2
(5 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost FROM edge_table',
    2, ARRAY[3,5],
    FALSE
);
 seq | path_seq | end_vid | node | edge | cost | agg_cost
-----+----------+---------+------+------+------+----------
   1 |        1 |       3 |    2 |    4 |    1 |        0
   2 |        2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |       3 |    6 |    5 |    1 |        2
   4 |        4 |       3 |    3 |   -1 |    0 |        3
   5 |        1 |       5 |    2 |    4 |    1 |        0
   6 |        2 |       5 |    5 |   -1 |    0 |        1
(6 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost FROM edge_table',
    ARRAY[2, 11], ARRAY[3,5],
    FALSE
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    4 |    1 |        0
   2 |        2 |         2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |         2 |       3 |    6 |    5 |    1 |        2
   4 |        4 |         2 |       3 |    3 |   -1 |    0 |        3
   5 |        1 |         2 |       5 |    2 |    4 |    1 |        0
   6 |        2 |         2 |       5 |    5 |   -1 |    0 |        1
   7 |        1 |        11 |       3 |   11 |   11 |    1 |        0
   8 |        2 |        11 |       3 |    6 |    5 |    1 |        1
   9 |        3 |        11 |       3 |    3 |   -1 |    0 |        2
  10 |        1 |        11 |       5 |   11 |   11 |    1 |        0
  11 |        2 |        11 |       5 |    6 |    8 |    1 |        1
  12 |        3 |        11 |       5 |    5 |   -1 |    0 |        2
(12 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost FROM edge_table',
    'SELECT * FROM (VALUES (2, 3), (2, 5), (11, 3), (11, 5)) AS combinations (source, target)',
    FALSE
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    4 |    1 |        0
   2 |        2 |         2 |       3 |    5 |    8 |    1 |        1
```

```
  3 |       3 |         2 |       3 |    6 |    5 |    1 |        2
  4 |       4 |         2 |       3 |    3 |   -1 |    0 |        3
  5 |       1 |         2 |       5 |    2 |    4 |    1 |        0
  6 |       2 |         2 |       5 |    5 |   -1 |    0 |        1
  7 |       1 |        11 |       3 |   11 |   11 |    1 |        0
  8 |       2 |        11 |       3 |    6 |    5 |    1 |        1
  9 |       3 |        11 |       3 |    3 |   -1 |    0 |        2
 10 |       1 |        11 |       5 |   11 |   11 |    1 |        0
 11 |       2 |        11 |       5 |    6 |    8 |    1 |        1
 12 |       3 |        11 |       5 |    5 |   -1 |    0 |        2
(12 rows)
```

Equvalences between signatures

Examples:

For queries marked as `directed` with `cost` and `reverse_cost` columns

The examples in this section use the following:

- **Network for queries marked as directed and cost and reverse_cost columns are used**

```
SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, 3,
    TRUE
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    4 |    1 |        0
   2 |        2 |    5 |    8 |    1 |        1
   3 |        3 |    6 |    9 |    1 |        2
   4 |        4 |    9 |   16 |    1 |        3
   5 |        5 |    4 |    3 |    1 |        4
   6 |        6 |    3 |   -1 |    0 |        5
(6 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2,3
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    4 |    1 |        0
   2 |        2 |    5 |    8 |    1 |        1
   3 |        3 |    6 |    9 |    1 |        2
   4 |        4 |    9 |   16 |    1 |        3
   5 |        5 |    4 |    3 |    1 |        4
   6 |        6 |    3 |   -1 |    0 |        5
(6 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, ARRAY[3],
    TRUE
);
 seq | path_seq | end_vid | node | edge | cost | agg_cost
-----+----------+---------+------+------+------+----------
   1 |        1 |       3 |    2 |    4 |    1 |        0
   2 |        2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |       3 |    6 |    9 |    1 |        2
   4 |        4 |       3 |    9 |   16 |    1 |        3
   5 |        5 |       3 |    4 |    3 |    1 |        4
   6 |        6 |       3 |    3 |   -1 |    0 |        5
(6 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, ARRAY[3]
);
 seq | path_seq | end_vid | node | edge | cost | agg_cost
-----+----------+---------+------+------+------+----------
   1 |        1 |       3 |    2 |    4 |    1 |        0
   2 |        2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |       3 |    6 |    9 |    1 |        2
   4 |        4 |       3 |    9 |   16 |    1 |        3
   5 |        5 |       3 |    4 |    3 |    1 |        4
   6 |        6 |       3 |    3 |   -1 |    0 |        5
(6 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[2], ARRAY[3],
    TRUE
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    4 |    1 |        0
   2 |        2 |         2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |         2 |       3 |    6 |    9 |    1 |        2
   4 |        4 |         2 |       3 |    9 |   16 |    1 |        3
   5 |        5 |         2 |       3 |    4 |    3 |    1 |        4
```

```
  5 |      5 |      2 |     3 |    4 |    3 |    1 |       4
  6 |      6 |      2 |     3 |    3 |   -1 |    0 |       5
(6 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[2], ARRAY[3]
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    4 |    1 |        0
   2 |        2 |         2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |         2 |       3 |    6 |    9 |    1 |        2
   4 |        4 |         2 |       3 |    9 |   16 |    1 |        3
   5 |        5 |         2 |       3 |    4 |    3 |    1 |        4
   6 |        6 |         2 |       3 |    3 |   -1 |    0 |        5
(6 rows)

SELECT * FROM pgr_dijkstra(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    'SELECT * FROM (VALUES(2, 3)) AS combinations (source, target)'
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    4 |    1 |        0
   2 |        2 |         2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |         2 |       3 |    6 |    9 |    1 |        2
   4 |        4 |         2 |       3 |    9 |   16 |    1 |        3
   5 |        5 |         2 |       3 |    4 |    3 |    1 |        4
   6 |        6 |         2 |       3 |    3 |   -1 |    0 |        5
(6 rows)
```

Examples:

For queries marked as `undirected` with `cost` and `reverse_cost` columns

The examples in this section use the following:

- **Network for queries marked as undirected and cost and reverse_cost columns are used**

```
SELECT * FROM pgr_dijkstra(
   'SELECT id, source, target, cost, reverse_cost FROM edge_table',
   2, 3,
   FALSE
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    2 |    1 |        0
   2 |        2 |    3 |   -1 |    0 |        1
(2 rows)

SELECT * FROM pgr_dijkstra(
   'SELECT id, source, target, cost, reverse_cost FROM edge_table',
   2, ARRAY[3],
   FALSE
);
 seq | path_seq | end_vid | node | edge | cost | agg_cost
-----+----------+---------+------+------+------+----------
   1 |        1 |       3 |    2 |    2 |    1 |        0
   2 |        2 |       3 |    3 |   -1 |    0 |        1
(2 rows)

SELECT * FROM pgr_dijkstra(
   'SELECT id, source, target, cost, reverse_cost FROM edge_table',
   ARRAY[2], 3,
   FALSE
);
 seq | path_seq | start_vid | node | edge | cost | agg_cost
-----+----------+-----------+------+------+------+----------
   1 |        1 |         2 |    2 |    2 |    1 |        0
   2 |        2 |         2 |    3 |   -1 |    0 |        1
(2 rows)

SELECT * FROM pgr_dijkstra(
   'SELECT id, source, target, cost, reverse_cost FROM edge_table',
   ARRAY[2], ARRAY[3],
   FALSE
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    2 |    1 |        0
   2 |        2 |         2 |       3 |    3 |   -1 |    0 |        1
(2 rows)

SELECT * FROM pgr_dijkstra(
   'SELECT id, source, target, cost, reverse_cost FROM edge_table',
   'SELECT * FROM (VALUES(2, 3)) AS combinations (source, target)',
   FALSE
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    2 |    1 |        0
   2 |        2 |         2 |       3 |    3 |   -1 |    0 |        1
(2 rows)
```

See Also

- **https://en.wikipedia.org/wiki/Dijkstra%27s_algorithm**
- The queries use the **Sample Data** network.

Indices and tables

- **Index**
- **Search Page**

- **Supported versions:** current(**3.1**) **3.0**
- **Unsupported versions:** **2.6 2.5 2.4 2.3 2.3**

pgr_dijkstraCost

pgr_dijkstraCost

Using Dijkstra algorithm implemented by Boost.Graph, and extract only the aggregate cost of the shortest path(s) found, for the combination of vertices given.

Boost Graph Inside

Availability

- Version 3.1.0
  - New **Proposed** functions:
    - pgr_dijkstraCost(combinations)
- Version 2.2.0
  - New **Official** function

Description

The `pgr_dijkstraCost` algorithm, is a good choice to calculate the sum of the costs of the shortest path for a subset of pairs of nodes of the graph. We make use of the Boost's implementation of dijkstra which runs in \(O(V \log V + E)\) time.

The main characteristics are:

- It does not return a path.
- Returns the sum of the costs of the shortest path for pair combination of nodes in the graph.
- Process is done only on edges with positive costs.
- Values are returned when there is a path.
  - The returned values are in the form of a set of *(start_vid, end_vid, agg_cost)*.
  - When the starting vertex and ending vertex are the same, there is no path.
    - The *agg_cost* int the non included values *(v, v)* is *0*
  - When the starting vertex and ending vertex are the different and there is no path.
    - The *agg_cost* in the non included values *(u, v)* is \(\infty\)
- Let be the case the values returned are stored in a table, so the unique index would be the pair: *(start_vid, end_vid)*.
- For undirected graphs, the results are symmetric.
  - The *agg_cost* of *(u, v)* is the same as for *(v, u)*.
- Any duplicated value in the *start_vids* or *end_vids* is ignored.
- The returned values are ordered:
  - *start_vid* ascending
  - *end_vid* ascending
- Running time: \(O(| start_vids | * (V \log V + E))\)

Signatures

Summary

```
pgr_dijkstraCost(edges_sql, from_vid,  to_vid  [, directed])
pgr_dijkstraCost(edges_sql, from_vid,  to_vids [, directed])
pgr_dijkstraCost(edges_sql, from_vids, to_vid  [, directed])
pgr_dijkstraCost(edges_sql, from_vids, to_vids [, directed])
pgr_dijkstraCost(edges_sql, combinations_sql   [, directed]) -- Proposed on v3.1
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Using defaults

```
pgr_dijkstraCost(edges_sql, from_vid,  to_vid)
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example:
From vertex \(2\) to vertex \(3\) on a **directed** graph

```
SELECT * FROM pgr_dijkstraCost(
    'select id, source, target, cost, reverse_cost from edge_table',
    2, 3);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |       3 |        5
(1 row)
```

One to One

```
pgr_dijkstraCost(edges_sql, from_vid,  to_vid  [, directed])
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example:
From vertex \(2\) to vertex \(3\) on an **undirected** graph

```
SELECT * FROM pgr_dijkstraCost(
    'select id, source, target, cost, reverse_cost from edge_table',
    2, 3, false);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |       3 |        1
(1 row)
```

One to Many

```
pgr_dijkstraCost(edges_sql, from_vid,  to_vids [, directed])
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example:

From vertex \(2\) to vertices \(\{3, 11\}\) on a **directed** graph

```
SELECT * FROM pgr_dijkstraCost(
    'select id, source, target, cost, reverse_cost from edge_table',
    2, ARRAY[3, 11]);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |       3 |        5
         2 |      11 |        3
(2 rows)
```

Many to One

```
pgr_dijkstraCost(edges_sql, from_vids, to_vid  [, directed])
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example:

From vertices \(\{2, 7\}\) to vertex \(3\) on a **directed** graph

```
SELECT * FROM pgr_dijkstraCost(
    'select id, source, target, cost, reverse_cost from edge_table',
    ARRAY[2, 7], 3);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |       3 |        5
         7 |       3 |        6
(2 rows)
```

Many to Many

```
pgr_dijkstraCost(edges_sql, from_vids, to_vids [, directed])
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example:

From vertices \(\{2, 7\}\) to vertices \(\{3, 11\}\) on a **directed** graph

```
SELECT * FROM pgr_dijkstraCost(
    'select id, source, target, cost, reverse_cost from edge_table',
    ARRAY[2, 7], ARRAY[3, 11]);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |       3 |        5
         2 |      11 |        3
         7 |       3 |        6
         7 |      11 |        4
(4 rows)
```

Combinations

```
pgr_dijkstraCost(TEXT edges_sql, TEXT combination_sql, BOOLEAN directed:=true);
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example:

Using a combinations table on an**undirected** graph

```
SELECT * FROM pgr_dijkstraCost(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    'SELECT source, target FROM combinations_table',
    FALSE
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         1 |       2 |        1
         1 |       4 |        3
         2 |       1 |        1
         2 |       4 |        2
(4 rows)
```

Parameters

Parameter	Type	Default	Description
Edges SQL	TEXT		**Edges query** as described below
Combinations SQL	TEXT		**Combinations query** as described below
start_vid	BIGINT		Identifier of the starting vertex of the path.
start_vids	ARRAY[BIGINT]		Array of identifiers of starting vertices.
end_vid	BIGINT		Identifier of the ending vertex of the path.
end_vids	ARRAY[BIGINT]		Array of identifiers of ending vertices.
directed	BOOLEAN	true	• When true Graph is considered *Directed* • When false the graph is considered as *Undirected*.

Inner query

Edges query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Combinations query

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

Return Columns

Returns SET OF (start_vid, end_vid, agg_cost)

Column	Type	Description
start_vid	BIGINT	Identifier of the starting vertex.
end_vid	BIGINT	Identifier of the ending vertex.

Column	Type	Description
agg_cost	FLOAT	Aggregate cost from start_vid to end_vid.

Additional Examples

Example 1:
Demonstration of repeated values are ignored, and result is sorted.

```
SELECT * FROM pgr_dijkstraCost(
        'select id, source, target, cost, reverse_cost from edge_table',
            ARRAY[5, 3, 4, 3, 3, 4], ARRAY[3, 5, 3, 4]);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         3 |       4 |        3
         3 |       5 |        2
         4 |       3 |        1
         4 |       5 |        3
         5 |       3 |        4
         5 |       4 |        3
(6 rows)
```

Example 2:
Making *start_vids* the same as *end_vids*

```
SELECT * FROM pgr_dijkstraCost(
        'select id, source, target, cost, reverse_cost from edge_table',
            ARRAY[5, 3, 4], ARRAY[5, 3, 4]);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         3 |       4 |        3
         3 |       5 |        2
         4 |       3 |        1
         4 |       5 |        3
         5 |       3 |        4
         5 |       4 |        3
(6 rows)
```

Example 3:
Four manually assigned (source, target) vertex combinations

```
SELECT * FROM pgr_dijkstraCost(
    'SELECT id, source, target, cost FROM edge_table',
    'SELECT * FROM (VALUES (2, 3), (2, 5), (11, 3), (11, 5)) AS combinations (source, target)',
    FALSE
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |       3 |        3
         2 |       5 |        1
        11 |       3 |        2
        11 |       5 |        2
(4 rows)
```

See Also

- **https://en.wikipedia.org/wiki/Dijkstra%27s_algorithm**
- **Sample Data** network.

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.1) 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3**

pgr_dijkstraCostMatrix

pgr_dijkstraCostMatrix - Calculates the a cost matrix using pgr_dijktras.

Boost Graph Inside

Availability

- Version 3.0.0
  - **Official** function
- Version 2.3.0
  - New **proposed** function

Description

Using Dijkstra algorithm, calculate and return a cost matrix.

Signatures

Summary

```
pgr_dijkstraCostMatrix(edges_sql, start_vids [, directed])
RETURNS SET OF (start_vid, end_vid, agg_cost)
```

Using defaults

```
pgr_dijkstraCostMatrix(edges_sql, start_vid)
RETURNS SET OF (start_vid, end_vid, agg_cost)
```

Example:
Cost matrix for vertices \(\{1, 2, 3, 4\}\) on a **directed** graph

```
SELECT * FROM pgr_dijkstraCostMatrix(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    (SELECT array_agg(id) FROM edge_table_vertices_pgr WHERE id < 5)
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         1 |       2 |        1
         1 |       3 |        6
         1 |       4 |        5
         2 |       1 |        1
         2 |       3 |        5
         2 |       4 |        4
         3 |       1 |        2
         3 |       2 |        1
         3 |       4 |        3
         4 |       1 |        3
         4 |       2 |        2
         4 |       3 |        1
(12 rows)
```

Complete Signature

```
pgr_dijkstraCostMatrix(edges_sql, start_vids [, directed])
RETURNS SET OF (start_vid, end_vid, agg_cost)
```

Example:
Symmetric cost matrix for vertices \(\{1, 2, 3, 4\}\) on an **undirected** graph

```
SELECT * FROM pgr_dijkstraCostMatrix(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    (SELECT array_agg(id) FROM edge_table_vertices_pgr WHERE id < 5),
    false
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         1 |       2 |        1
         1 |       3 |        2
         1 |       4 |        3
         2 |       1 |        1
         2 |       3 |        1
         2 |       4 |        2
         3 |       1 |        2
         3 |       2 |        1
         3 |       4 |        1
         4 |       1 |        3
         4 |       2 |        2
         4 |       3 |        1
(12 rows)
```

Parameters

Parameter	Type	Description
edges_sql	TEXT	Edges SQL query as described above.
start_vids	ARRAY[ANY-INTEGER]	Array of identifiers of the vertices.
directed	BOOLEAN	(optional). When false the graph is considered as Undirected. Default istrue which considers the graph as Directed.

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Return Columns

Returns SET OF (start_vid, end_vid, agg_cost)

Column	Type	Description
start_vid	BIGINT	Identifier of the starting vertex.
end_vid	BIGINT	Identifier of the ending vertex.
agg_cost	FLOAT	Aggregate cost from start_vid to end_vid.

Additional Examples

Example:
Use with tsp

```
SELECT * FROM pgr_TSP(
    $$
    SELECT * FROM pgr_dijkstraCostMatrix(
        'SELECT id, source, target, cost, reverse_cost FROM edge_table',
        (SELECT array_agg(id) FROM edge_table_vertices_pgr WHERE id < 5),
        false
    )
    $$,
    randomize := false
);
 seq | node | cost | agg_cost
-----+------+------+----------
   1 |    1 |    0 |        0
   2 |    2 |    1 |        1
   3 |    3 |    1 |        2
   4 |    4 |    1 |        3
   5 |    1 |    3 |        6
(5 rows)
```

See Also

- **Dijkstra - Family of functions**
- **Cost Matrix - Category**
- **Traveling Sales Person - Family of functions**
- The queries use the **Sample Data** network.

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest** (**3.2**) **3.1**) **3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2 2.1 2.0**

pgr_drivingDistance

`pgr_drivingDistance` - Returns the driving distance from a start node.

Boost Graph Inside

Availability

- Version 2.1.0:
  - Signature change pgr_drivingDistance(single vertex)
  - New **Official** pgr_drivingDistance(multiple vertices)
- Version 2.0.0:
  - **Official** pgr_drivingDistance(single vertex)

Description

Using the Dijkstra algorithm, extracts all the nodes that have costs less than or equal to the value `distance`. The edges extracted will conform to the corresponding spanning tree.

Signatures

Summary

```
pgr_drivingDistance(edges_sql, start_vid,  distance [, directed])
pgr_drivingDistance(edges_sql, start_vids, distance [, directed] [, equicost])
RETURNS SET OF (seq, [start_vid,] node, edge, cost, agg_cost)
```

Using defaults

```
pgr_drivingDistance(edges_sql, start_vid, distance)
RETURNS SET OF (seq, node, edge, cost, agg_cost)
```

Example:
TBD

Single Vertex

```
pgr_drivingDistance(edges_sql, start_vid, distance [, directed])
RETURNS SET OF (seq, node, edge, cost, agg_cost)
```

Example:
TBD

Multiple Vertices

```
pgr_drivingDistance(edges_sql, start_vids, distance, [, directed] [, equicost])
RETURNS SET OF (seq, start_vid, node, edge, cost, agg_cost)
```

Example:
TBD

Parameters

Column	Type	Description
edges_sql	TEXT	SQL query as described above.
start_vid	BIGINT	Identifier of the starting vertex.
start_vids	ARRAY[ANY-INTEGER]	Array of identifiers of the starting vertices.
distance	FLOAT	Upper limit for the inclusion of the node in the result.
directed	BOOLEAN	(optional). When false the graph is considered as Undirected. Default is true which considers the graph as Directed.
equicost	BOOLEAN	(optional). When true the node will only appear in the closest start_vid list. Default is false which resembles several calls using the single starting point signatures. Tie brakes are arbitrary.

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns set of (seq [, start_v], node, edge, cost, agg_cost)

Column	Type	Description
seq	INTEGER	Sequential value starting from **1**.
start_vid	INTEGER	Identifier of the starting vertex.
node	BIGINT	Identifier of the node in the path within the limits from start_vid.
edge	BIGINT	Identifier of the edge used to arrive to node. 0 when the node is the start_vid.
cost	FLOAT	Cost to traverse edge.
agg_cost	FLOAT	Aggregate cost from start_vid to node.

Additional Examples

Example:
For queries marked as `directed` with `cost` and `reverse_cost` columns

The examples in this section use the following **Network for queries marked as directed and cost and reverse_cost columns are used**

```
SELECT * FROM pgr_drivingDistance(
        'SELECT id, source, target, cost, reverse_cost FROM edge_table',
        2, 3
      );
 seq | node | edge | cost | agg_cost
-----+------+------+------+----------
   1 |    2 |   -1 |    0 |        0
   2 |    1 |    1 |    1 |        1
   3 |    5 |    4 |    1 |        1
   4 |    6 |    8 |    1 |        2
   5 |    8 |    7 |    1 |        2
   6 |   10 |   10 |    1 |        2
   7 |    7 |    6 |    1 |        3
   8 |    9 |    9 |    1 |        3
   9 |   11 |   12 |    1 |        3
  10 |   13 |   14 |    1 |        3
(10 rows)

SELECT * FROM pgr_drivingDistance(
        'SELECT id, source, target, cost, reverse_cost FROM edge_table',
        13, 3
      );
 seq | node | edge | cost | agg_cost
-----+------+------+------+----------
   1 |   13 |   -1 |    0 |        0
   2 |   10 |   14 |    1 |        1
   3 |    5 |   10 |    1 |        2
   4 |   11 |   12 |    1 |        2
   5 |    2 |    4 |    1 |        3
   6 |    6 |    8 |    1 |        3
   7 |    8 |    7 |    1 |        3
   8 |   12 |   13 |    1 |        3
(8 rows)

SELECT * FROM pgr_drivingDistance(
        'SELECT id, source, target, cost, reverse_cost FROM edge_table',
        array[2,13], 3
      );
 seq | from_v | node | edge | cost | agg_cost
-----+--------+------+------+------+----------
   1 |      2 |    2 |   -1 |    0 |        0
   2 |      2 |    1 |    1 |    1 |        1
   3 |      2 |    5 |    4 |    1 |        1
   4 |      2 |    6 |    8 |    1 |        2
   5 |      2 |    8 |    7 |    1 |        2
   6 |      2 |   10 |   10 |    1 |        2
   7 |      2 |    7 |    6 |    1 |        3
   8 |      2 |    9 |    9 |    1 |        3
   9 |      2 |   11 |   12 |    1 |        3
  10 |      2 |   13 |   14 |    1 |        3
  11 |     13 |   13 |   -1 |    0 |        0
  12 |     13 |   10 |   14 |    1 |        1
  13 |     13 |    5 |   10 |    1 |        2
  14 |     13 |   11 |   12 |    1 |        2
  15 |     13 |    2 |    4 |    1 |        3
  16 |     13 |    6 |    8 |    1 |        3
  17 |     13 |    8 |    7 |    1 |        3
  18 |     13 |   12 |   13 |    1 |        3
(18 rows)

SELECT * FROM pgr_drivingDistance(
        'SELECT id, source, target, cost, reverse_cost FROM edge_table',
        array[2,13], 3, equicost:=true
      );
 seq | from_v | node | edge | cost | agg_cost
-----+--------+------+------+------+----------
   1 |      2 |    2 |   -1 |    0 |        0
   2 |      2 |    1 |    1 |    1 |        1
   3 |      2 |    5 |    4 |    1 |        1
   4 |      2 |    6 |    8 |    1 |        2
   5 |      2 |    8 |    7 |    1 |        2
   6 |      2 |    7 |    6 |    1 |        3
   7 |      2 |    9 |    9 |    1 |        3
   8 |     13 |   13 |   -1 |    0 |        0
   9 |     13 |   10 |   14 |    1 |        1
  10 |     13 |   11 |   12 |    1 |        2
  11 |     13 |   12 |   13 |    1 |        3
(11 rows)
```

Example:
For queries marked as `undirected` with `cost` and `reverse_cost` columns

The examples in this section use the following **Network for queries marked as undirected and cost and reverse_cost**

columns are used

```
SELECT * FROM pgr_drivingDistance(
        'SELECT id, source, target, cost, reverse_cost FROM edge_table',
        2, 3, false
      );
 seq | node | edge | cost | agg_cost
-----+------+------+------+----------
   1 |    2 |   -1 |    0 |        0
   2 |    1 |    1 |    1 |        1
   3 |    3 |    2 |    1 |        1
   4 |    5 |    4 |    1 |        1
   5 |    4 |    3 |    1 |        2
   6 |    6 |    8 |    1 |        2
   7 |    8 |    7 |    1 |        2
   8 |   10 |   10 |    1 |        2
   9 |    7 |    6 |    1 |        3
  10 |    9 |   16 |    1 |        3
  11 |   11 |   12 |    1 |        3
  12 |   13 |   14 |    1 |        3
(12 rows)

SELECT * FROM pgr_drivingDistance(
        'SELECT id, source, target, cost, reverse_cost FROM edge_table',
        13, 3, false
      );
 seq | node | edge | cost | agg_cost
-----+------+------+------+----------
   1 |   13 |   -1 |    0 |        0
   2 |   10 |   14 |    1 |        1
   3 |    5 |   10 |    1 |        2
   4 |   11 |   12 |    1 |        2
   5 |    2 |    4 |    1 |        3
   6 |    6 |    8 |    1 |        3
   7 |    8 |    7 |    1 |        3
   8 |   12 |   13 |    1 |        3
(8 rows)

SELECT * FROM pgr_drivingDistance(
        'SELECT id, source, target, cost, reverse_cost FROM edge_table',
        array[2,13], 3, false
      );
 seq | from_v | node | edge | cost | agg_cost
-----+--------+------+------+------+----------
   1 |      2 |    2 |   -1 |    0 |        0
   2 |      2 |    1 |    1 |    1 |        1
   3 |      2 |    3 |    2 |    1 |        1
   4 |      2 |    5 |    4 |    1 |        1
   5 |      2 |    4 |    3 |    1 |        2
   6 |      2 |    6 |    8 |    1 |        2
   7 |      2 |    8 |    7 |    1 |        2
   8 |      2 |   10 |   10 |    1 |        2
   9 |      2 |    7 |    6 |    1 |        3
  10 |      2 |    9 |   16 |    1 |        3
  11 |      2 |   11 |   12 |    1 |        3
  12 |      2 |   13 |   14 |    1 |        3
  13 |     13 |   13 |   -1 |    0 |        0
  14 |     13 |   10 |   14 |    1 |        1
  15 |     13 |    5 |   10 |    1 |        2
  16 |     13 |   11 |   12 |    1 |        2
  17 |     13 |    2 |    4 |    1 |        3
  18 |     13 |    6 |    8 |    1 |        3
  19 |     13 |    8 |    7 |    1 |        3
  20 |     13 |   12 |   13 |    1 |        3
(20 rows)

SELECT * FROM pgr_drivingDistance(
        'SELECT id, source, target, cost, reverse_cost FROM edge_table',
        array[2,13], 3, false, equicost:=true
      );
 seq | from_v | node | edge | cost | agg_cost
-----+--------+------+------+------+----------
   1 |      2 |    2 |   -1 |    0 |        0
   2 |      2 |    1 |    1 |    1 |        1
   3 |      2 |    3 |    2 |    1 |        1
   4 |      2 |    5 |    4 |    1 |        1
   5 |      2 |    4 |    3 |    1 |        2
   6 |      2 |    6 |    8 |    1 |        2
   7 |      2 |    8 |    7 |    1 |        2
   8 |      2 |    7 |    6 |    1 |        3
   9 |      2 |    9 |   16 |    1 |        3
  10 |     13 |   13 |   -1 |    0 |        0
  11 |     13 |   10 |   14 |    1 |        1
  12 |     13 |   11 |   12 |    1 |        2
  13 |     13 |   12 |   13 |    1 |        3
(13 rows)
```

Example:

For queries marked as `directed` with `cost` column

The examples in this section use the following **Network for queries marked as directed and only cost column is used**

```
SELECT * FROM pgr_drivingDistance(
        'SELECT id, source, target, cost FROM edge_table',
        2, 3
      );
 seq | node | edge | cost | agg_cost
-----+------+------+------+----------
   1 |    2 |   -1 |    0 |        0
   2 |    5 |    4 |    1 |        1
   3 |    6 |    8 |    1 |        2
   4 |   10 |   10 |    1 |        2
   5 |    9 |    9 |    1 |        3
   6 |   11 |   11 |    1 |        3
   7 |   13 |   14 |    1 |        3
(7 rows)

SELECT * FROM pgr_drivingDistance(
        'SELECT id, source, target, cost FROM edge_table',
        13, 3
      );
 seq | node | edge | cost | agg_cost
-----+------+------+------+----------
   1 |   13 |   -1 |    0 |        0
(1 row)

SELECT * FROM pgr_drivingDistance(
        'SELECT id, source, target, cost FROM edge_table',
        array[2,13], 3
      );
 seq | from_v | node | edge | cost | agg_cost
-----+--------+------+------+------+----------
   1 |      2 |    2 |   -1 |    0 |        0
   2 |      2 |    5 |    4 |    1 |        1
   3 |      2 |    6 |    8 |    1 |        2
   4 |      2 |   10 |   10 |    1 |        2
   5 |      2 |    9 |    9 |    1 |        3
   6 |      2 |   11 |   11 |    1 |        3
   7 |      2 |   13 |   14 |    1 |        3
   8 |     13 |   13 |   -1 |    0 |        0
(8 rows)

SELECT * FROM pgr_drivingDistance(
        'SELECT id, source, target, cost FROM edge_table',
        array[2,13], 3, equicost:=true
      );
 seq | from_v | node | edge | cost | agg_cost
-----+--------+------+------+------+----------
   1 |      2 |    2 |   -1 |    0 |        0
   2 |      2 |    5 |    4 |    1 |        1
   3 |      2 |    6 |    8 |    1 |        2
   4 |      2 |   10 |   10 |    1 |        2
   5 |      2 |    9 |    9 |    1 |        3
   6 |      2 |   11 |   11 |    1 |        3
   7 |     13 |   13 |   -1 |    0 |        0
(7 rows)
```

Example:
For queries marked as `undirected` with `cost` column

The examples in this section use the following **Network for queries marked as undirected and only cost column is used**

```
SELECT * FROM pgr_drivingDistance(
        'SELECT id, source, target, cost FROM edge_table',
        2, 3, false
      );
 seq | node | edge | cost | agg_cost
-----+------+------+------+----------
   1 |    2 |   -1 |    0 |        0
   2 |    1 |    1 |    1 |        1
   3 |    5 |    4 |    1 |        1
   4 |    6 |    8 |    1 |        2
   5 |    8 |    7 |    1 |        2
   6 |   10 |   10 |    1 |        2
   7 |    3 |    5 |    1 |        3
   8 |    7 |    6 |    1 |        3
   9 |    9 |    9 |    1 |        3
  10 |   11 |   12 |    1 |        3
  11 |   13 |   14 |    1 |        3
(11 rows)

SELECT * FROM pgr_drivingDistance(
        'SELECT id, source, target, cost FROM edge_table',
        13, 3, false
      );
 seq | node | edge | cost | agg_cost
-----+------+------+------+----------
   1 |   13 |   -1 |    0 |        0
   2 |   10 |   14 |    1 |        1
   3 |    5 |   10 |    1 |        2
   4 |   11 |   12 |    1 |        2
   5 |    2 |    4 |    1 |        3
   6 |    6 |    8 |    1 |        3
   7 |    8 |    7 |    1 |        3
   8 |   12 |   13 |    1 |        3
(8 rows)

SELECT * FROM pgr_drivingDistance(
        'SELECT id, source, target, cost FROM edge_table',
        array[2,13], 3, false
      );
 seq | from_v | node | edge | cost | agg_cost
-----+--------+------+------+------+----------
   1 |      2 |    2 |   -1 |    0 |        0
   2 |      2 |    1 |    1 |    1 |        1
   3 |      2 |    5 |    4 |    1 |        1
   4 |      2 |    6 |    8 |    1 |        2
   5 |      2 |    8 |    7 |    1 |        2
   6 |      2 |   10 |   10 |    1 |        2
   7 |      2 |    3 |    5 |    1 |        3
   8 |      2 |    7 |    6 |    1 |        3
   9 |      2 |    9 |    9 |    1 |        3
  10 |      2 |   11 |   12 |    1 |        3
  11 |      2 |   13 |   14 |    1 |        3
  12 |     13 |   13 |   -1 |    0 |        0
  13 |     13 |   10 |   14 |    1 |        1
  14 |     13 |    5 |   10 |    1 |        2
  15 |     13 |   11 |   12 |    1 |        2
  16 |     13 |    2 |    4 |    1 |        3
  17 |     13 |    6 |    8 |    1 |        3
  18 |     13 |    8 |    7 |    1 |        3
  19 |     13 |   12 |   13 |    1 |        3
(19 rows)

SELECT * FROM pgr_drivingDistance(
        'SELECT id, source, target, cost FROM edge_table',
        array[2,13], 3, false, equicost:=true
      );
 seq | from_v | node | edge | cost | agg_cost
-----+--------+------+------+------+----------
   1 |      2 |    2 |   -1 |    0 |        0
   2 |      2 |    1 |    1 |    1 |        1
   3 |      2 |    5 |    4 |    1 |        1
   4 |      2 |    6 |    8 |    1 |        2
   5 |      2 |    8 |    7 |    1 |        2
   6 |      2 |    3 |    5 |    1 |        3
   7 |      2 |    7 |    6 |    1 |        3
   8 |      2 |    9 |    9 |    1 |        3
   9 |     13 |   13 |   -1 |    0 |        0
  10 |     13 |   10 |   14 |    1 |        1
  11 |     13 |   11 |   12 |    1 |        2
  12 |     13 |   12 |   13 |    1 |        3
(12 rows)
```

See Also

- **pgr_alphaShape** - Alpha shape computation
- **Sample Data** network.

Indices and tables

- **Supported versions:** Latest (3.2) 3.1) 3.0
- **Unsupported versions:** 2.6 2.5 2.4 2.3 2.2 2.1 2.0

pgr_KSP

`pgr_KSP` — Returns the “K” shortest paths.

Boost Graph Inside

Availability

- Version 2.1.0
  - Signature change
    - Old signature no longer supported
- Version 2.0.0
  - **Official** function

Description

The K shortest path routing algorithm based on Yen’s algorithm. “K” is the number of shortest paths desired.

Signatures

Summary

```
pgr_KSP(edges_sql, start_vid, end_vid, K [, directed] [, heap_paths])
RETURNS SET OF (seq, path_id, path_seq, node, edge, cost, agg_cost) or EMPTY SET
```

Using defaults

```
pgr_ksp(edges_sql, start_vid, end_vid, K);
RETURNS SET OF (seq, path_id, path_seq, node, edge, cost, agg_cost) or EMPTY SET
```

Example:
TBD

Complete Signature

```
pgr_KSP(edges_sql, start_vid, end_vid, K [, directed] [, heap_paths])
RETURNS SET OF (seq, path_id, path_seq, node, edge, cost, agg_cost) or EMPTY SET
```

Example:
TBD

Parameters

Column	Type	Description
edges_sql	`TEXT`	SQL query as described above.
start_vid	`BIGINT`	Identifier of the starting vertex.
end_vid	`BIGINT`	Identifier of the ending vertex.
k	`INTEGER`	The desiered number of paths.
directed	`BOOLEAN`	(optional). When `false` the graph is considered as Undirected. Default is`true` which considers the graph as Directed.
heap_paths	`BOOLEAN`	(optional). When `true` returns all the paths stored in the process heap. Default is`false` which only returns `k` paths.

Roughly, if the shortest path has`N` edges, the heap will contain about than`N * k` paths for small value of`k` and `k > 1`.

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns set of `(seq, path_seq, path_id, node, edge, cost, agg_cost)`

Column	Type	Description
seq	INTEGER	Sequential value starting from **1**.
path_seq	INTEGER	Relative position in the path of `node` and `edge`. Has value **1** for the beginning of a path.
path_id	BIGINT	Path identifier. The ordering of the paths For two paths i, j if i < j then agg_cost(i) <= agg_cost(j).
node	BIGINT	Identifier of the node in the path.
edge	BIGINT	Identifier of the edge used to go from `node` to the next node in the path sequence. `-1` for the last node of the route.
cost	FLOAT	Cost to traverse from `node` using `edge` to the next node in the path sequence.
agg_cost	FLOAT	Aggregate cost from `start_vid` to `node`.

Additional Examples

Example:
To handle the one flag to choose signatures

The examples in this section use the following **Network for queries marked as directed and cost and reverse_cost columns are used**

```
SELECT * FROM pgr_KSP(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
     2, 12, 2,
     directed:=true
  );
 seq | path_id | path_seq | node | edge | cost | agg_cost
-----+---------+----------+------+------+------+----------
   1 |       1 |        1 |    2 |    4 |    1 |        0
   2 |       1 |        2 |    5 |    8 |    1 |        1
   3 |       1 |        3 |    6 |    9 |    1 |        2
   4 |       1 |        4 |    9 |   15 |    1 |        3
   5 |       1 |        5 |   12 |   -1 |    0 |        4
   6 |       2 |        1 |    2 |    4 |    1 |        0
   7 |       2 |        2 |    5 |    8 |    1 |        1
   8 |       2 |        3 |    6 |   11 |    1 |        2
   9 |       2 |        4 |   11 |   13 |    1 |        3
  10 |       2 |        5 |   12 |   -1 |    0 |        4
(10 rows)

SELECT * FROM pgr_KSP(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
     2, 12, 2
  );
 seq | path_id | path_seq | node | edge | cost | agg_cost
-----+---------+----------+------+------+------+----------
   1 |       1 |        1 |    2 |    4 |    1 |        0
   2 |       1 |        2 |    5 |    8 |    1 |        1
   3 |       1 |        3 |    6 |    9 |    1 |        2
   4 |       1 |        4 |    9 |   15 |    1 |        3
   5 |       1 |        5 |   12 |   -1 |    0 |        4
   6 |       2 |        1 |    2 |    4 |    1 |        0
   7 |       2 |        2 |    5 |    8 |    1 |        1
   8 |       2 |        3 |    6 |   11 |    1 |        2
   9 |       2 |        4 |   11 |   13 |    1 |        3
  10 |       2 |        5 |   12 |   -1 |    0 |        4
(10 rows)
```

Example:

For queries marked as `directed` with `cost` and `reverse_cost` columns

The examples in this section use the following **Network for queries marked as directed and cost and reverse_cost columns are used**

```
SELECT * FROM pgr_KSP(
     'SELECT id, source, target, cost, reverse_cost FROM edge_table',
      2, 12, 2
   );
 seq | path_id | path_seq | node | edge | cost | agg_cost
-----+---------+----------+------+------+------+----------
   1 |       1 |        1 |    2 |    4 |    1 |        0
   2 |       1 |        2 |    5 |    8 |    1 |        1
   3 |       1 |        3 |    6 |    9 |    1 |        2
   4 |       1 |        4 |    9 |   15 |    1 |        3
   5 |       1 |        5 |   12 |   -1 |    0 |        4
   6 |       2 |        1 |    2 |    4 |    1 |        0
   7 |       2 |        2 |    5 |    8 |    1 |        1
   8 |       2 |        3 |    6 |   11 |    1 |        2
   9 |       2 |        4 |   11 |   13 |    1 |        3
  10 |       2 |        5 |   12 |   -1 |    0 |        4
(10 rows)

SELECT * FROM pgr_KSP(
     'SELECT id, source, target, cost, reverse_cost FROM edge_table',
      2, 12, 2, heap_paths:=true
   );
 seq | path_id | path_seq | node | edge | cost | agg_cost
-----+---------+----------+------+------+------+----------
   1 |       1 |        1 |    2 |    4 |    1 |        0
   2 |       1 |        2 |    5 |    8 |    1 |        1
   3 |       1 |        3 |    6 |    9 |    1 |        2
   4 |       1 |        4 |    9 |   15 |    1 |        3
   5 |       1 |        5 |   12 |   -1 |    0 |        4
   6 |       2 |        1 |    2 |    4 |    1 |        0
   7 |       2 |        2 |    5 |    8 |    1 |        1
   8 |       2 |        3 |    6 |   11 |    1 |        2
   9 |       2 |        4 |   11 |   13 |    1 |        3
  10 |       2 |        5 |   12 |   -1 |    0 |        4
  11 |       3 |        1 |    2 |    4 |    1 |        0
  12 |       3 |        2 |    5 |   10 |    1 |        1
  13 |       3 |        3 |   10 |   12 |    1 |        2
  14 |       3 |        4 |   11 |   13 |    1 |        3
  15 |       3 |        5 |   12 |   -1 |    0 |        4
(15 rows)

SELECT * FROM pgr_KSP(
     'SELECT id, source, target, cost, reverse_cost FROM edge_table',
      2, 12, 2, true, true
   );
 seq | path_id | path_seq | node | edge | cost | agg_cost
-----+---------+----------+------+------+------+----------
   1 |       1 |        1 |    2 |    4 |    1 |        0
   2 |       1 |        2 |    5 |    8 |    1 |        1
   3 |       1 |        3 |    6 |    9 |    1 |        2
   4 |       1 |        4 |    9 |   15 |    1 |        3
   5 |       1 |        5 |   12 |   -1 |    0 |        4
   6 |       2 |        1 |    2 |    4 |    1 |        0
   7 |       2 |        2 |    5 |    8 |    1 |        1
   8 |       2 |        3 |    6 |   11 |    1 |        2
   9 |       2 |        4 |   11 |   13 |    1 |        3
  10 |       2 |        5 |   12 |   -1 |    0 |        4
  11 |       3 |        1 |    2 |    4 |    1 |        0
  12 |       3 |        2 |    5 |   10 |    1 |        1
  13 |       3 |        3 |   10 |   12 |    1 |        2
  14 |       3 |        4 |   11 |   13 |    1 |        3
  15 |       3 |        5 |   12 |   -1 |    0 |        4
(15 rows)
```

Examples:

For queries marked as `undirected` with `cost` and `reverse_cost` columns

The examples in this section use the following **Network for queries marked as undirected and cost and reverse_cost columns are used**

```
SELECT * FROM pgr_KSP(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, 12, 2, directed:=false
  );
 seq | path_id | path_seq | node | edge | cost | agg_cost
-----+---------+----------+------+------+------+----------
   1 |       1 |        1 |    2 |    2 |    1 |        0
   2 |       1 |        2 |    3 |    3 |    1 |        1
   3 |       1 |        3 |    4 |   16 |    1 |        2
   4 |       1 |        4 |    9 |   15 |    1 |        3
   5 |       1 |        5 |   12 |   -1 |    0 |        4
   6 |       2 |        1 |    2 |    4 |    1 |        0
   7 |       2 |        2 |    5 |   10 |    1 |        1
   8 |       2 |        3 |   10 |   12 |    1 |        2
   9 |       2 |        4 |   11 |   13 |    1 |        3
  10 |       2 |        5 |   12 |   -1 |    0 |        4
(10 rows)

SELECT * FROM pgr_KSP(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, 12, 2, false, true
  );
 seq | path_id | path_seq | node | edge | cost | agg_cost
-----+---------+----------+------+------+------+----------
   1 |       1 |        1 |    2 |    2 |    1 |        0
   2 |       1 |        2 |    3 |    3 |    1 |        1
   3 |       1 |        3 |    4 |   16 |    1 |        2
   4 |       1 |        4 |    9 |   15 |    1 |        3
   5 |       1 |        5 |   12 |   -1 |    0 |        4
   6 |       2 |        1 |    2 |    4 |    1 |        0
   7 |       2 |        2 |    5 |    8 |    1 |        1
   8 |       2 |        3 |    6 |   11 |    1 |        2
   9 |       2 |        4 |   11 |   13 |    1 |        3
  10 |       2 |        5 |   12 |   -1 |    0 |        4
  11 |       3 |        1 |    2 |    4 |    1 |        0
  12 |       3 |        2 |    5 |   10 |    1 |        1
  13 |       3 |        3 |   10 |   12 |    1 |        2
  14 |       3 |        4 |   11 |   13 |    1 |        3
  15 |       3 |        5 |   12 |   -1 |    0 |        4
  16 |       4 |        1 |    2 |    4 |    1 |        0
  17 |       4 |        2 |    5 |   10 |    1 |        1
  18 |       4 |        3 |   10 |   12 |    1 |        2
  19 |       4 |        4 |   11 |   11 |    1 |        3
  20 |       4 |        5 |    6 |    9 |    1 |        4
  21 |       4 |        6 |    9 |   15 |    1 |        5
  22 |       4 |        7 |   12 |   -1 |    0 |        6
(22 rows)
```

Example:

For queries marked as `directed` with `cost` column

The examples in this section use the following **Network for queries marked as directed and only cost column is used**

```
SELECT  * FROM pgr_KSP(
    'SELECT id, source, target, cost FROM edge_table',
     2, 3, 2
  );
 seq | path_id | path_seq | node | edge | cost | agg_cost
-----+---------+----------+------+------+------+----------
(0 rows)

SELECT  * FROM pgr_KSP(
    'SELECT id, source, target, cost FROM edge_table',
     2, 12, 2
  );
 seq | path_id | path_seq | node | edge | cost | agg_cost
-----+---------+----------+------+------+------+----------
   1 |       1 |        1 |    2 |    4 |    1 |        0
   2 |       1 |        2 |    5 |    8 |    1 |        1
   3 |       1 |        3 |    6 |    9 |    1 |        2
   4 |       1 |        4 |    9 |   15 |    1 |        3
   5 |       1 |        5 |   12 |   -1 |    0 |        4
   6 |       2 |        1 |    2 |    4 |    1 |        0
   7 |       2 |        2 |    5 |    8 |    1 |        1
   8 |       2 |        3 |    6 |   11 |    1 |        2
   9 |       2 |        4 |   11 |   13 |    1 |        3
  10 |       2 |        5 |   12 |   -1 |    0 |        4
(10 rows)

SELECT   * FROM pgr_KSP(
    'SELECT id, source, target, cost FROM edge_table',
     2, 12, 2, heap_paths:=true
  );
 seq | path_id | path_seq | node | edge | cost | agg_cost
-----+---------+----------+------+------+------+----------
   1 |       1 |        1 |    2 |    4 |    1 |        0
   2 |       1 |        2 |    5 |    8 |    1 |        1
   3 |       1 |        3 |    6 |    9 |    1 |        2
   4 |       1 |        4 |    9 |   15 |    1 |        3
   5 |       1 |        5 |   12 |   -1 |    0 |        4
   6 |       2 |        1 |    2 |    4 |    1 |        0
   7 |       2 |        2 |    5 |    8 |    1 |        1
   8 |       2 |        3 |    6 |   11 |    1 |        2
   9 |       2 |        4 |   11 |   13 |    1 |        3
  10 |       2 |        5 |   12 |   -1 |    0 |        4
  11 |       3 |        1 |    2 |    4 |    1 |        0
  12 |       3 |        2 |    5 |   10 |    1 |        1
  13 |       3 |        3 |   10 |   12 |    1 |        2
  14 |       3 |        4 |   11 |   13 |    1 |        3
  15 |       3 |        5 |   12 |   -1 |    0 |        4
(15 rows)

SELECT  * FROM pgr_KSP(
    'SELECT id, source, target, cost FROM edge_table',
     2, 12, 2, true, true
  );
 seq | path_id | path_seq | node | edge | cost | agg_cost
-----+---------+----------+------+------+------+----------
   1 |       1 |        1 |    2 |    4 |    1 |        0
   2 |       1 |        2 |    5 |    8 |    1 |        1
   3 |       1 |        3 |    6 |    9 |    1 |        2
   4 |       1 |        4 |    9 |   15 |    1 |        3
   5 |       1 |        5 |   12 |   -1 |    0 |        4
   6 |       2 |        1 |    2 |    4 |    1 |        0
   7 |       2 |        2 |    5 |    8 |    1 |        1
   8 |       2 |        3 |    6 |   11 |    1 |        2
   9 |       2 |        4 |   11 |   13 |    1 |        3
  10 |       2 |        5 |   12 |   -1 |    0 |        4
  11 |       3 |        1 |    2 |    4 |    1 |        0
  12 |       3 |        2 |    5 |   10 |    1 |        1
  13 |       3 |        3 |   10 |   12 |    1 |        2
  14 |       3 |        4 |   11 |   13 |    1 |        3
  15 |       3 |        5 |   12 |   -1 |    0 |        4
(15 rows)
```

Example:

For queries marked as `undirected` with `cost` column

The examples in this section use the following **Network for queries marked as undirected and only cost column is used**

```
SELECT  * FROM pgr_KSP(
    'SELECT id, source, target, cost FROM edge_table',
     2, 12, 2, directed:=false
  );
 seq | path_id | path_seq | node | edge | cost | agg_cost
-----+---------+----------+------+------+------+----------
   1 |       1 |        1 |    2 |    4 |    1 |        0
   2 |       1 |        2 |    5 |    8 |    1 |        1
   3 |       1 |        3 |    6 |    9 |    1 |        2
   4 |       1 |        4 |    9 |   15 |    1 |        3
   5 |       1 |        5 |   12 |   -1 |    0 |        4
   6 |       2 |        1 |    2 |    4 |    1 |        0
   7 |       2 |        2 |    5 |    8 |    1 |        1
   8 |       2 |        3 |    6 |   11 |    1 |        2
   9 |       2 |        4 |   11 |   13 |    1 |        3
  10 |       2 |        5 |   12 |   -1 |    0 |        4
(10 rows)

SELECT  * FROM pgr_KSP(
    'SELECT id, source, target, cost FROM edge_table',
     2, 12, 2, directed:=false, heap_paths:=true
  );
 seq | path_id | path_seq | node | edge | cost | agg_cost
-----+---------+----------+------+------+------+----------
   1 |       1 |        1 |    2 |    4 |    1 |        0
   2 |       1 |        2 |    5 |    8 |    1 |        1
   3 |       1 |        3 |    6 |    9 |    1 |        2
   4 |       1 |        4 |    9 |   15 |    1 |        3
   5 |       1 |        5 |   12 |   -1 |    0 |        4
   6 |       2 |        1 |    2 |    4 |    1 |        0
   7 |       2 |        2 |    5 |    8 |    1 |        1
   8 |       2 |        3 |    6 |   11 |    1 |        2
   9 |       2 |        4 |   11 |   13 |    1 |        3
  10 |       2 |        5 |   12 |   -1 |    0 |        4
  11 |       3 |        1 |    2 |    4 |    1 |        0
  12 |       3 |        2 |    5 |   10 |    1 |        1
  13 |       3 |        3 |   10 |   12 |    1 |        2
  14 |       3 |        4 |   11 |   13 |    1 |        3
  15 |       3 |        5 |   12 |   -1 |    0 |        4
(15 rows)
```

See Also

- **https://en.wikipedia.org/wiki/K_shortest_path_routing**
- **Sample Data** network.

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2**

pgr_dijkstraVia - Proposed

`pgr_dijkstraVia` — Using dijkstra algorithm, it finds the route that goes through a list of vertices.

> **Warning**
>
> Proposed functions for next mayor release.
>
> - They are not officially in the current release.
> - They will likely officially be part of the next mayor release:
>   - The functions make use of ANY-INTEGER and ANY-NUMERICAL
>   - Name might not change. (But still can)
>   - Signature might not change. (But still can)
>   - Functionality might not change. (But still can)
>   - pgTap tests have being done. But might need more.
>   - Documentation might need refinement.

Boost Graph Inside

Availability

- Version 2.2.0
  - New **proposed** function

Description

Given a list of vertices and a graph, this function is equivalent to finding the shortest path between \(vertex_i\) and \(vertex_{i+1}\) for all \(i < size_of(vertex_via)\).

The paths represents the sections of the route.

Signatures

Summary

```
pgr_dijkstraVia(edges_sql, via_vertices [, directed] [, strict] [, U_turn_on_edge])
RETURNS SET OF (seq, path_pid, path_seq, start_vid, end_vid,
    node, edge, cost, agg_cost, route_agg_cost)
OR EMPTY SET
```

Using default

```
pgr_dijkstraVia(edges_sql, via_vertices)
RETURNS SET OF (seq, path_pid, path_seq, start_vid, end_vid,
    node, edge, cost, agg_cost, route_agg_cost)
OR EMPTY SET
```

Example:
Find the route that visits the vertices \(\{ 1, 3, 9\}\) in that order

```
SELECT * FROM pgr_dijkstraVia(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table order by id',
    ARRAY[1, 3, 9]
);
 seq | path_id | path_seq | start_vid | end_vid | node | edge | cost | agg_cost | route_agg_cost
-----+---------+----------+-----------+---------+------+------+------+----------+---------------
   1 |       1 |        1 |         1 |       3 |    1 |    1 |    1 |        0 |              0
   2 |       1 |        2 |         1 |       3 |    2 |    4 |    1 |        1 |              1
   3 |       1 |        3 |         1 |       3 |    5 |    8 |    1 |        2 |              2
   4 |       1 |        4 |         1 |       3 |    6 |    9 |    1 |        3 |              3
   5 |       1 |        5 |         1 |       3 |    9 |   16 |    1 |        4 |              4
   6 |       1 |        6 |         1 |       3 |    4 |    3 |    1 |        5 |              5
   7 |       1 |        7 |         1 |       3 |    3 |   -1 |    0 |        6 |              6
   8 |       2 |        1 |         3 |       9 |    3 |    5 |    1 |        0 |              6
   9 |       2 |        2 |         3 |       9 |    6 |    9 |    1 |        1 |              7
  10 |       2 |        3 |         3 |       9 |    9 |   -2 |    0 |        2 |              8
(10 rows)
```

Complete Signature

```
pgr_dijkstraVia(edges_sql, via_vertices [, directed] [, strict] [, U_turn_on_edge])
RETURNS SET OF (seq, path_pid, path_seq, start_vid, end_vid,
    node, edge, cost, agg_cost, route_agg_cost)
OR EMPTY SET
```

Example:
Find the route that visits the vertices \(\{ 1, 3, 9\}\) in that order on an **undirected** graph, avoiding U-turns when possible

```
SELECT * FROM pgr_dijkstraVia(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table order by id',
    ARRAY[1, 3, 9], false, strict:=true, U_turn_on_edge:=false
);
 seq | path_id | path_seq | start_vid | end_vid | node | edge | cost | agg_cost | route_agg_cost
-----+---------+----------+-----------+---------+------+------+------+----------+---------------
   1 |       1 |        1 |         1 |       3 |    1 |    1 |    1 |        0 |              0
   2 |       1 |        2 |         1 |       3 |    2 |    2 |    1 |        1 |              1
   3 |       1 |        3 |         1 |       3 |    3 |   -1 |    0 |        2 |              2
   4 |       2 |        1 |         3 |       9 |    3 |    3 |    1 |        0 |              2
   5 |       2 |        2 |         3 |       9 |    4 |   16 |    1 |        1 |              3
   6 |       2 |        3 |         3 |       9 |    9 |   -2 |    0 |        2 |              4
(6 rows)
```

Parameters

Parameter	Type	Default	Description

Parameter	Type	Default	Description
edges_sql	TEXT		SQL query as described above.
via_vertices	ARRAY[ANY-INTEGER]		Array of ordered vertices identifiers that are going to be visited.
directed	BOOLEAN	true	• When true Graph is considered *Directed* • When false the graph is considered as Undirected.
strict	BOOLEAN	false	• When false ignores missing paths returning all paths found • When true if a path is missing stops and returns *EMPTY SET*
U_turn_on_edge	BOOLEAN	true	• When true departing from a visited vertex will not try to avoid using the edge used to reach it. In other words, U turn using the edge with same *id* is allowed. • When false when a departing from a visited vertex tries to avoid using the edge used to reach it. In other words, U turn using the edge with same *id* is used when no other path is found.

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Return Columns

Returns set of (start_vid, end_vid, agg_cost)

Column	Type	Description
seq	BIGINT	Sequential value starting from 1.
path_pid	BIGINT	Identifier of the path.
path_seq	BIGINT	Sequential value starting from 1 for the path.
start_vid	BIGINT	Identifier of the starting vertex of the path.
end_vid	BIGINT	Identifier of the ending vertex of the path.
node	BIGINT	Identifier of the node in the path from start_vid to end_vid.
edge	BIGINT	Identifier of the edge used to go from node to the next node in the path sequence. -1 for the last node of the path. -2 for the last node of the route.
cost	FLOAT	Cost to traverse from node using edge to the next node in the route sequence.
agg_cost	FLOAT	Total cost from start_vid to end_vid of the path.
route_agg_cost	FLOAT	Total cost from start_vid of path_pid = 1 to end_vid of the current path_pid .

Additional Examples

Example 1:
Find the route that visits the vertices \(\{1, 5, 3, 9, 4\}\) in that order

```
SELECT * FROM pgr_dijkstraVia(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table order by id',
    ARRAY[1, 5, 3, 9, 4]
);
 seq | path_id | path_seq | start_vid | end_vid | node | edge | cost | agg_cost | route_agg_cost
-----+---------+----------+-----------+---------+------+------+------+----------+----------------
   1 |       1 |        1 |         1 |       5 |    1 |    1 |    1 |        0 |              0
   2 |       1 |        2 |         1 |       5 |    2 |    4 |    1 |        1 |              1
   3 |       1 |        3 |         1 |       5 |    5 |   -1 |    0 |        2 |              2
   4 |       2 |        1 |         5 |       3 |    5 |    8 |    1 |        0 |              2
   5 |       2 |        2 |         5 |       3 |    6 |    9 |    1 |        1 |              3
   6 |       2 |        3 |         5 |       3 |    9 |   16 |    1 |        2 |              4
   7 |       2 |        4 |         5 |       3 |    4 |    3 |    1 |        3 |              5
   8 |       2 |        5 |         5 |       3 |    3 |   -1 |    0 |        4 |              6
   9 |       3 |        1 |         3 |       9 |    3 |    5 |    1 |        0 |              6
  10 |       3 |        2 |         3 |       9 |    6 |    9 |    1 |        1 |              7
  11 |       3 |        3 |         3 |       9 |    9 |   -1 |    0 |        2 |              8
  12 |       4 |        1 |         9 |       4 |    9 |   16 |    1 |        0 |              8
  13 |       4 |        2 |         9 |       4 |    4 |   -2 |    0 |        1 |              9
(13 rows)
```

Example 2:

What's the aggregate cost of the third path?

```
SELECT agg_cost FROM  pgr_dijkstraVia(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table order by id',
    ARRAY[1, 5, 3, 9, 4]
)
WHERE path_id = 3 AND edge <0;
 agg_cost
----------
        2
(1 row)
```

Example 3:

What's the route's aggregate cost of the route at the end of the third path?

```
SELECT route_agg_cost FROM  pgr_dijkstraVia(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table order by id',
    ARRAY[1, 5, 3, 9, 4]
)
WHERE path_id = 3 AND edge < 0;
 route_agg_cost
----------------
              8
(1 row)
```

Example 4:

How are the nodes visited in the route?

```
SELECT row_number() over () as node_seq, node
FROM  pgr_dijkstraVia(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table order by id',
    ARRAY[1, 5, 3, 9, 4]
)
WHERE edge <> -1 ORDER BY seq;
 node_seq | node
----------+------
        1 |    1
        2 |    2
        3 |    5
        4 |    6
        5 |    9
        6 |    4
        7 |    3
        8 |    6
        9 |    9
       10 |    4
(10 rows)
```

Example 5:

What are the aggregate costs of the route when the visited vertices are reached?

```
SELECT path_id, route_agg_cost FROM  pgr_dijkstraVia(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table order by id',
    ARRAY[1, 5, 3, 9, 4]
)
WHERE edge < 0;
 path_id | route_agg_cost
---------+----------------
       1 |              2
       2 |              6
       3 |              8
       4 |              9
(4 rows)
```

Example 6:

Show the route's seq and aggregate cost and a status of "passes in front" or "visits" node\(9\)

```
SELECT seq, route_agg_cost, node, agg_cost ,
CASE WHEN edge = -1 THEN 'visits'
ELSE 'passes in front'
END as status
FROM  pgr_dijkstraVia(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table order by id',
    ARRAY[1, 5, 3, 9, 4])
WHERE node = 9 and (agg_cost  <> 0 or seq = 1);
 seq | route_agg_cost | node | agg_cost |     status
-----+----------------+------+----------+-----------------
   6 |              4 |    9 |        2 | passes in front
  11 |              8 |    9 |        2 | visits
(2 rows)

ROLLBACK;
ROLLBACK
```

See Also

- **https://en.wikipedia.org/wiki/Dijkstra%27s_algorithm**
- **Sample Data** network.

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2)**

pgr_dijkstraNear - Experimental

`pgr_dijkstraNear` — Using dijkstra algorithm, finds the route that leads to the nearest vertex.

> **Warning**
>
> Possible server crash
>
> - These functions might create a server crash

> **Warning**
>
> Experimental functions
>
> - They are not officially of the current release.
> - They likely will not be officially be part of the next release:
>   - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
>   - Name might change.
>   - Signature might change.
>   - Functionality might change.
>   - pgTap tests might be missing.
>   - Might need c/c++ coding.
>   - May lack documentation.
>   - Documentation if any might need to be rewritten.
>   - Documentation examples might need to be automatically generated.
>   - Might need a lot of feedback from the comunity.
>   - Might depend on a proposed function of pgRouting
>   - Might depend on a deprecated function of pgRouting

Boost Graph Inside

Availability

- Version 3.2.0
  - New **experimental** function

Description

Given a graph, a starting vertex and a set of ending vertices, this function finds the shortest path from the starting vertex to the nearest ending vertex.

Characteristics

- Uses Dijkstra algorithm.
- Works for **directed** and **undirected** graphs.
- When there are more than one path to the same vertex with same cost:
  - The algorithm will return just one path
- Optionally allows to find more than one path.
  - When more than one path is to be returned:
    - Results are sorted in increasing order of:
      - aggregate cost
      - Within the same value of aggregate costs:
        - results are sorted by (source, target)
- Running time: Dijkstra running time: $drt = O((|E| + |V|)log|V|)$
  - One to Many; drt
  - Many to One: drt
  - Many to Many: $drt * |Starting vids|$
  - Combinations: $drt * |Starting vids|$

Signatures

Summary

```
pgr_dijkstraNear(Edges SQL, Start vid,  End vids  [, directed] [, cap])
pgr_dijkstraNear(Edges SQL, Start vids, End vid   [, directed] [, cap])
pgr_dijkstraNear(Edges SQL, Start vids, End vids  [, directed] [, cap], [global])
pgr_dijkstraNear(Edges SQL, Combinations SQL  [, directed] [, cap], [global])
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

One to Many

```
pgr_dijkstraNear(Edges SQL, Start vid,  End vids [, directed] [, cap])
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
Departing on car from vertex 2 find the nearest subway station.

- Using a **directed** graph for car routing.
- The subway stations are on the following vertices $\{ 3, 6, 7\}$
- The defaults used:
  - *directed => true*
  - *cap => 1*

```
SELECT * FROM pgr_dijkstraNear(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, ARRAY[3, 6, 7]
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       6 |    2 |    4 |    1 |        0
   2 |        2 |         2 |       6 |    5 |    8 |    1 |        1
   3 |        3 |         2 |       6 |    6 |   -1 |    0 |        2
(3 rows)

```

The result shows that station at vertex\(6\) is the nearest.

Many to One

```
pgr_dijkstraNear(Edges SQL, Start vids, End vid  [, directed] [, cap])
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
Departing on a car from a subway station find the nearest **two** stations to vertex \(2\)

- Using a **directed** graph for car routing.
- The subway stations are on the following vertices \(\{ 3, 6, 7\}\)
- On line *4*: using the positional parameter: *directed* set to `true`
- In line *5*: using named parameter *cap => 2*

```
1 SELECT * FROM pgr_dijkstraNear(
2     'SELECT id, source, target, cost, reverse_cost FROM edge_table',
3     ARRAY[3, 6, 7], 2,
4     true,
5     cap => 2
6 );
7  seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
8 -----+----------+-----------+---------+------+------+------+----------
9    1 |        1 |         3 |       2 |    3 |    2 |    1 |        0
10   2 |        2 |         3 |       2 |    2 |   -1 |    0 |        1
11   3 |        1 |         6 |       2 |    6 |    8 |    1 |        0
12   4 |        2 |         6 |       2 |    5 |    4 |    1 |        1
13   5 |        3 |         6 |       2 |    2 |   -1 |    0 |        2
14 (5 rows)
15
```

The result shows that station at vertex \(3\) is the nearest and the next best is \(6\).

Many to Many

```
pgr_dijkstraNear(Edges SQL, Start vids, End vids [, directed] [, cap], [global])
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
Find the best pedestrian connection between two lines of buses

- Unsing an **undirected** graph for pedestrian routing
- The first subway line stations stops are at \(\{3, 6, 7\}\)
- The second subway line stations are at \(\{4, 9\}\)
- On line *4*: using the named parameter: *directed => false*
- The defaults used:
  - *cap => 1*
  - *global => true*

```
1 SELECT * FROM pgr_dijkstraNear(
2     'SELECT id, source, target, cost, reverse_cost FROM edge_table',
3     ARRAY[4, 9], ARRAY[3, 6, 7],
4     directed => false
5 );
6  seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
7 -----+----------+-----------+---------+------+------+------+----------
8    1 |        1 |         4 |       3 |    4 |    3 |    1 |        0
9    2 |        2 |         4 |       3 |    3 |   -1 |    0 |        1
10 (2 rows)
11
```

For a pedestrian the best connection is to get on/off is at vertex \(3\) of the first subway line and at vertex \(4\) of the second subway line.

Only *one* route is returned because *global* is `true` and *cap* is `1`

Combinations

```
pgr_dijkstraNear(Edges SQL, Combinations SQL  [, directed] [, cap], [global])
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
Find the best car connection between all the stations of two subway lines

- Using a **directed** graph for car routing.
- The first subway line stations stops are at\(\{3, 6, 7\}\)
- The second subway line stations are at\(\{4, 9\}\)
- line *3* sets the start vertices to be from the fisrt subway line and the ending vertices to be from the second subway line
- line *5* sets the start vertices to be from the first subway line and the ending vertices to be from the first subway line
- On line *6*: using the named parameter is *global => false*
- The defaults used:
  - *directed => true*
  - *cap => 1*

```
1  SELECT * FROM pgr_dijkstraNear(
2    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
3    'SELECT unnest(ARRAY[3, 6, 7]) as source, target FROM (SELECT unnest(ARRAY[4, 9]) AS target) a
4    UNION
5    SELECT unnest(ARRAY[4, 9]), target FROM (SELECT unnest(ARRAY[3, 6, 7]) AS target) b',
6    global => false
7  );
8   seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
9  -----+----------+-----------+---------+------+------+------+----------
10    1 |        1 |         4 |       3 |    4 |    3 |    1 |        0
11    2 |        2 |         4 |       3 |    3 |   -1 |    0 |        1
12    3 |        1 |         6 |       9 |    6 |    9 |    1 |        0
13    4 |        2 |         6 |       9 |    9 |   -1 |    0 |        1
14    5 |        1 |         9 |       6 |    9 |    9 |    1 |        0
15    6 |        2 |         9 |       6 |    6 |   -1 |    0 |        1
16    7 |        1 |         3 |       9 |    3 |    5 |    1 |        0
17    8 |        2 |         3 |       9 |    6 |    9 |    1 |        1
18    9 |        3 |         3 |       9 |    9 |   -1 |    0 |        2
19   10 |        1 |         7 |       9 |    7 |    6 |    1 |        0
20   11 |        2 |         7 |       9 |    8 |    7 |    1 |        1
21   12 |        3 |         7 |       9 |    5 |    8 |    1 |        2
22   13 |        4 |         7 |       9 |    6 |    9 |    1 |        3
23   14 |        5 |         7 |       9 |    9 |   -1 |    0 |        4
24 (14 rows)
25
```

From the results:

- making a connection from the first subway line to the second:
  - \({(3 -> 9) (6 -> 9) (7 -> 9)}\)and the best one is\((6 -> 9)\) with a cost of\(1\) (lines: *12* and *13*)
- making a connection from the second subway line to the first:
  - \({(4 -> 3) (9 -> 6)}\) and both are equaly good as they have the same cost. (lines:*10* and *11* and lines: *14* and *15*)

Parameters

Parameter	Type	Default	Description
Edges SQL	TEXT		**Edges query** as described below
Combinations SQL	TEXT		*Combinations query* as described below
Start vid	BIGINT		Identifier of the starting vertex of the path.
Start vids	ARRAY[BIGINT]		Array of identifiers of starting vertices.
End vid	BIGINT		Identifier of the ending vertex of the path.
End vids	ARRAY[BIGINT]		Array of identifiers of ending vertices.
directed	BOOLEAN	true	• When true the graph is considered *Directed* • When false the graph is considered as *Undirected*.
cap	BIGINT	1	Find at most cap number of nearest shortest paths
global	BOOLEAN	true	• When true: only cap limit results will be returned • When false: cap limit per Start vid will be returned

Inner query

Edges query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.

Column	Type	Default	Description
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Combinations query

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

Return Columns

RETURNS SET OF `(seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)` OR EMPTY SET

Column	Type	Description
seq	BIGINT	Sequential value starting from 1.
path_seq	BIGINT	Sequential value starting from 1 for each $(start\_vid \to end\_vid)$ path.
start_vid	BIGINT	Identifier of the starting vertex of the path.
end_vid	BIGINT	Identifier of the ending vertex of the path.
node	BIGINT	Identifier of the node at position `path_seq` in the $(start\_vid \to end\_vid)$ path.
edge	BIGINT	Identifier of the edge used to go from node at `path_seq` to the node at `path_seq + 1` in the $(start\_vid \to end\_vid)$ path. • -1 for the last node of the path.
cost	FLOAT	Cost to traverse from `node` using `edge` to the next node in the route sequence. • 0 for the last row of the path.
agg_cost	FLOAT	Total cost of traversing $(start\_vid \to node)$ section of the $(start\_vid \to end\_vid)$ path.

See Also

- **Dijkstra - Family of functions**
- **pgr_dijkstraNearCost - Experimental**
- **Sample Data** network.
- boost: **https://www.boost.org/libs/graph/doc/table_of_contents.html**
- Wikipedia: **https://en.wikipedia.org/wiki/Dijkstra%27s_algorithm**

Indices and tables

- **Index**
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- **Supported versions: Latest (3.2)**

pgr_dijkstraNearCost - Experimental

`pgr_dijkstraNearCost` — Using dijkstra algorithm, finds the route that leads to the nearest vertex.

> **Warning**
>
> Possible server crash
>
> - These functions might create a server crash

Warning

Experimental functions

- They are not officially of the current release.
- They likely will not be officially be part of the next release:
    - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
    - Name might change.
    - Signature might change.
    - Functionality might change.
    - pgTap tests might be missing.
    - Might need c/c++ coding.
    - May lack documentation.
    - Documentation if any might need to be rewritten.
    - Documentation examples might need to be automatically generated.
    - Might need a lot of feedback from the comunity.
    - Might depend on a proposed function of pgRouting
    - Might depend on a deprecated function of pgRouting

Boost Graph Inside

Availability

- Version 3.2.0
    - New **experimental** function

Description

Given a graph, a starting vertex and a set of ending vertices, this function finds the shortest path from the starting vertex to the nearest ending vertex.

Characteristics

- Uses Dijkstra algorithm.
- Works for **directed** and **undirected** graphs.
- When there are more than one path to the same vertex with same cost:
    - The algorithm will return just one path
- Optionally allows to find more than one path.
    - When more than one path is to be returned:
        - Results are sorted in increasing order of:
            - aggregate cost
            - Within the same value of aggregate costs:
                - results are sorted by (source, target)
- Running time: Dijkstra running time: \(drt = O((|E| + |V|)log|V|)\)
    - One to Many; \(drt\)
    - Many to One: \(drt\)
    - Many to Many: \(drt * |Starting vids|\)
    - Combinations: \(drt * |Starting vids|\)

Signatures

Summary

```
pgr_dijkstraNearCost(Edges SQL, Start vid,  End vids  [, directed] [, cap])
pgr_dijkstraNearCost(Edges SQL, Start vids, End vid   [, directed] [, cap])
pgr_dijkstraNearCost(Edges SQL, Start vids, End vids  [, directed] [, cap], [global])
pgr_dijkstraNearCost(Edges SQL, Combinations SQL  [, directed] [, cap], [global])
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

One to Many

```
pgr_dijkstraNearCost(Edges SQL, Start vid,  End vids [, directed] [, cap])
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example:

Departing on car from vertex \(2\) find the nearest subway station.

- Using a **directed** graph for car routing.
- The subway stations are on the following vertices\(\{ 3, 6, 7\}\)
- The defaults used:
  - *directed => true*
  - *cap => 1*

```
SELECT * FROM pgr_dijkstraNearCost(
  'SELECT id, source, target, cost, reverse_cost FROM edge_table',
  2, ARRAY[3, 6, 7]
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |       6 |        2
(1 row)

```

The result shows that station at vertex\(6\) is the nearest.

Many to One

```
pgr_dijkstraNearCost(Edges SQL, Start vids, End vid  [, directed] [, cap])
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example:

Departing on a car from a subway station find the nearest**two** stations to vertex \(2\)

- Using a **directed** graph for car routing.
- The subway stations are on the following vertices\(\{ 3, 6, 7\}\)
- On line *4*: using the positional parameter: *directed* set to `true`
- In line *5*: using named parameter *cap => 2*

```
1  SELECT * FROM pgr_dijkstraNearCost(
2    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
3    ARRAY[3, 6, 7], 2,
4    true,
5    cap => 2
6  );
7   start_vid | end_vid | agg_cost
8  -----------+---------+----------
9           3 |       2 |        1
10          6 |       2 |        2
11 (2 rows)
12
```

The result shows that station at vertex\(3\) is the nearest and the next best is\(6\).

Many to Many

```
pgr_dijkstraNearCost(Edges SQL, Start vids, End vids [, directed] [, cap], [global])
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example:

Find the best pedestrian connection between two lines of buses

- Unsing an **undirected** graph for pedestrian routing
- The first subway line stations stops are at\(\{3, 6, 7\}\)
- The second subway line stations are at\(\{4, 9\}\)
- On line *4*: using the named parameter: *directed => false*
- The defaults used:
  - *cap => 1*
  - *global => true*

```
SELECT * FROM pgr_dijkstraNearCost(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[4, 9], ARRAY[3, 6, 7],
    directed => false
);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         4 |       3 |        1
(1 row)

```

For a pedestrian the best connection is to get on/off is at vertex\(3\) of the first subway line and at vertex\(4\) of the second subway line.

Only *one* route is returned because *global* is `true` and *cap* is `1`

Combinations

```
pgr_dijkstraNearCost(Edges SQL, Combinations SQL  [, directed] [, cap], [global])
RETURNS SET OF (start_vid, end_vid, agg_cost)
OR EMPTY SET
```

Example:
Find the best car connection between all the stations of two subway lines

- Using a **directed** graph for car routing.
- The first subway line stations stops are at\(\{3, 6, 7\}\)
- The second subway line stations are at\(\{4, 9\}\)
- line *3* sets the start vertices to be from the fisrt subway line and the ending vertices to be from the second subway line
- line *5* sets the start vertices to be from the first subway line and the ending vertices to be from the first subway line
- On line *6*: using the named parameter is *global => false*
- The defaults used:
  - *directed => true*
  - *cap => 1*

```
1 SELECT * FROM pgr_dijkstraNearCost(
2     'SELECT id, source, target, cost, reverse_cost FROM edge_table',
3     'SELECT unnest(ARRAY[3, 6, 7]) as source, target FROM (SELECT unnest(ARRAY[4, 9]) AS target) a
4     UNION
5     SELECT unnest(ARRAY[4, 9]), target FROM (SELECT unnest(ARRAY[3, 6, 7]) AS target) b',
6     global => false
7 );
8  start_vid | end_vid | agg_cost
9 -----------+---------+----------
10         4 |       3 |        1
11         6 |       9 |        1
12         9 |       6 |        1
13         3 |       9 |        2
14         7 |       9 |        4
15 (5 rows)
16
```

From the results:

- making a connection from the first subway line to the second:
  - \({(3 -> 9) (6 -> 9) (7 -> 9)}\)and the best one is\((6 -> 9)\) with a cost of\(1\) (line: *11*)
- making a connection from the second subway line to the first:
  - \({(4 -> 3) (9 -> 6)}\) and both are equaly good as they have the same cost. (lines:*10* and *12*)

Parameters

Parameter	Type	Default	Description
Edges SQL	`TEXT`		**Edges query** as described below
Combinations SQL	`TEXT`		*Combinations query* as described below
Start vid	`BIGINT`		Identifier of the starting vertex of the path.
Start vids	`ARRAY[BIGINT]`		Array of identifiers of starting vertices.
End vid	`BIGINT`		Identifier of the ending vertex of the path.
End vids	`ARRAY[BIGINT]`		Array of identifiers of ending vertices.
directed	`BOOLEAN`	`true`	• When `true` the graph is considered *Directed* • When `false` the graph is considered as *Undirected*.
cap	`BIGINT`	1	Find at most `cap` number of nearest shortest paths

Parameter	Type	Default	Description
global	BOOLEAN	true	- When true: only cap limit results will be returned - When false: cap limit per Start vid will be returned

Inner query

Edges query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* - When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, - When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Combinations query

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

Return Columns

Returns SET OF (start_vid, end_vid, agg_cost)

Column	Type	Description
start_vid	BIGINT	Identifier of the starting vertex.
end_vid	BIGINT	Identifier of the ending vertex.
agg_cost	FLOAT	Aggregate cost from start_vid to end_vid.

See Also

- **Dijkstra - Family of functions**
- **pgr_dijkstraNear - Experimental**
- **Sample Data** network.
- boost: **https://www.boost.org/libs/graph/doc/table_of_contents.html**
- Wikipedia: **https://en.wikipedia.org/wiki/Dijkstra%27s_algorithm**

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The problem definition (Advanced documentation)

Given the following query:

pgr_dijkstra(\(sql, start_{vid}, end_{vid}, directed\))

where \(sql = \{(id_i, source_i, target_i, cost_i, reverse_cost_i)\}\)

and

- \(source = \bigcup source_i\),
- \(target = \bigcup target_i\),

The graphs are defined as follows:

Directed graph

The weighted directed graph, \(G_d(V,E)\), is definied by:

- the set of vertices \(V\)
  - \(V = source \cup target \cup {start_{vid}} \cup {end_{vid}}\)
- the set of edges \(E\)
  - \(E = \begin{cases} \text{ } \{(source_i, target_i, cost_i) \text{ when } cost >=0 \} & \quad \text{if } reverse_cost = \varnothing \\ \text{ } \text{ } & \quad \text{ } \\ \text{ } \{(source_i, target_i, cost_i) \text{ when } cost >=0 \} & \quad \text{ } \\ \cup \{(target_i, source_i, reverse_cost_i) \text{ when } reverse_cost_i>=0 \} & \quad \text{if } reverse_cost \neq \varnothing \\ \end{cases}\)

Undirected graph

The weighted undirected graph, \(G_u(V,E)\), is definied by:

- the set of vertices \(V\)
  - \(V = source \cup target \cup {start_v{vid}} \cup {end_{vid}}\)
- the set of edges \(E\)
  - \(E = \begin{cases} \text{ } \{(source_i, target_i, cost_i) \text{ when } cost >=0 \} & \quad \text{ } \\ \cup \{(target_i, source_i, cost_i) \text{ when } cost >=0 \} & \quad \text{ if } reverse_cost = \varnothing \\ \text{ } \text{ } & \text{ } \\ \text{ } \{(source_i, target_i, cost_i) \text{ when } cost >=0 \} & \text{ } \\ \cup \{(target_i, source_i, cost_i) \text{ when } cost >=0 \} & \text{ } \\ \cup \{(target_i, source_i, reverse_cost_i) \text{ when } reverse_cost_i >=0)\} & \text{ } \\ \cup \{(source_i, target_i, reverse_cost_i) \text{ when } reverse_cost_i >=0)\} & \quad \text{ if } reverse_cost \neq \varnothing \\ \end{cases}\)

The problem

Given:

- \(start_{vid} \in V\) a starting vertex
- \(end_{vid} \in V\) an ending vertex
- \(G(V,E) = \begin{cases} G_d(V,E) & \quad \text{ if6 } directed = true \\ G_u(V,E) & \quad \text{ if5 } directed = false \\ \end{cases}\)

Then:

- \(\boldsymbol{\pi} = \{(path_seq_i, node_i, edge_i, cost_i, agg_cost_i)\}\)

where:

  - \(path_seq_i = i\)
  - \(path_seq_{| \pi |} = | \pi |\)
  - \(node_i \in V\)
  - \(node_1 = start_{vid}\)
  - \(node_{| \pi |} = end_{vid}\)
  - \(\forall i \neq | \pi |, \quad (node_i, node_{i+1}, cost_i) \in E\)
  - \(edge_i = \begin{cases} id_{(node_i, node_{i+1},cost_i)} &\quad \text{when } i \neq | \pi | \\ -1 &\quad \text{when } i = | \pi | \\ \end{cases}\)
  - \(cost_i = cost_{(node_i, node_{i+1})}\)
  - \(agg_cost_i = \begin{cases} 0 &\quad \text{when } i = 1 \\ \displaystyle\sum_{k=1}^{i} cost_{(node_{k-1}, node_k)} &\quad \text{when } i \neq 1 \\ \end{cases}\)

In other words: The algorithm returns a the shortest path between\(start_{vid}\) and \(end_{vid}\) , if it exists, in terms of a sequence of nodes and of edges,

  - \(path_seq\) indicates the relative position in the path of the\(node\) or \(edge\).
  - \(cost\) is the cost of the edge to be used to go to the next node.
  - \(agg_cost\) is the cost from the \(start_{vid}\) up to the node.

If there is no path, the resulting set is empty.

See Also

Indices and tables

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- **Supported versions: Latest** (**3.2**) current(**3.2**) **3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3**

Flow - Family of functions

- **pgr_maxFlow** - Only the Max flow calculation using Push and Relabel algorithm.
- **pgr_boykovKolmogorov** - Boykov and Kolmogorov with details of flow on edges.
- **pgr_edmondsKarp** - Edmonds and Karp algorithm with details of flow on edges.
- **pgr_pushRelabel** - Push and relabel algorithm with details of flow on edges.
- Applications
  - **pgr_edgeDisjointPaths** - Calculates edge disjoint paths between two groups of vertices.
  - **pgr_maxCardinalityMatch** - Calculates a maximum cardinality matching in a graph.

Experimental

> **Warning**
>
> Possible server crash
>
> - These functions might create a server crash

> **Warning**
>
> Experimental functions
>
> - They are not officially of the current release.
> - They likely will not be officially be part of the next release:
>   - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
>   - Name might change.
>   - Signature might change.
>   - Functionality might change.
>   - pgTap tests might be missing.
>   - Might need c/c++ coding.
>   - May lack documentation.
>   - Documentation if any might need to be rewritten.
>   - Documentation examples might need to be automatically generated.
>   - Might need a lot of feedback from the comunity.
>   - Might depend on a proposed function of pgRouting
>   - Might depend on a deprecated function of pgRouting

- **pgr_maxFlowMinCost - Experimental** - Details of flow and cost on edges.
- **pgr_maxFlowMinCost_Cost - Experimental** - Only the Min Cost calculation.

- **Supported versions: Latest** (**3.2**) **3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4**

pgr_maxFlow

`pgr_maxFlow` — Calculates the maximum flow in a directed graph from the source(s) to the targets(s) using the Push Relabel algorithm.

Boost Graph Inside

Availability

- Version 3.2.0
  - New **proposed** function:
    - pgr_maxFlow(Combinations)
- Version 3.0.0
  - **Official** function

- Version 2.4.0
  - New **Proposed** function

Description

The main characteristics are:

- The graph is **directed**.
- Calculates the maximum flow from the *source(s)* to the *target(s)*.
  - When the maximum flow is **0** then there is no flow and **0** is returned.
  - There is no flow when a **source** is the same as a **target**.
- Any duplicated value in the source(s) or target(s) are ignored.
- Uses the **pgr_pushRelabel** algorithm.
- Running time: \(O(V ^ 3)\)

Signatures

Summary

```
pgr_maxFlow(Edges SQL, source,  target)
pgr_maxFlow(Edges SQL, sources,  target)
pgr_maxFlow(Edges SQL, source,  targets)
pgr_maxFlow(Edges SQL, sources,  targets)
pgr_maxFlow(Edges SQL, Combinations SQL) -- Proposed on v3.2
RETURNS BIGINT
```

One to One

```
pgr_maxFlow(Edges SQL, source,  target)
RETURNS BIGINT
```

Example:
From vertex \(6\) to vertex \(11\)

```
SELECT * FROM pgr_maxFlow(
    'SELECT id,
            source,
            target,
            capacity,
            reverse_capacity
    FROM edge_table'
    , 6, 11
);
 pgr_maxflow
-------------
         230
(1 row)
```

One to Many

```
pgr_maxFlow(Edges SQL, source,  targets)
RETURNS BIGINT
```

Example:
From vertex \(6\) to vertices \(\{11, 1, 13\}\)

```
SELECT * FROM pgr_maxFlow(
    'SELECT id,
            source,
            target,
            capacity,
            reverse_capacity
    FROM edge_table'
    , 6, ARRAY[11, 1, 13]
);
 pgr_maxflow
-------------
         340
(1 row)
```

Many to One

```
pgr_maxFlow(Edges SQL, sources,  target)
RETURNS BIGINT
```

Example:
From vertices \(\{6, 8, 12\}\) to vertex \(11\)

```
SELECT * FROM pgr_maxFlow(
    'SELECT id,
            source,
            target,
            capacity,
            reverse_capacity
    FROM edge_table'
    , ARRAY[6, 8, 12], 11
);
 pgr_maxflow
-------------
         230
(1 row)
```

Many to Many

```
pgr_maxFlow(Edges SQL, sources,  targets)
RETURNS BIGINT
```

Example:
From vertices \(\{6, 8, 12\}\) to vertices \(\{1, 3, 11\}\)

```
SELECT * FROM pgr_maxFlow(
    'SELECT id,
            source,
            target,
            capacity,
            reverse_capacity
    FROM edge_table'
    , ARRAY[6, 8, 12], ARRAY[1, 3, 11]
);
 pgr_maxflow
-------------
         360
(1 row)
```

Combinations

```
pgr_maxFlow(Edges SQL, Combinations SQL)
RETURNS BIGINT
```

Example:
Using a combinations table, equivalent to calculating result from vertices\(\{6, 8, 12\}\) to vertices \(\{1, 3, 11\}\).

```
SELECT * FROM pgr_maxFlow(
    'SELECT id,
            source,
            target,
            capacity,
            reverse_capacity
    FROM edge_table',
    'SELECT * FROM ( VALUES (6, 1), (8, 3), (12, 11), (8, 1) ) AS t(source, target)'
);
 pgr_maxflow
-------------
         360
(1 row)
```

Parameters

Column	Type	Default	Description
Edges SQL	TEXT		Edges query as described in **Inner Queries**.
Combinations SQL	TEXT		Combinations query as described in **Inner Queries**.
source	BIGINT		Identifier of the starting vertex of the flow.
sources	ARRAY[BIGINT]		Array of identifiers of the starting vertices of the flow.
target	BIGINT		Identifier of the ending vertex of the flow.
targets	ARRAY[BIGINT]		Array of identifiers of the ending vertices of the flow.

Inner queries

Edges SQL:
an SQL query of a directed graph of capacities, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
capacity	ANY-INTEGER		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_capacity	ANY-INTEGER	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

Combinations SQL:
an SQL query which should return a set of rows with the following columns:

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

The function aggregates the sources and the targets, removes the duplicates, and then it calculates the result from the resultant source vertices to the target vertices.

Return Columns

Type	Description
BIGINT	Maximum flow possible from the source(s) to the target(s)

See Also

- **Flow - Family of functions**
- **https://www.boost.org/libs/graph/doc/push_relabel_max_flow.html**
- **https://en.wikipedia.org/wiki/Push%E2%80%93relabel_maximum_flow_algorithm**

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- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3**

pgr_boykovKolmogorov

pgr_boykovKolmogorov — Calculates the flow on the graph edges that maximizes the flow from the sources to the targets using Boykov Kolmogorov algorithm.

Boost Graph Inside

Availability:

- Version 3.2.0
  - New **proposed** function:
    - pgr_boykovKolmogorov(Combinations)
- Version 3.0.0
  - **Official** function
- Version 2.5.0
  - Renamed from `pgr_maxFlowBoykovKolmogorov`
  - **Proposed** function
- Version 2.3.0
  - New **Experimental** function

Description

The main characteristics are:

- The graph is **directed**.
- Process is done only on edges with positive capacities.
- When the maximum flow is 0 then there is no flow and **EMPTY SET** is returned.
  - There is no flow when a **source** is the same as a **target**.
- Any duplicated value in the source(s) or target(s) are ignored.
- Calculates the flow/residual capacity for each edge. In the output
  - Edges with zero flow are omitted.
- Creates a **super source** and edges to all the source(s), and a **super target** and the edges from all the targets(s).
- The maximum flow through the graph is guaranteed to be the value returned by **pgr_maxFlow** when executed with the same parameters and can be calculated:
  - By aggregation of the outgoing flow from the sources
  - By aggregation of the incoming flow to the targets
- Running time: Polynomial

Signatures

Summary

```
pgr_boykovKolmogorov(Edges SQL, source,  target)
pgr_boykovKolmogorov(Edges SQL, sources, target)
pgr_boykovKolmogorov(Edges SQL, source,  targets)
pgr_boykovKolmogorov(Edges SQL, sources, targets)
pgr_boykovKolmogorov(Edges SQL, Combinations SQL) -- Proposed on v3.2
RETURNS SET OF (seq, edge, start_vid, end_vid, flow, residual_capacity)
OR EMPTY SET
```

One to One

```
pgr_boykovKolmogorov(Edges SQL, source,  target)
RETURNS SET OF (seq, edge, start_vid, end_vid, flow, residual_capacity)
OR EMPTY SET
```

Example:

From vertex \(6\) to vertex \(11\)

```
SELECT * FROM pgr_boykovKolmogorov(
    'SELECT id,
            source,
            target,
            capacity,
            reverse_capacity
    FROM edge_table'
    , 6, 11
);
 seq | edge | start_vid | end_vid | flow | residual_capacity
-----+------+-----------+---------+------+-------------------
   1 |   10 |         5 |      10 |  100 |                30
   2 |    8 |         6 |       5 |  100 |                30
   3 |   11 |         6 |      11 |  130 |                 0
   4 |   12 |        10 |      11 |  100 |                 0
(4 rows)
```

One to Many

```
pgr_boykovKolmogorov(Edges SQL, source,  targets)
RETURNS SET OF (seq, edge, start_vid, end_vid, flow, residual_capacity)
OR EMPTY SET
```

Example:

From vertex \(6\) to vertices \(\{1, 3, 11\}\)

```
SELECT * FROM pgr_boykovKolmogorov(
    'SELECT id,
            source,
            target,
            capacity,
            reverse_capacity
    FROM edge_table'
    , 6, ARRAY[1, 3, 11]
);
 seq | edge | start_vid | end_vid | flow | residual_capacity
-----+------+-----------+---------+------+-------------------
   1 |    1 |         2 |       1 |   50 |                80
   2 |    3 |         4 |       3 |   80 |                50
   3 |    4 |         5 |       2 |   50 |                 0
   4 |   10 |         5 |      10 |   80 |                50
   5 |    8 |         6 |       5 |  130 |                 0
   6 |    9 |         6 |       9 |   80 |                50
   7 |   11 |         6 |      11 |  130 |                 0
   8 |   16 |         9 |       4 |   80 |                 0
   9 |   12 |        10 |      11 |   80 |                20
(9 rows)
```

Many to One

```
pgr_boykovKolmogorov(Edges SQL, sources,  target)
RETURNS SET OF (seq, edge, start_vid, end_vid, flow, residual_capacity)
OR EMPTY SET
```

Example:

From vertices \(\{6, 8, 12\}\) to vertex \(11\)

```
SELECT * FROM pgr_boykovKolmogorov(
    'SELECT id,
            source,
            target,
            capacity,
            reverse_capacity
    FROM edge_table'
    , ARRAY[6, 8, 12], 11
);
 seq | edge | start_vid | end_vid | flow | residual_capacity
-----+------+-----------+---------+------+-------------------
   1 |   10 |         5 |      10 |  100 |                30
   2 |    8 |         6 |       5 |  100 |                30
   3 |   11 |         6 |      11 |  130 |                 0
   4 |   12 |        10 |      11 |  100 |                 0
(4 rows)
```

Many to Many

```
pgr_boykovKolmogorov(Edges SQL, sources,  targets)
RETURNS SET OF (seq, edge, start_vid, end_vid, flow, residual_capacity)
OR EMPTY SET
```

Example:

From vertices \(\{6, 8, 12\}\) to vertices \(\{1, 3, 11\}\)

```
SELECT * FROM pgr_boykovKolmogorov(
   'SELECT id,
         source,
         target,
         capacity,
         reverse_capacity
   FROM edge_table'
   , ARRAY[6, 8, 12], ARRAY[1, 3, 11]
);
 seq | edge | start_vid | end_vid | flow | residual_capacity
-----+------+-----------+---------+------+-------------------
   1 |    1 |         2 |       1 |   50 |                80
   2 |    3 |         4 |       3 |   80 |                50
   3 |    4 |         5 |       2 |   50 |                 0
   4 |   10 |         5 |      10 |  100 |                30
   5 |    8 |         6 |       5 |  130 |                 0
   6 |    9 |         6 |       9 |   80 |                50
   7 |   11 |         6 |      11 |  130 |                 0
   8 |    7 |         8 |       5 |   20 |                30
   9 |   16 |         9 |       4 |   80 |                 0
  10 |   12 |        10 |      11 |  100 |                 0
(10 rows)
```

Combinations

```
pgr_boykovKolmogorov(Edges SQL, Combinations SQL)
RETURNS SET OF (seq, edge, start_vid, end_vid, flow, residual_capacity)
OR EMPTY SET
```

Example:
Using a combinations table, equivalent to calculating result from vertices\(\{6, 8, 12\}\) to vertices \(\{1, 3, 11\}\).

```
SELECT * FROM pgr_boykovKolmogorov(
   'SELECT id,
         source,
         target,
         capacity,
         reverse_capacity
   FROM edge_table',
   'SELECT * FROM ( VALUES (6, 1), (8, 3), (12, 11), (8, 1) ) AS t(source, target)'
);
 seq | edge | start_vid | end_vid | flow | residual_capacity
-----+------+-----------+---------+------+-------------------
   1 |    1 |         2 |       1 |   50 |                80
   2 |    3 |         4 |       3 |   80 |                50
   3 |    4 |         5 |       2 |   50 |                 0
   4 |   10 |         5 |      10 |  100 |                30
   5 |    8 |         6 |       5 |  130 |                 0
   6 |    9 |         6 |       9 |   80 |                50
   7 |   11 |         6 |      11 |  130 |                 0
   8 |    7 |         8 |       5 |   20 |                30
   9 |   16 |         9 |       4 |   80 |                 0
  10 |   12 |        10 |      11 |  100 |                 0
(10 rows)
```

Parameters

Column	Type	Default	Description
Edges SQL	TEXT		Edges query as described in **Inner Queries**.
Combinations SQL	TEXT		Combinations query as described in **Inner Queries**.
source	BIGINT		Identifier of the starting vertex of the flow.
sources	ARRAY[BIGINT]		Array of identifiers of the starting vertices of the flow.
target	BIGINT		Identifier of the ending vertex of the flow.
targets	ARRAY[BIGINT]		Array of identifiers of the ending vertices of the flow.

Inner queries

Edges SQL:
an SQL query of a directed graph of capacities, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Column	Type	Default	Description
capacity	ANY-INTEGER		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_capacity	ANY-INTEGER	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

Combinations SQL:
an SQL query which should return a set of rows with the following columns:

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

The function aggregates the sources and the targets, removes the duplicates, and then it calculates the result from the resultant source vertices to the target vertices.

Result Columns

Column	Type	Description
seq	INT	Sequential value starting from **1**.
edge	BIGINT	Identifier of the edge in the original query(edges_sql).
start_vid	BIGINT	Identifier of the first end point vertex of the edge.
end_vid	BIGINT	Identifier of the second end point vertex of the edge.
flow	BIGINT	Flow through the edge in the direction (start_vid, end_vid).
residual_capacity	BIGINT	Residual capacity of the edge in the direction (start_vid, end_vid).

See Also

- **Flow - Family of functions**, **pgr_pushRelabel**, **pgr_edmondsKarp**
- **https://www.boost.org/libs/graph/doc/boykov_kolmogorov_max_flow.html**

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- **Supported versions: Latest** (**3.2**) **3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3**

pgr_edmondsKarp

pgr_edmondsKarp — Calculates the flow on the graph edges that maximizes the flow from the sources to the targets using Push Relabel Algorithm.

Boost Graph Inside

Availability

- Version 3.2.0
  - New **proposed** function:
    - pgr_edmondsKarp(Combinations)
- Version 3.0.0
  - **Official** function
- Version 2.5.0
  - Renamed from `pgr_maxFlowEdmondsKarp`
  - **Proposed** function
- Version 2.3.0
  - New **Experimental** function

Description

The main characteristics are:

- The graph is **directed**.
- Process is done only on edges with positive capacities.
- When the maximum flow is 0 then there is no flow and **EMPTY SET** is returned.
  - There is no flow when a **source** is the same as a **target**.
- Any duplicated value in the source(s) or target(s) are ignored.
- Calculates the flow/residual capacity for each edge. In the output
  - Edges with zero flow are omitted.
- Creates a **super source** and edges to all the source(s), and a **super target** and the edges from all the targets(s).
- The maximum flow through the graph is guaranteed to be the value returned by **pgr_maxFlow** when executed with the same parameters and can be calculated:
  - By aggregation of the outgoing flow from the sources
  - By aggregation of the incoming flow to the targets

- Running time: \(O(V * E ^ 2)\)

Signatures

Summary

```
pgr_edmondsKarp(Edges SQL, source,  target)
pgr_edmondsKarp(Edges SQL, sources, target)
pgr_edmondsKarp(Edges SQL, source,  targets)
pgr_edmondsKarp(Edges SQL, sources, targets)
pgr_edmondsKarp(Edges SQL, Combinations SQL) -- Proposed on v3.2
RETURNS SET OF (seq, edge, start_vid, end_vid, flow, residual_capacity)
OR EMPTY SET
```

One to One

```
pgr_edmondsKarp(Edges SQL, source,  target)
RETURNS SET OF (seq, edge, start_vid, end_vid, flow, residual_capacity)
OR EMPTY SET
```

Example:

From vertex \(6\) to vertex \(11\)

```
SELECT * FROM pgr_edmondsKarp(
    'SELECT id,
            source,
            target,
            capacity,
            reverse_capacity
    FROM edge_table'
    , 6, 11
);
 seq | edge | start_vid | end_vid | flow | residual_capacity
-----+------+-----------+---------+------+-------------------
   1 |   10 |         5 |      10 |  100 |                30
   2 |    8 |         6 |       5 |  100 |                30
   3 |   11 |         6 |      11 |  130 |                 0
   4 |   12 |        10 |      11 |  100 |                 0
(4 rows)
```

One to Many

```
pgr_edmondsKarp(Edges SQL, source,  targets)
RETURNS SET OF (seq, edge, start_vid, end_vid, flow, residual_capacity)
OR EMPTY SET
```

Example:
From vertex \(6\) to vertices \(\{1, 3, 11\}\)

```
SELECT * FROM pgr_edmondsKarp(
    'SELECT id,
            source,
            target,
            capacity,
            reverse_capacity
    FROM edge_table'
    , 6, ARRAY[1, 3, 11]
);
 seq | edge | start_vid | end_vid | flow | residual_capacity
-----+------+-----------+---------+------+-------------------
   1 |    1 |         2 |       1 |   50 |                80
   2 |    3 |         4 |       3 |   80 |                50
   3 |    4 |         5 |       2 |   50 |                 0
   4 |   10 |         5 |      10 |   80 |                50
   5 |    8 |         6 |       5 |  130 |                 0
   6 |    9 |         6 |       9 |   80 |                50
   7 |   11 |         6 |      11 |  130 |                 0
   8 |   16 |         9 |       4 |   80 |                 0
   9 |   12 |        10 |      11 |   80 |                20
(9 rows)
```

Many to One

```
pgr_edmondsKarp(Edges SQL, sources,  target)
RETURNS SET OF (seq, edge, start_vid, end_vid, flow, residual_capacity)
OR EMPTY SET
```

Example:
From vertices \(\{6, 8, 12\}\) to vertex \(11\)

```
SELECT * FROM pgr_edmondsKarp(
    'SELECT id,
            source,
            target,
            capacity,
            reverse_capacity
    FROM edge_table'
    , ARRAY[6, 8, 12], 11
);
 seq | edge | start_vid | end_vid | flow | residual_capacity
-----+------+-----------+---------+------+-------------------
   1 |   10 |         5 |      10 |  100 |                30
   2 |    8 |         6 |       5 |  100 |                30
   3 |   11 |         6 |      11 |  130 |                 0
   4 |   12 |        10 |      11 |  100 |                 0
(4 rows)
```

Many to Many

```
pgr_edmondsKarp(Edges SQL, sources,  targets)
RETURNS SET OF (seq, edge, start_vid, end_vid, flow, residual_capacity)
OR EMPTY SET
```

Example:
From vertices \(\{6, 8, 12\}\) to vertices \(\{1, 3, 11\}\)

```
SELECT * FROM pgr_edmondsKarp(
   'SELECT id,
          source,
          target,
          capacity,
          reverse_capacity
   FROM edge_table'
  , ARRAY[6, 8, 12], ARRAY[1, 3, 11]
);
 seq | edge | start_vid | end_vid | flow | residual_capacity
-----+------+-----------+---------+------+-------------------
   1 |    1 |         2 |       1 |   50 |                80
   2 |    3 |         4 |       3 |   80 |                50
   3 |    4 |         5 |       2 |   50 |                 0
   4 |   10 |         5 |      10 |  100 |                30
   5 |    8 |         6 |       5 |  130 |                 0
   6 |    9 |         6 |       9 |   80 |                50
   7 |   11 |         6 |      11 |  130 |                 0
   8 |    7 |         8 |       5 |   20 |                30
   9 |   16 |         9 |       4 |   80 |                 0
  10 |   12 |        10 |      11 |  100 |                 0
(10 rows)
```

Combinations

```
pgr_edmondsKarp(Edges SQL, Combinations SQL)
RETURNS SET OF (seq, edge, start_vid, end_vid, flow, residual_capacity)
OR EMPTY SET
```

Example:
Using a combinations table, equivalent to calculating result from vertices\(\{6, 8, 12\}\) to vertices \(\{1, 3, 11\}\).

```
SELECT * FROM pgr_edmondsKarp(
   'SELECT id,
          source,
          target,
          capacity,
          reverse_capacity
   FROM edge_table',
   'SELECT * FROM ( VALUES (6, 1), (8, 3), (12, 11), (8, 1) ) AS t(source, target)'
);
 seq | edge | start_vid | end_vid | flow | residual_capacity
-----+------+-----------+---------+------+-------------------
   1 |    1 |         2 |       1 |   50 |                80
   2 |    3 |         4 |       3 |   80 |                50
   3 |    4 |         5 |       2 |   50 |                 0
   4 |   10 |         5 |      10 |  100 |                30
   5 |    8 |         6 |       5 |  130 |                 0
   6 |    9 |         6 |       9 |   80 |                50
   7 |   11 |         6 |      11 |  130 |                 0
   8 |    7 |         8 |       5 |   20 |                30
   9 |   16 |         9 |       4 |   80 |                 0
  10 |   12 |        10 |      11 |  100 |                 0
(10 rows)
```

Parameters

Column	Type	Default	Description
Edges SQL	TEXT		Edges query as described in **Inner Queries**.
Combinations SQL	TEXT		Combinations query as described in **Inner Queries**.
source	BIGINT		Identifier of the starting vertex of the flow.
sources	ARRAY[BIGINT]		Array of identifiers of the starting vertices of the flow.
target	BIGINT		Identifier of the ending vertex of the flow.
targets	ARRAY[BIGINT]		Array of identifiers of the ending vertices of the flow.

Inner queries

Edges SQL:
an SQL query of a directed graph of capacities, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Column	Type	Default	Description
capacity	ANY-INTEGER		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_capacity	ANY-INTEGER	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

Combinations SQL:
an SQL query which should return a set of rows with the following columns:

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

The function aggregates the sources and the targets, removes the duplicates, and then it calculates the result from the resultant source vertices to the target vertices.

Result Columns

Column	Type	Description
seq	INT	Sequential value starting from **1**.
edge	BIGINT	Identifier of the edge in the original query(edges_sql).
start_vid	BIGINT	Identifier of the first end point vertex of the edge.
end_vid	BIGINT	Identifier of the second end point vertex of the edge.
flow	BIGINT	Flow through the edge in the direction (start_vid, end_vid).
residual_capacity	BIGINT	Residual capacity of the edge in the direction (start_vid, end_vid).

See Also

- **Flow - Family of functions**, **pgr_boykovKolmogorov**, **pgr_pushRelabel**
- **https://www.boost.org/libs/graph/doc/edmonds_karp_max_flow.html**
- **https://en.wikipedia.org/wiki/Edmonds%E2%80%93Karp_algorithm**

Indices and tables

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- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3**

pgr_pushRelabel

pgr_pushRelabel — Calculates the flow on the graph edges that maximizes the flow from the sources to the targets using Push Relabel Algorithm.

Boost Graph Inside

Availability

- Version 3.2.0
  - New **proposed** function:
    - pgr_pushRelabel(Combinations)
- Version 3.0.0
  - **Official** function
- Version 2.5.0
  - Renamed from `pgr_maxFlowPushRelabel`
  - **Proposed** function
- Version 2.3.0
  - New **Experimental** function

Description

The main characteristics are:

- The graph is **directed**.
- Process is done only on edges with positive capacities.
- When the maximum flow is 0 then there is no flow and **EMPTY SET** is returned.
  - There is no flow when a **source** is the same as a **target**.
- Any duplicated value in the source(s) or target(s) are ignored.
- Calculates the flow/residual capacity for each edge. In the output
  - Edges with zero flow are omitted.
- Creates a **super source** and edges to all the source(s), and a **super target** and the edges from all the targets(s).
- The maximum flow through the graph is guaranteed to be the value returned by **pgr_maxFlow** when executed with the same parameters and can be calculated:
  - By aggregation of the outgoing flow from the sources
  - By aggregation of the incoming flow to the targets
- Running time: $O(V ^ 3)$

Signatures

Summary

```
pgr_pushRelabel(Edges SQL, source,  target)
pgr_pushRelabel(Edges SQL, sources, target)
pgr_pushRelabel(Edges SQL, source,  targets)
pgr_pushRelabel(Edges SQL, sources, targets)
pgr_pushRelabel(Edges SQL, Combinations SQL) -- Proposed on v3.2
RETURNS SET OF (seq, edge, start_vid, end_vid, flow, residual_capacity)
OR EMPTY SET
```

One to One

```
pgr_pushRelabel(Edges SQL, source,  target)
RETURNS SET OF (seq, edge, start_vid, end_vid, flow, residual_capacity)
OR EMPTY SET
```

Example:
From vertex 6 to vertex 11

```
SELECT * FROM pgr_pushRelabel(
    'SELECT id,
            source,
            target,
            capacity,
            reverse_capacity
    FROM edge_table'
    , 6, 11
);
 seq | edge | start_vid | end_vid | flow | residual_capacity
-----+------+-----------+---------+------+-------------------
   1 |   10 |         5 |      10 |  100 |                30
   2 |    8 |         6 |       5 |  100 |                30
   3 |   11 |         6 |      11 |  130 |                 0
   4 |   12 |        10 |      11 |  100 |                 0
(4 rows)
```

One to Many

Calculates the flow on the graph edges that maximizes the flow from the *source* to all of the *targets*.

```
pgr_pushRelabel(Edges SQL, source,  targets)
RETURNS SET OF (seq, edge, start_vid, end_vid, flow, residual_capacity)
OR EMPTY SET
```

Example:

From vertex \(6\) to vertices \(\{11, 1, 13\}\)

```
SELECT * FROM pgr_pushRelabel(
    'SELECT id,
            source,
            target,
            capacity,
            reverse_capacity
    FROM edge_table'
    , 6, ARRAY[11, 1, 13]
);
 seq | edge | start_vid | end_vid | flow | residual_capacity
-----+------+-----------+---------+------+-------------------
   1 |    1 |         2 |       1 |  130 |                 0
   2 |    2 |         3 |       2 |   80 |                20
   3 |    3 |         4 |       3 |   80 |                50
   4 |    4 |         5 |       2 |   50 |                 0
   5 |    7 |         5 |       8 |   50 |                80
   6 |   10 |         5 |      10 |   80 |                50
   7 |    8 |         6 |       5 |  130 |                 0
   8 |    9 |         6 |       9 |   80 |                50
   9 |   11 |         6 |      11 |  130 |                 0
  10 |    6 |         7 |       8 |   50 |                 0
  11 |    6 |         8 |       7 |   50 |                50
  12 |    7 |         8 |       5 |   50 |                 0
  13 |   16 |         9 |       4 |   80 |                 0
  14 |   12 |        10 |      11 |   80 |                20
(14 rows)
```

Many to One

```
pgr_pushRelabel(Edges SQL, sources,  target)
RETURNS SET OF (seq, edge, start_vid, end_vid, flow, residual_capacity)
OR EMPTY SET
```

Example:

From vertices \(\{6, 8, 12\}\) to vertex \(11\)

```
SELECT * FROM pgr_pushRelabel(
    'SELECT id,
            source,
            target,
            capacity,
            reverse_capacity
    FROM edge_table'
    , ARRAY[6, 8, 12], 11
);
 seq | edge | start_vid | end_vid | flow | residual_capacity
-----+------+-----------+---------+------+-------------------
   1 |   10 |         5 |      10 |  100 |                30
   2 |    8 |         6 |       5 |  100 |                30
   3 |   11 |         6 |      11 |  130 |                 0
   4 |   12 |        10 |      11 |  100 |                 0
(4 rows)
```

Many to Many

```
pgr_pushRelabel(Edges SQL, sources,  targets)
RETURNS SET OF (seq, edge, start_vid, end_vid, flow, residual_capacity)
OR EMPTY SET
```

Example:

From vertices \(\{6, 8, 12\}\) to vertices \(\{1, 3, 11\}\)

```
SELECT * FROM pgr_pushRelabel(
    'SELECT id,
            source,
            target,
            capacity,
            reverse_capacity
    FROM edge_table'
    , ARRAY[6, 8, 12], ARRAY[1, 3, 11]
);
 seq | edge | start_vid | end_vid | flow | residual_capacity
-----+------+-----------+---------+------+-------------------
   1 |    1 |         2 |       1 |   50 |                80
   2 |    3 |         4 |       3 |   80 |                50
   3 |    4 |         5 |       2 |   50 |                 0
   4 |   10 |         5 |      10 |  100 |                30
   5 |    8 |         6 |       5 |  130 |                 0
   6 |    9 |         6 |       9 |   30 |               100
   7 |   11 |         6 |      11 |  130 |                 0
   8 |    7 |         8 |       5 |   20 |                30
   9 |   16 |         9 |       4 |   80 |                 0
  10 |   12 |        10 |      11 |  100 |                 0
  11 |   15 |        12 |       9 |   50 |                 0
(11 rows)
```

Combinations

```
pgr_pushRelabel(Edges SQL, Combinations SQL)
RETURNS SET OF (seq, edge, start_vid, end_vid, flow, residual_capacity)
OR EMPTY SET
```

Example:
Using a combinations table, equivalent to calculating result from vertices\(\{6, 8, 12\}\) to vertices \(\{1, 3, 11\}\).

```
SELECT * FROM pgr_pushRelabel(
    'SELECT id,
            source,
            target,
            capacity,
            reverse_capacity
    FROM edge_table',
    'SELECT * FROM ( VALUES (6, 1), (8, 3), (12, 11), (8, 1) ) AS t(source, target)'
);
 seq | edge | start_vid | end_vid | flow | residual_capacity
-----+------+-----------+---------+------+-------------------
   1 |    1 |         2 |       1 |   50 |                80
   2 |    3 |         4 |       3 |   80 |                50
   3 |    4 |         5 |       2 |   50 |                 0
   4 |   10 |         5 |      10 |  100 |                30
   5 |    8 |         6 |       5 |  130 |                 0
   6 |    9 |         6 |       9 |   30 |               100
   7 |   11 |         6 |      11 |  130 |                 0
   8 |    7 |         8 |       5 |   20 |                30
   9 |   16 |         9 |       4 |   80 |                 0
  10 |   12 |        10 |      11 |  100 |                 0
  11 |   15 |        12 |       9 |   50 |                 0
(11 rows)
```

Parameters

Column	Type	Default	Description
Edges SQL	TEXT		Edges query as described in **Inner Queries**.
Combinations SQL	TEXT		Combinations query as described in **Inner Queries**.
source	BIGINT		Identifier of the starting vertex of the flow.
sources	ARRAY[BIGINT]		Array of identifiers of the starting vertices of the flow.
target	BIGINT		Identifier of the ending vertex of the flow.
targets	ARRAY[BIGINT]		Array of identifiers of the ending vertices of the flow.

Inner queries

Edges SQL:
an SQL query of a directed graph of capacities, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Column	Type	Default	Description
capacity	ANY-INTEGER		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_capacity	ANY-INTEGER	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

Combinations SQL:
an SQL query which should return a set of rows with the following columns:

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

The function aggregates the sources and the targets, removes the duplicates, and then it calculates the result from the resultant source vertices to the target vertices.

Result Columns

Column	Type	Description
seq	INT	Sequential value starting from **1**.
edge	BIGINT	Identifier of the edge in the original query(edges_sql).
start_vid	BIGINT	Identifier of the first end point vertex of the edge.
end_vid	BIGINT	Identifier of the second end point vertex of the edge.
flow	BIGINT	Flow through the edge in the direction (start_vid, end_vid).
residual_capacity	BIGINT	Residual capacity of the edge in the direction (start_vid, end_vid).

See Also

- **Flow - Family of functions**, **pgr_boykovKolmogorov**, **pgr_edmondsKarp**
- **https://www.boost.org/libs/graph/doc/push_relabel_max_flow.html**
- **https://en.wikipedia.org/wiki/Push%E2%80%93relabel_maximum_flow_algorithm**

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- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3**

pgr_edgeDisjointPaths

pgr_edgeDisjointPaths — Calculates edge disjoint paths between two groups of vertices.

Boost Graph Inside

Availability

- Version 3.2.0
  - New **proposed** function:
    - pgr_edgeDisjointPaths(Combinations)
- Version 3.0.0
  - **Official** function
- Version 2.5.0
  - **Proposed** function
- Version 2.3.0
  - New **Experimental** function

Description

Calculates the edge disjoint paths between two groups of vertices. Utilizes underlying maximum flow algorithms to calculate the paths.

The main characterics are:

- Calculates the edge disjoint paths between any two groups of vertices.
- Returns EMPTY SET when source and destination are the same, or cannot be reached.
- The graph can be directed or undirected.
- One to many, many to one, many to many versions are also supported.
- Uses **pgr_boykovKolmogorov** to calculate the paths.

Signatures

Summary

```
pgr_edgeDisjointPaths(Edges SQL, start_vid, end_vid)
pgr_edgeDisjointPaths(Edges SQL, start_vid, end_vid [, directed])
pgr_edgeDisjointPaths(Edges SQL, start_vid, end_vids [, directed])
pgr_edgeDisjointPaths(Edges SQL, start_vids, end_vid [, directed])
pgr_edgeDisjointPaths(Edges SQL, start_vids, end_vids [, directed])
pgr_edgeDisjointPaths(Edges SQL, Combinations SQL [, directed]) -- Proposed on v3.2

RETURNS SET OF (seq, path_id, path_seq, [start_vid,] [end_vid,] node, edge, cost, agg_cost)
OR EMPTY SET
```

Using defaults

```
pgr_edgeDisjointPaths(Edges SQL, start_vid, end_vid)
RETURNS SET OF (seq, path_id, path_seq, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertex \(3\) to vertex \(5\) on a **directed** graph

```
SELECT * FROM pgr_edgeDisjointPaths(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    3, 5
);
 seq | path_id | path_seq | node | edge | cost | agg_cost
-----+---------+----------+------+------+------+----------
   1 |       1 |        1 |    3 |    2 |    1 |        0
   2 |       1 |        2 |    2 |    4 |    1 |        1
   3 |       1 |        3 |    5 |   -1 |    0 |        2
   4 |       2 |        1 |    3 |    5 |    1 |        0
   5 |       2 |        2 |    6 |    8 |    1 |        1
   6 |       2 |        3 |    5 |   -1 |    0 |        2
(6 rows)
```

One to One

```
pgr_edgeDisjointPaths(Edges SQL, start_vid, end_vid, directed)
RETURNS SET OF (seq, path_id, path_seq, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertex \(3\) to vertex \(5\) on an **undirected** graph

```
SELECT * FROM pgr_edgeDisjointPaths(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    3, 5,
    directed := false
);
 seq | path_id | path_seq | node | edge | cost | agg_cost
-----+---------+----------+------+------+------+----------
   1 |       1 |        1 |    3 |    2 |    1 |        0
   2 |       1 |        2 |    2 |    4 |    1 |        1
   3 |       1 |        3 |    5 |   -1 |    0 |        2
   4 |       2 |        1 |    3 |    3 |   -1 |        0
   5 |       2 |        2 |    4 |   16 |    1 |       -1
   6 |       2 |        3 |    9 |    9 |    1 |        0
   7 |       2 |        4 |    6 |    8 |    1 |        1
   8 |       2 |        5 |    5 |   -1 |    0 |        2
   9 |       3 |        1 |    3 |    5 |    1 |        0
  10 |       3 |        2 |    6 |   11 |    1 |        1
  11 |       3 |        3 |   11 |   12 |   -1 |        2
  12 |       3 |        4 |   10 |   10 |    1 |        1
  13 |       3 |        5 |    5 |   -1 |    0 |        2
(13 rows)
```

One to Many

```
pgr_edgeDisjointPaths(Edges SQL, start_vid, end_vids, directed)
RETURNS SET OF (seq, path_id, path_seq, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertex \(3\) to vertices \(\{4, 5, 10\}\) on a **directed** graph

```
SELECT * FROM pgr_edgeDisjointPaths(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    3, ARRAY[4, 5, 10]
);
 seq | path_id | path_seq | end_vid | node | edge | cost | agg_cost
-----+---------+----------+---------+------+------+------+----------
   1 |       1 |        1 |       4 |    3 |    5 |    1 |        0
   2 |       1 |        2 |       4 |    6 |    9 |    1 |        1
   3 |       1 |        3 |       4 |    9 |   16 |    1 |        2
   4 |       1 |        4 |       4 |    4 |   -1 |    0 |        3
   5 |       2 |        1 |       5 |    3 |    2 |    1 |        0
   6 |       2 |        2 |       5 |    2 |    4 |    1 |        1
   7 |       2 |        3 |       5 |    5 |   -1 |    0 |        2
   8 |       3 |        1 |       5 |    3 |    5 |    1 |        0
   9 |       3 |        2 |       5 |    6 |    8 |    1 |        1
  10 |       3 |        3 |       5 |    5 |   -1 |    0 |        2
  11 |       4 |        1 |      10 |    3 |    2 |    1 |        0
  12 |       4 |        2 |      10 |    2 |    4 |    1 |        1
  13 |       4 |        3 |      10 |    5 |   10 |    1 |        2
  14 |       4 |        4 |      10 |   10 |   -1 |    0 |        3
(14 rows)
```

Many to One

```
pgr_edgeDisjointPaths(Edges SQL, start_vids, end_vid, directed)
RETURNS SET OF (seq, path_id, path_seq, start_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertices \(\{3, 6\}\) to vertex \(5\) on a **directed** graph

```
SELECT * FROM pgr_edgeDisjointPaths(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[3, 6], 5
);
 seq | path_id | path_seq | start_vid | node | edge | cost | agg_cost
-----+---------+----------+-----------+------+------+------+----------
   1 |       1 |        1 |         0 |    3 |    2 |    1 |        0
   2 |       1 |        2 |         0 |    2 |    4 |    1 |        1
   3 |       1 |        3 |         0 |    5 |   -1 |    0 |        2
   4 |       2 |        1 |         1 |    3 |    5 |    1 |        0
   5 |       2 |        2 |         1 |    6 |    8 |    1 |        1
   6 |       2 |        3 |         1 |    5 |   -1 |    0 |        2
   7 |       3 |        1 |         2 |    6 |    8 |    1 |        0
   8 |       3 |        2 |         2 |    5 |   -1 |    0 |        1
   9 |       4 |        1 |         3 |    6 |    9 |    1 |        0
  10 |       4 |        2 |         3 |    9 |   16 |    1 |        1
  11 |       4 |        3 |         3 |    4 |    3 |    1 |        2
  12 |       4 |        4 |         3 |    3 |    2 |    1 |        3
  13 |       4 |        5 |         3 |    2 |    4 |    1 |        4
  14 |       4 |        6 |         3 |    5 |   -1 |    0 |        5
(14 rows)
```

Many to Many

```
pgr_edgeDisjointPaths(Edges SQL, start_vids, end_vids, directed)
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertices \(\{3, 6\}\) to vertices \(\{4, 5, 10\}\) on a **directed** graph

```
SELECT * FROM pgr_edgeDisjointPaths(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[3, 6], ARRAY[4, 5, 10]
);
 seq | path_id | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+---------+----------+-----------+---------+------+------+------+----------
   1 |       1 |        1 |         0 |       4 |    3 |    5 |    1 |        0
   2 |       1 |        2 |         0 |       4 |    6 |    9 |    1 |        1
   3 |       1 |        3 |         0 |       4 |    9 |   16 |    1 |        2
   4 |       1 |        4 |         0 |       4 |    4 |   -1 |    0 |        3
   5 |       2 |        1 |         1 |       5 |    3 |    2 |    1 |        0
   6 |       2 |        2 |         1 |       5 |    2 |    4 |    1 |        1
   7 |       2 |        3 |         1 |       5 |    5 |   -1 |    0 |        2
   8 |       3 |        1 |         2 |       5 |    3 |    5 |    1 |        0
   9 |       3 |        2 |         2 |       5 |    6 |    8 |    1 |        1
  10 |       3 |        3 |         2 |       5 |    5 |   -1 |    0 |        2
  11 |       4 |        1 |         3 |      10 |    3 |    2 |    1 |        0
  12 |       4 |        2 |         3 |      10 |    2 |    4 |    1 |        1
  13 |       4 |        3 |         3 |      10 |    5 |   10 |    1 |        2
  14 |       4 |        4 |         3 |      10 |   10 |   -1 |    0 |        3
  15 |       5 |        1 |         4 |       4 |    6 |    9 |    1 |        0
  16 |       5 |        2 |         4 |       4 |    9 |   16 |    1 |        1
  17 |       5 |        3 |         4 |       4 |    4 |   -1 |    0 |        2
  18 |       6 |        1 |         5 |       5 |    6 |    8 |    1 |        0
  19 |       6 |        2 |         5 |       5 |    5 |   -1 |    0 |        1
  20 |       7 |        1 |         6 |       5 |    6 |    9 |    1 |        0
  21 |       7 |        2 |         6 |       5 |    9 |   16 |    1 |        1
  22 |       7 |        3 |         6 |       5 |    4 |    3 |    1 |        2
  23 |       7 |        4 |         6 |       5 |    3 |    2 |    1 |        3
  24 |       7 |        5 |         6 |       5 |    2 |    4 |    1 |        4
  25 |       7 |        6 |         6 |       5 |    5 |   -1 |    0 |        5
  26 |       8 |        1 |         7 |      10 |    6 |    8 |    1 |        0
  27 |       8 |        2 |         7 |      10 |    5 |   10 |    1 |        1
  28 |       8 |        3 |         7 |      10 |   10 |   -1 |    0 |        2
(28 rows)
```

Combinations

```
pgr_edgeDisjointPaths(Edges SQL, Combinations SQL, directed)
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
Using a combinations table, equivalent to calculating result from vertices\(\{3, 6\}\) to vertices \(\{4, 5, 10\}\) on a **directed** graph.

```
SELECT * FROM pgr_edgeDisjointPaths(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    'SELECT * FROM ( VALUES (3, 4), (6, 5), (3, 10) ) AS t(source, target)'
);
 seq | path_id | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+---------+----------+-----------+---------+------+------+------+----------
   1 |       1 |        1 |         0 |       4 |    3 |    5 |    1 |        0
   2 |       1 |        2 |         0 |       4 |    6 |    9 |    1 |        1
   3 |       1 |        3 |         0 |       4 |    9 |   16 |    1 |        2
   4 |       1 |        4 |         0 |       4 |    4 |   -1 |    0 |        3
   5 |       2 |        1 |         1 |       5 |    3 |    2 |    1 |        0
   6 |       2 |        2 |         1 |       5 |    2 |    4 |    1 |        1
   7 |       2 |        3 |         1 |       5 |    5 |   -1 |    0 |        2
   8 |       3 |        1 |         2 |       5 |    3 |    5 |    1 |        0
   9 |       3 |        2 |         2 |       5 |    6 |    8 |    1 |        1
  10 |       3 |        3 |         2 |       5 |    5 |   -1 |    0 |        2
  11 |       4 |        1 |         3 |      10 |    3 |    2 |    1 |        0
  12 |       4 |        2 |         3 |      10 |    2 |    4 |    1 |        1
  13 |       4 |        3 |         3 |      10 |    5 |   10 |    1 |        2
  14 |       4 |        4 |         3 |      10 |   10 |   -1 |    0 |        3
  15 |       5 |        1 |         4 |       4 |    6 |    9 |    1 |        0
  16 |       5 |        2 |         4 |       4 |    9 |   16 |    1 |        1
  17 |       5 |        3 |         4 |       4 |    4 |   -1 |    0 |        2
  18 |       6 |        1 |         5 |       5 |    6 |    8 |    1 |        0
  19 |       6 |        2 |         5 |       5 |    5 |   -1 |    0 |        1
  20 |       7 |        1 |         6 |       5 |    6 |    9 |    1 |        0
  21 |       7 |        2 |         6 |       5 |    9 |   16 |    1 |        1
  22 |       7 |        3 |         6 |       5 |    4 |    3 |    1 |        2
  23 |       7 |        4 |         6 |       5 |    3 |    2 |    1 |        3
  24 |       7 |        5 |         6 |       5 |    2 |    4 |    1 |        4
  25 |       7 |        6 |         6 |       5 |    5 |   -1 |    0 |        5
  26 |       8 |        1 |         7 |      10 |    6 |    8 |    1 |        0
  27 |       8 |        2 |         7 |      10 |    5 |   10 |    1 |        1
  28 |       8 |        3 |         7 |      10 |   10 |   -1 |    0 |        2
(28 rows)
```

Parameters

Parameter	Type	Default	Description
Edges SQL	TEXT		*Edges query* as described below
Combinations SQL	TEXT		*Combinations query* as described below
start_vid	BIGINT		Identifier of the starting vertex of the path.
start_vids	ARRAY[BIGINT]		Array of identifiers of starting vertices.
end_vid	BIGINT		Identifier of the ending vertex of the path.
end_vids	ARRAY[BIGINT]		Array of identifiers of ending vertices.
directed	BOOLEAN	true	• When true Graph is considered *Directed* • When false the graph is considered as *Undirected*.

Inner queries

Edges query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Combinations query

Combinations SQL:

an SQL query which should return a set of rows with the following columns:

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

The function aggregates the sources and the targets, removes the duplicates, and then it calculates the result from the resultant source vertices to the target vertices.

Return Columns

Returns set of (seq, path_id, path_seq [, start_vid] [, end_vid], node, edge, cost, agg_cost)

Column	Type	Description
seq	INT	Sequential value starting from **1**.
path_id	INT	Path identifier. Has value **1** for the first of a path. Used when there are multiple paths for the same start_vid to end_vid combination.
path_seq	INT	Relative position in the path. Has value **1** for the beginning of a path.
start_vid	BIGINT	Identifier of the starting vertex. Returned when multiple starting vetrices are in the query. • **Many to One** • **Many to Many**
end_vid	BIGINT	Identifier of the ending vertex. Returned when multiple ending vertices are in the query. • **One to Many** • **Many to Many**
node	BIGINT	Identifier of the node in the path from start_vid to end_vid.
edge	BIGINT	Identifier of the edge used to go from node to the next node in the path sequence. -1 for the last node of the path.
cost	FLOAT	Cost to traverse from node using edge to the next node in the path sequence.
agg_cost	FLOAT	Aggregate cost from start_v to node.

See Also

- **Flow - Family of functions**

Indices and tables

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- **Supported versions: Latest** (**3.1**) **3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3**

pgr_maxCardinalityMatch

pgr_maxCardinalityMatch — Calculates a maximum cardinality matching in a graph.

Boost Graph Inside

Availability

- Version 3.0.0
  - **Official** function
- Version 2.5.0
  - Renamed from pgr_maximumCardinalityMatching

- **Proposed** function
- Version 2.3.0
  - New **Experimental** function

Description

The main characteristics are:

- A matching or independent edge set in a graph is a set of edges without common vertices.
- A maximum matching is a matching that contains the largest possible number of edges.
  - There may be many maximum matchings.
  - Calculates **one** possible maximum cardinality matching in a graph.
- The graph can be **directed** or **undirected**.
- Running time: \(O(E*V * \alpha(E,V))\)
  - \(\alpha(E,V)\) is the inverse of the **Ackermann function**.

Signatures

```
pgr_maxCardinalityMatch(Edges SQL [, directed])

RETURNS SET OF (seq, edge_id, source, target)
OR EMPTY SET
```

Example:
For an **undirected** graph

```
SELECT * FROM pgr_maxCardinalityMatch(
    'SELECT id, source, target, cost AS going, reverse_cost AS coming FROM edge_table',
    directed := false
);
 seq | edge | source | target
-----+------+--------+--------
   1 |    1 |      1 |      2
   2 |    3 |      3 |      4
   3 |    9 |      6 |      9
   4 |    6 |      7 |      8
   5 |   14 |     10 |     13
   6 |   13 |     11 |     12
   7 |   17 |     14 |     15
   8 |   18 |     16 |     17
(8 rows)
```

Parameters

Parameter	Type	Default	Description
edges_sql	TEXT		SQL query as described above.
directed	BOOLEAN	true	Determines the type of the graph. - When true Graph is considered *Directed* - When false the graph is considered as *Undirected*.

Inner query

Edges SQL:
an SQL query, which should return a set of rows with the following columns:

Column	Type	Description
id	ANY-INTEGER	Identifier of the edge.
source	ANY-INTEGER	Identifier of the first end point vertex of the edge.
target	ANY-INTEGER	Identifier of the second end point vertex of the edge.
going	ANY-NUMERIC	A positive value represents the existence of the edge (source, target).
coming	ANY-NUMERIC	A positive value represents the existence of the edge (target, source).

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERIC:
SMALLINT, INTEGER, BIGINT, REAL FLOAT

Result Columns

Column	Type	Description
seq	INT	Sequential value starting from **1**.
edge	BIGINT	Identifier of the edge in the original query.
source	BIGINT	Identifier of the first end point of the edge.
target	BIGINT	Identifier of the second end point of the edge.

See Also

- **Flow - Family of functions**
- **https://www.boost.org/libs/graph/doc/maximum_matching.html**
- **https://en.wikipedia.org/wiki/Matching_%28graph_theory%29**
- **https://en.wikipedia.org/wiki/Ackermann_function**

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- **Supported versions: Latest (3.2) 3.1 3.0**

pgr_maxFlowMinCost - Experimental

pgr_maxFlowMinCost — Calculates the flow on the graph edges that maximizes the flow and minimizes the cost from the sources to the targets.

Boost Graph Inside

Warning

Possible server crash

- These functions might create a server crash

Warning

Experimental functions

- They are not officially of the current release.
- They likely will not be officially be part of the next release:
  - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
  - Name might change.
  - Signature might change.
  - Functionality might change.
  - pgTap tests might be missing.
  - Might need c/c++ coding.
  - May lack documentation.
  - Documentation if any might need to be rewritten.
  - Documentation examples might need to be automatically generated.
  - Might need a lot of feedback from the comunity.
  - Might depend on a proposed function of pgRouting
  - Might depend on a deprecated function of pgRouting

Availability

- Version 3.2.0
  - New **experimental** function:
    - pgr_maxFlowMinCost(Combinations)
- Version 3.0.0
- New **experimental** function

Description

The main characteristics are:

- The graph is **directed**.
- Process is done only on edges with positive capacities.
- When the maximum flow is 0 then there is no flow and **EMPTY SET** is returned.
  - There is no flow when a **source** is the same as a **target**.
- Any duplicated value in the source(s) or target(s) are ignored.
- Calculates the flow/residual capacity for each edge. In the output
  - Edges with zero flow are omitted.
- Creates a **super source** and edges to all the source(s), and a **super target** and the edges from all the targets(s).
- The maximum flow through the graph is guaranteed to be the value returned by **pgr_maxFlow** when executed with the same parameters and can be calculated:
  - By aggregation of the outgoing flow from the sources
  - By aggregation of the incoming flow to the targets
- **TODO** check which statement is true:
  - The cost value of all input edges must be nonnegative.
  - Process is done when the cost value of all input edges is nonnegative.
  - Process is done on edges with nonnegative cost.
- Running time: $O(U * (E + V * logV))$
  - where U is the value of the max flow.
  - U is upper bound on number of iterations. In many real world cases number of iterations is much smaller than U.

Signatures

Summary

```
pgr_maxFlowMinCost(Edges SQL, source,  target)
pgr_maxFlowMinCost(Edges SQL, sources, target)
pgr_maxFlowMinCost(Edges SQL, source,  targets)
pgr_maxFlowMinCost(Edges SQL, sources, targets)
pgr_maxFlowMinCost(Edges SQL, Combinations SQL) -- Experimental on v3.2
RETURNS SET OF (seq, edge, source, target, flow, residual_capacity, cost, agg_cost)
OR EMPTY SET
```

One to One

```
pgr_maxFlowMinCost(Edges SQL, source, target)
RETURNS SET OF (seq, edge, source, target, flow, residual_capacity, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertex 2 to vertex 3

```
SELECT * FROM pgr_MaxFlowMinCost(
   'SELECT id,
    source, target,
    capacity, reverse_capacity,
    cost, reverse_cost FROM edge_table',
   2, 3
);
 seq | edge | source | target | flow | residual_capacity | cost | agg_cost
-----+------+--------+--------+------+-------------------+------+----------
   1 |    4 |      2 |      5 |   80 |                20 |   80 |       80
   2 |    3 |      4 |      3 |   80 |                50 |   80 |      160
   3 |    8 |      5 |      6 |   80 |                20 |   80 |      240
   4 |    9 |      6 |      9 |   80 |                50 |   80 |      320
   5 |   16 |      9 |      4 |   80 |                 0 |   80 |      400
(5 rows)
```

One to Many

```
pgr_maxFlowMinCost(Edges SQL, source, targets)
RETURNS SET OF (seq, edge, source, target, flow, residual_capacity, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertex 13 to vertices $\{7, 1, 4\}$

```
SELECT * FROM pgr_MaxFlowMinCost(
   'SELECT id,
    source, target,
    capacity, reverse_capacity,
    cost, reverse_cost FROM edge_table',
   13, ARRAY[7, 1, 4]
);
 seq | edge | source | target | flow | residual_capacity | cost | agg_cost
-----+------+--------+--------+------+-------------------+------+----------
   1 |    1 |      2 |      1 |   50 |                80 |   50 |       50
   2 |    4 |      5 |      2 |   50 |                 0 |   50 |      100
   3 |   16 |      9 |      4 |   50 |                30 |   50 |      150
   4 |   10 |     10 |      5 |   50 |                 0 |   50 |      200
   5 |   12 |     10 |     11 |   50 |                50 |   50 |      250
   6 |   13 |     11 |     12 |   50 |                50 |   50 |      300
   7 |   15 |     12 |      9 |   50 |                 0 |   50 |      350
   8 |   14 |     13 |     10 |  100 |                30 |  100 |      450
(8 rows)
```

Many to One

```
pgr_maxFlowMinCost(Edges SQL, sources, target)
RETURNS SET OF (seq, edge, source, target, flow, residual_capacity, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertices \(\{1, 7, 14\}\) to vertex \(12\)

```
SELECT * FROM pgr_MaxFlowMinCost(
   'SELECT id,
    source, target,
    capacity, reverse_capacity,
    cost, reverse_cost FROM edge_table',
   ARRAY[1, 7, 14], 12
);
 seq | edge | source | target | flow | residual_capacity | cost | agg_cost
-----+------+--------+--------+------+-------------------+------+----------
   1 |    1 |      1 |      2 |   80 |                 0 |   80 |       80
   2 |    4 |      2 |      5 |   80 |                20 |   80 |      160
   3 |    8 |      5 |      6 |  100 |                 0 |  100 |      260
   4 |   10 |      5 |     10 |   30 |               100 |   30 |      290
   5 |    9 |      6 |      9 |   50 |                80 |   50 |      340
   6 |   11 |      6 |     11 |   50 |                80 |   50 |      390
   7 |    6 |      7 |      8 |   50 |                 0 |   50 |      440
   8 |    7 |      8 |      5 |   50 |                 0 |   50 |      490
   9 |   15 |      9 |     12 |   50 |                30 |   50 |      540
  10 |   12 |     10 |     11 |   30 |                70 |   30 |      570
  11 |   13 |     11 |     12 |   80 |                20 |   80 |      650
(11 rows)
```

Many to Many

```
pgr_maxFlowMinCost(Edges SQL, sources, targets)
RETURNS SET OF (seq, edge, source, target, flow, residual_capacity, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertices \(\{7, 13\}\) to vertices \(\{3, 9\}\)

```
SELECT * FROM pgr_MaxFlowMinCost(
   'SELECT id,
    source, target,
    capacity, reverse_capacity,
    cost, reverse_cost FROM edge_table',
   ARRAY[7, 13], ARRAY[3, 9]
);
 seq | edge | source | target | flow | residual_capacity | cost | agg_cost
-----+------+--------+--------+------+-------------------+------+----------
   1 |    8 |      5 |      6 |  100 |                 0 |  100 |      100
   2 |    9 |      6 |      9 |  100 |                30 |  100 |      200
   3 |    6 |      7 |      8 |   50 |                 0 |   50 |      250
   4 |    7 |      8 |      5 |   50 |                 0 |   50 |      300
   5 |   10 |     10 |      5 |   50 |                 0 |   50 |      350
   6 |   12 |     10 |     11 |   50 |                50 |   50 |      400
   7 |   13 |     11 |     12 |   50 |                50 |   50 |      450
   8 |   15 |     12 |      9 |   50 |                 0 |   50 |      500
   9 |   14 |     13 |     10 |  100 |                30 |  100 |      600
(9 rows)
```

Combinations

```
pgr_maxFlowMinCost(Edges SQL, Combinations SQL)
RETURNS SET OF (seq, edge, source, target, flow, residual_capacity, cost, agg_cost)
OR EMPTY SET
```

Example:
Using a combinations table, equivalent to calculating result from vertices\(\{7, 13\}\) to vertices \(\{3, 9\}\).

```
SELECT * FROM pgr_MaxFlowMinCost(
   'SELECT id,
     source, target,
     capacity, reverse_capacity,
     cost, reverse_cost FROM edge_table',
   'SELECT * FROM ( VALUES (7, 3), (13, 9) ) AS t(source, target)'
);
 seq | edge | source | target | flow | residual_capacity | cost | agg_cost
-----+------+--------+--------+------+-------------------+------+----------
   1 |    8 |      5 |      6 |  100 |                 0 |  100 |      100
   2 |    9 |      6 |      9 |  100 |                30 |  100 |      200
   3 |    6 |      7 |      8 |   50 |                 0 |   50 |      250
   4 |    7 |      8 |      5 |   50 |                 0 |   50 |      300
   5 |   10 |     10 |      5 |   50 |                 0 |   50 |      350
   6 |   12 |     10 |     11 |   50 |                50 |   50 |      400
   7 |   13 |     11 |     12 |   50 |                50 |   50 |      450
   8 |   15 |     12 |      9 |   50 |                 0 |   50 |      500
   9 |   14 |     13 |     10 |  100 |                30 |  100 |      600
(9 rows)
```

Parameters

Column	Type	Default	Description
Edges SQL	TEXT		Edges query as described in **Inner Queries**.
Combinations SQL	TEXT		Combinations query as described in **Inner Queries**.
source	BIGINT		Identifier of the starting vertex of the flow.
sources	ARRAY[BIGINT]		Array of identifiers of the starting vertices of the flow.
target	BIGINT		Identifier of the ending vertex of the flow.
targets	ARRAY[BIGINT]		Array of identifiers of the ending vertices of the flow.

Inner queries

Edges SQL:
an SQL query of a directed graph of capacities, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
capacity	ANY-INTEGER		Capacity of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_capacity	ANY-INTEGER	-1	Capacity of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* if it exists.
reverse_cost	ANY-NUMERICAL	0	Weight of the edge *(target, source)* if it exists.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
smallint, int, bigint, real, float

Combinations SQL:
an SQL query which should return a set of rows with the following columns:

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Column	Type	Default	Description

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

The function aggregates the sources and the targets, removes the duplicates, and then it calculates the result from the resultant source vertices to the target vertices.

Result Columns

Column	Type	Description
seq	INT	Sequential value starting from **1**.
edge	BIGINT	Identifier of the edge in the original query(edges_sql).
source	BIGINT	Identifier of the first end point vertex of the edge.
target	BIGINT	Identifier of the second end point vertex of the edge.
flow	BIGINT	Flow through the edge in the direction (source, target).
residual_capacity	BIGINT	Residual capacity of the edge in the direction (source, target).
cost	FLOAT	The cost of sending this flow through the edge in the direction (source, target).
agg_cost	FLOAT	The aggregate cost.

See Also

- **Flow - Family of functions**
- **https://www.boost.org/libs/graph/doc/successive_shortest_path_nonnegative_weights.html**

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- **Supported versions: Latest (3.2) 3.1 3.0**

pgr_maxFlowMinCost_Cost - Experimental

pgr_maxFlowMinCost_Cost — Calculates the minmum cost maximum flow in a directed graph from the source(s) to the targets(s).

Boost Graph Inside

Warning

Possible server crash

- These functions might create a server crash

Warning

Experimental functions

- They are not officially of the current release.
- They likely will not be officially be part of the next release:
  - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
  - Name might change.
  - Signature might change.
  - Functionality might change.
  - pgTap tests might be missing.
  - Might need c/c++ coding.
  - May lack documentation.

- Documentation if any might need to be rewritten.
- Documentation examples might need to be automatically generated.
- Might need a lot of feedback from the comunity.
- Might depend on a proposed function of pgRouting
- Might depend on a deprecated function of pgRouting

Availability

- Version 3.2.0
  - New **experimental** function:
    - pgr_maxFlowMinCost_Cost(Combinations)
- Version 3.0.0
  - New **experimental** function

Description

The main characteristics are:

- The graph is **directed**.
- **The cost value of all input edges must be nonnegative.**
- When the maximum flow is 0 then there is no flow and **0** is returned.
  - There is no flow when a **source** is the same as a **target**.
- Any duplicated value in the source(s) or target(s) are ignored.
- Uses the **pgr_maxFlowMinCost** algorithm.
- Running time: $O(U * (E + V * logV))$, where U is the value of the max flow. U is upper bound on number of iteration. In many real world cases number of iterations is much smaller than U.

Signatures

Summary

```
pgr_maxFlowMinCost_Cost(Edges SQL, source, target)
pgr_maxFlowMinCost_Cost(Edges SQL, sources, target)
pgr_maxFlowMinCost_Cost(Edges SQL, source, targets)
pgr_maxFlowMinCost_Cost(Edges SQL, sources, targets)
pgr_maxFlowMinCost_Cost(Edges SQL, Combinations SQL) -- Experimental on v3.2
RETURNS FLOAT
```

One to One

```
pgr_maxFlowMinCost_Cost(Edges SQL, source, target)
RETURNS FLOAT
```

Example:
From vertex 2 to vertex 3

```
SELECT * FROM pgr_MaxFlowMinCost_Cost(
   'SELECT id,
    source, target,
    capacity, reverse_capacity,
    cost, reverse_cost FROM edge_table',
   2, 3
);
 pgr_maxflowmincost_cost
-------------------------
                     400
(1 row)
```

One to Many

```
pgr_maxFlowMinCost_Cost(Edges SQL, source, targets)
RETURNS FLOAT
```

Example:
From vertex 13 to vertices $\{7, 1, 4\}$

```
SELECT * FROM pgr_MaxFlowMinCost_Cost(
    'SELECT id,
     source, target,
     capacity, reverse_capacity,
     cost, reverse_cost FROM edge_table',
    13, ARRAY[7, 1, 4]
);
 pgr_maxflowmincost_cost
-------------------------
                     450
(1 row)
```

Many to One

```
pgr_maxFlowMinCost_Cost(Edges SQL, sources, target)
RETURNS FLOAT
```

Example:
From vertices \(\{1, 7, 14\}\) to vertex \(12\)

```
SELECT * FROM pgr_MaxFlowMinCost_Cost(
    'SELECT id,
     source, target,
     capacity, reverse_capacity,
     cost, reverse_cost FROM edge_table',
    ARRAY[1, 7, 14], 12
);
 pgr_maxflowmincost_cost
-------------------------
                     650
(1 row)
```

Many to Many

```
pgr_maxFlowMinCost_Cost(Edges SQL, sources, targets)
RETURNS FLOAT
```

Example:
From vertices \(\{7, 13\}\) to vertices \(\{3, 9\}\)

```
SELECT * FROM pgr_MaxFlowMinCost_Cost(
    'SELECT id,
     source, target,
     capacity, reverse_capacity,
     cost, reverse_cost FROM edge_table',
    ARRAY[7, 13], ARRAY[3, 9]
);
 pgr_maxflowmincost_cost
-------------------------
                     600
(1 row)
```

Combinations

```
pgr_maxFlowMinCost_Cost(Edges SQL, Combinations SQL)
RETURNS FLOAT
```

Example:
Using a combinations table, equivalent to calculating result from vertices\(\{7, 13\}\) to vertices \(\{3, 9\}\).

```
SELECT * FROM pgr_MaxFlowMinCost_Cost(
    'SELECT id,
     source, target,
     capacity, reverse_capacity,
     cost, reverse_cost FROM edge_table',
    'SELECT * FROM ( VALUES (7, 3), (13, 9) ) AS t(source, target)'
);
 pgr_maxflowmincost_cost
-------------------------
                     600
(1 row)
```

Parameters

Column	Type	Default	Description

Column	Type	Default	Description
Edges SQL	TEXT		Edges query as described in **Inner Queries**.
Combinations SQL	TEXT		Combinations query as described in **Inner Queries**.
source	BIGINT		Identifier of the starting vertex of the flow.
sources	ARRAY[BIGINT]		Array of identifiers of the starting vertices of the flow.
target	BIGINT		Identifier of the ending vertex of the flow.
targets	ARRAY[BIGINT]		Array of identifiers of the ending vertices of the flow.

Inner queries

Edges SQL:
an SQL query of a directed graph of capacities, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
capacity	ANY-INTEGER		Capacity of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_capacity	ANY-INTEGER	-1	Capacity of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* if it exists.
reverse_cost	ANY-NUMERICAL	0	Weight of the edge *(target, source)* if it exists.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
smallint, int, bigint, real, float

Combinations SQL:
an SQL query which should return a set of rows with the following columns:

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

The function aggregates the sources and the targets, removes the duplicates, and then it calculates the result from the resultant source vertices to the target vertices.

Result Columns

Type	Description
FLOAT	Minimum Cost Maximum Flow possible from the source(s) to the target(s)

See Also

- **Flow - Family of functions**
- **https://www.boost.org/libs/graph/doc/successive_shortest_path_nonnegative_weights.html**

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Flow Functions General Information

The main characteristics are:

- The graph is **directed**.
- Process is done only on edges with positive capacities.
- When the maximum flow is 0 then there is no flow and **EMPTY SET** is returned.
  - There is no flow when a **source** is the same as a **target**.
- Any duplicated value in the source(s) or target(s) are ignored.
- Calculates the flow/residual capacity for each edge. In the output
  - Edges with zero flow are omitted.
- Creates a **super source** and edges to all the source(s), and a **super target** and the edges from all the targets(s).
- The maximum flow through the graph is guaranteed to be the value returned by **pgr_maxFlow** when executed with the same parameters and can be calculated:
  - By aggregation of the outgoing flow from the sources
  - By aggregation of the incoming flow to the targets

pgr_maxFlow is the maximum Flow and that maximum is guaranteed to be the same on the functions **pgr_pushRelabel**, **pgr_edmondsKarp**, **pgr_boykovKolmogorov**, but the actual flow through each edge may vary.

Parameters

Column	Type	Default	Description
Edges SQL	TEXT		Edges query as described in **Inner Queries**.
Combinations SQL	TEXT		Combinations query as described in **Inner Queries**.
source	BIGINT		Identifier of the starting vertex of the flow.
sources	ARRAY[BIGINT]		Array of identifiers of the starting vertices of the flow.
target	BIGINT		Identifier of the ending vertex of the flow.
targets	ARRAY[BIGINT]		Array of identifiers of the ending vertices of the flow.

Inner queries

For pgr_pushRelabel, pgr_edmondsKarp, pgr_boykovKolmogorov :

Edges SQL:
an SQL query of a directed graph of capacities, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
capacity	ANY-INTEGER		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_capacity	ANY-INTEGER	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

For **pgr_maxFlowMinCost - Experimental** and **pgr_maxFlowMinCost_Cost - Experimental**:

Edges SQL:
an SQL query of a directed graph of capacities, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
capacity	ANY-INTEGER		Capacity of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.

Column	Type	Default	Description
reverse_capacity	ANY-INTEGER	-1	Capacity of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* if it exists.
reverse_cost	ANY-NUMERICAL	0	Weight of the edge *(target, source)* if it exists.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
smallint, int, bigint, real, float

For **pgr_pushRelabel**, **pgr_edmondsKarp**, **pgr_boykovKolmogorov**, **pgr_edgeDisjointPaths**, **pgr_maxFlowMinCost** and **pgr_maxFlowMinCost_Cost** :

Combinations SQL:
an SQL query which should return a set of rows with the following columns:

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

The function aggregates the sources and the targets, removes the duplicates, and then it calculates the result from the resultant source vertices to the target vertices.

Result Columns

For pgr_pushRelabel, pgr_edmondsKarp, pgr_boykovKolmogorov :

Column	Type	Description
seq	INT	Sequential value starting from **1**.
edge	BIGINT	Identifier of the edge in the original query(edges_sql).
start_vid	BIGINT	Identifier of the first end point vertex of the edge.
end_vid	BIGINT	Identifier of the second end point vertex of the edge.
flow	BIGINT	Flow through the edge in the direction (start_vid, end_vid).
residual_capacity	BIGINT	Residual capacity of the edge in the direction (start_vid, end_vid).

For pgr_maxFlowMinCost - Experimental

Column	Type	Description
seq	INT	Sequential value starting from **1**.
edge	BIGINT	Identifier of the edge in the original query(edges_sql).
source	BIGINT	Identifier of the first end point vertex of the edge.
target	BIGINT	Identifier of the second end point vertex of the edge.
flow	BIGINT	Flow through the edge in the direction (source, target).
residual_capacity	BIGINT	Residual capacity of the edge in the direction (source, target).
cost	FLOAT	The cost of sending this flow through the edge in the direction (source, target).
agg_cost	FLOAT	The aggregate cost.

Adcanced Documentation

A flow network is a directed graph where each edge has a capacity and a flow. The flow through an edge must not exceed the capacity of the edge. Additionally, the incoming and outgoing flow of a node must be equal except for source which only has outgoing flow, and the destination(sink) which only has incoming flow.

Maximum flow algorithms calculate the maximum flow through the graph and the flow of each edge.

The maximum flow through the graph is guaranteed to be the same with all implementations, but the actual flow through each edge may vary. Given the following query:

pgr_maxFlow \((edges_sql, source_vertex, sink_vertex)\)

where \(edges_sql = \{(id_i, source_i, target_i, capacity_i, reverse_capacity_i)\}\)

Graph definition

The weighted directed graph, \(G(V,E)\), is defined as:

- the set of vertices \(V\)
  - \(source_vertex \cup sink_vertex \bigcup source_i \bigcup target_i\)
- the set of edges \(E\)
  - \(E = \begin{cases} \text{ } \{(source_i, target_i, capacity_i) \text{ when } capacity > 0 \} & \quad \text{ if } reverse_capacity = \varnothing \\ \text{ } & \quad \text{ } \\ \{(source_i, target_i, capacity_i) \text{ when } capacity > 0 \} & \text{ } \\ \cup \{(target_i, source_i, reverse_capacity_i) \text{ when } reverse_capacity_i > 0)\} & \quad \text{ if } reverse_capacity \neq \varnothing \\ \end{cases}\)

Maximum flow problem

Given:

- \(G(V,E)\)
- \(source_vertex \in V\) the source vertex
- \(sink_vertex \in V\) the sink vertex

Then:

- \(pgr_maxFlow(edges_sql, source, sink) = \boldsymbol{\Phi}\)
- \(\boldsymbol{\Phi} = {(id_i, edge_id_i, source_i, target_i, flow_i, residual_capacity_i)}\)

Where:

\(\boldsymbol{\Phi}\) is a subset of the original edges with their residual capacity and flow. The maximum flow through the graph can be obtained by aggregating on the source or sink and summing the flow from/to it. In particular:

- \(id_i = i\)
- \(edge_id = id_i\) in edges_sql
- \(residual_capacity_i = capacity_i - flow_i\)

See Also

- **https://en.wikipedia.org/wiki/Maximum_flow_problem**

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- **Supported versions: Latest (3.2) 3.1 3.0**

Kruskal - Family of functions

- **pgr_kruskal**
- **pgr_kruskalBFS**
- **pgr_kruskalDD**
- **pgr_kruskalDFS**

Boost Graph Inside

- **Supported versions: Latest (3.2) 3.1 3.0**

pgr_kruskal

pgr_kruskal — Returns the minimum spanning tree of graph using Kruskal algorithm.

Boost Graph Inside

Availability

- Version 3.0.0
  - New **Official** function

Description

This algorithm finds the minimum spanning forest in a possibly disconnected graph using Kruskal’s algorithm.

The main Characteristics are:

- It’s implementation is only on **undirected** graph.
- Process is done only on edges with positive costs.
- The total weight of all the edges in the tree or forest is minimized.
- When the graph is connected
  - The resulting edges make up a tree
- When the graph is not connected,
  - Finds a minimum spanning tree for each connected component.
  - The resulting edges make up a forest.
- Kruskal’s running time: $O(E * log E)$
- EMPTY SET is returned when there are no edges in the graph.

Signatures

Summary

```
pgr_kruskal(edges_sql)

RETURNS SET OF (seq, edge, cost)
OR EMPTY SET
```

Example:
Minimum Spanning Forest

```
SELECT * FROM pgr_kruskal(
   'SELECT id, source, target, cost, reverse_cost
       FROM edge_table ORDER BY id'
) ORDER BY edge;
 edge | cost
------+------
    1 |    1
    2 |    1
    3 |    1
    6 |    1
    7 |    1
   10 |    1
   11 |    1
   12 |    1
   13 |    1
   14 |    1
   15 |    1
   16 |    1
   17 |    1
   18 |    1
(14 rows)
```

Parameters

Parameter	Type	Description
Edges SQL	TEXT	SQL query described in **Inner query**.

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns SET OF (edge, cost)

Column	Type	Description
edge	BIGINT	Identifier of the edge.
cost	FLOAT	Cost to traverse the edge.

See Also

- **Spanning Tree - Category**
- **Kruskal - Family of functions**
- The queries use the **Sample Data** network.
- **Boost: Kruskal's algorithm documentation**
- **Wikipedia: Kruskal's algorithm**

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- **Supported versions: Latest** (**3.2**) **3.1** **3.0**

pgr_kruskalBFS

pgr_kruskalBFS — Prim algorithm for Minimum Spanning Tree with Depth First Search ordering.

Boost Graph Inside

Availability

- Version 3.0.0
  - New **Official** function

Description

Visits and extracts the nodes information in Breath First Search ordering of the Minimum Spanning Tree created using Prims's algorithm.

The main Characteristics are:

- It's implementation is only on **undirected** graph.
- Process is done only on edges with positive costs.

- The total weight of all the edges in the tree or forest is minimized.
- When the graph is connected
  - The resulting edges make up a tree
- When the graph is not connected,
  - Finds a minimum spanning tree for each connected component.
  - The resulting edges make up a forest.
- Kruskal's running time: \(O(E * log E)\)

- Returned tree nodes from a root vertex are on Breath First Search order
- Breath First Search Running time: \(O(E + V)\)

Signatures

```
pgr_kruskalBFS(Edges SQL, Root vid [, max_depth])
pgr_kruskalBFS(Edges SQL, Root vids [, max_depth])

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Single vertex

```
pgr_kruskalBFS(Edges SQL, Root vid [, max_depth])

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Example:
The Minimum Spanning Tree having as root vertex \(2\)

```
SELECT * FROM pgr_kruskalBFS(
   'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
   2
);
 seq | depth | start_vid | node | edge | cost | agg_cost
-----+-------+-----------+------+------+------+----------
   1 |     0 |         2 |    2 |   -1 |    0 |        0
   2 |     1 |         2 |    1 |    1 |    1 |        1
   3 |     1 |         2 |    3 |    2 |    1 |        1
   4 |     2 |         2 |    4 |    3 |    1 |        2
   5 |     3 |         2 |    9 |   16 |    1 |        3
   6 |     4 |         2 |   12 |   15 |    1 |        4
   7 |     5 |         2 |   11 |   13 |    1 |        5
   8 |     6 |         2 |    6 |   11 |    1 |        6
   9 |     6 |         2 |   10 |   12 |    1 |        6
  10 |     7 |         2 |    5 |   10 |    1 |        7
  11 |     7 |         2 |   13 |   14 |    1 |        7
  12 |     8 |         2 |    8 |    7 |    1 |        8
  13 |     9 |         2 |    7 |    6 |    1 |        9
(13 rows)
```

Multiple vertices

```
pgr_kruskalBFS(Edges SQL, Root vids [, max_depth])

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Example:
The Minimum Spanning Tree starting on vertices \(\{13, 2\}\) with \(depth <= 3\)

```
SELECT * FROM pgr_kruskalBFS(
   'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
   ARRAY[13,2], max_depth := 3
);
 seq | depth | start_vid | node | edge | cost | agg_cost
-----+-------+-----------+------+------+------+----------
   1 |     0 |         2 |    2 |   -1 |    0 |        0
   2 |     1 |         2 |    1 |    1 |    1 |        1
   3 |     1 |         2 |    3 |    2 |    1 |        1
   4 |     2 |         2 |    4 |    3 |    1 |        2
   5 |     3 |         2 |    9 |   16 |    1 |        3
   6 |     0 |        13 |   13 |   -1 |    0 |        0
   7 |     1 |        13 |   10 |   14 |    1 |        1
   8 |     2 |        13 |    5 |   10 |    1 |        2
   9 |     2 |        13 |   11 |   12 |    1 |        2
  10 |     3 |        13 |    8 |    7 |    1 |        3
  11 |     3 |        13 |    6 |   11 |    1 |        3
  12 |     3 |        13 |   12 |   13 |    1 |        3
(12 rows)
```

Parameters

Parameter	Type	Description
Edges SQL	TEXT	SQL query described in **Inner query**.
Root vid	BIGINT	Identifier of the root vertex of the tree. • Used on **Single vertex** • When value is \(0\) then gets the spanning forest starting in aleatory nodes for each tree in the forest.
Root vids	ARRAY[ANY-INTEGER]	Array of identifiers of the root vertices. • Used on **Multiple vertices** • \(0\) values are ignored • For optimization purposes, any duplicated value is ignored.

Optional Parameters

Parameter	Type	Default	Description
max_depth	BIGINT	\(9223372036854775807\)	Upper limit for depth of node in the tree • When value is Negative then **throws error**

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)

Column	Type	Description
seq	BIGINT	Sequential value starting from \(1\).
depth	BIGINT	Depth of the node. • \(0\) when node = start_vid.
start_vid	BIGINT	Identifier of the root vertex. • I n **Multiple Vertices** results are in ascending order.
node	BIGINT	Identifier of node reached using edge.
edge	BIGINT	Identifier of the edge used to arrive to node. • \(-1\) when node = start_vid.
cost	FLOAT	Cost to traverse edge.
agg_cost	FLOAT	Aggregate cost from start_vid to node.

See Also

- **Spanning Tree - Category**
- **Kruskal - Family of functions**
- The queries use the **Sample Data** network.
- **Boost: Kruskal's algorithm documentation**

- **Wikipedia: Kruskal's algorithm**

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- **Supported versions: Latest (3.2) 3.1 3.0**

pgr_kruskalDD

`pgr_kruskalDD` — Catchament nodes using Kruskal's algorithm.

Boost Graph Inside

Availability

- Version 3.0.0
  - New **Official** function

Description

Using Kruskal's algorithm, extracts the nodes that have aggregate costs less than or equal to the value `Distance` from a **root** vertex (or vertices) within the calculated minimum spanning tree.

The main Characteristics are:

- It's implementation is only on **undirected** graph.
- Process is done only on edges with positive costs.
- The total weight of all the edges in the tree or forest is minimized.
- When the graph is connected
  - The resulting edges make up a tree
- When the graph is not connected,
  - Finds a minimum spanning tree for each connected component.
  - The resulting edges make up a forest.
- Kruskal's running time: $O(E * \log E)$
- Returned tree nodes from a root vertex are on Depth First Search order.
- Depth First Search running time: $O(E + V)$

Signatures

```
pgr_kruskalDD(edges_sql, root_vid, distance)
pgr_kruskalDD(edges_sql, root_vids, distance)

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Single vertex

```
pgr_kruskalDD(edges_sql, root_vid, distance)

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Example:
The Minimum Spanning Tree starting on vertex 2 with $agg\_cost <= 3.5$

```
SELECT * FROM pgr_kruskalDD(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    2, 3.5
);
 seq | depth | start_vid | node | edge | cost | agg_cost
-----+-------+-----------+------+------+------+----------
   1 |     0 |         2 |    2 |   -1 |    0 |        0
   2 |     1 |         2 |    1 |    1 |    1 |        1
   3 |     1 |         2 |    3 |    2 |    1 |        1
   4 |     2 |         2 |    4 |    3 |    1 |        2
   5 |     3 |         2 |    9 |   16 |    1 |        3
(5 rows)
```

Multiple vertices

```
pgr_kruskalDD(edges_sql, root_vids, distance)

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Example:
The Minimum Spanning Tree starting on vertices \(\{13, 2\}\) with \(agg_cost <= 3.5\);

```
SELECT * FROM pgr_kruskalDD(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    ARRAY[13,2],
    3.5
);
 seq | depth | start_vid | node | edge | cost | agg_cost
-----+-------+-----------+------+------+------+----------
   1 |     0 |         2 |    2 |   -1 |    0 |        0
   2 |     1 |         2 |    1 |    1 |    1 |        1
   3 |     1 |         2 |    3 |    2 |    1 |        1
   4 |     2 |         2 |    4 |    3 |    1 |        2
   5 |     3 |         2 |    9 |   16 |    1 |        3
   6 |     0 |        13 |   13 |   -1 |    0 |        0
   7 |     1 |        13 |   10 |   14 |    1 |        1
   8 |     2 |        13 |    5 |   10 |    1 |        2
   9 |     3 |        13 |    8 |    7 |    1 |        3
  10 |     2 |        13 |   11 |   12 |    1 |        2
  11 |     3 |        13 |    6 |   11 |    1 |        3
  12 |     3 |        13 |   12 |   13 |    1 |        3
(12 rows)
```

Parameters

Parameter	Type	Description
Edges SQL	TEXT	SQL query described in **Inner query**.
Root vid	BIGINT	Identifier of the root vertex of the tree. • Used on **Single vertex** • When \(0\) gets the spanning forest starting in aleatory nodes for each tree.
Root vids	ARRAY[ANY-INTEGER]	Array of identifiers of the root vertices. • Used on **Multiple vertices** • \(0\) values are ignored • For optimization purposes, any duplicated value is ignored.
Distance	ANY-NUMERIC	Upper limit for the inclusion of the node in the result. • When the value is Negative **throws error**

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERIC:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT, NUMERIC

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Column	Type	Default	Description
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns SET OF `(seq, depth, start_vid, node, edge, cost, agg_cost)`

Column	Type	Description
seq	BIGINT	Sequential value starting from \(1\).
depth	BIGINT	Depth of the `node`. • \(0\) when `node` = `start_vid`.
start_vid	BIGINT	Identifier of the root vertex. • I n **Multiple Vertices** results are in ascending order.
node	BIGINT	Identifier of `node` reached using `edge`.
edge	BIGINT	Identifier of the `edge` used to arrive to `node`. • \(-1\) when `node` = `start_vid`.
cost	FLOAT	Cost to traverse `edge`.
agg_cost	FLOAT	Aggregate cost from `start_vid` to `node`.

See Also

- **Spanning Tree - Category**
- **Kruskal - Family of functions**
- The queries use the **Sample Data** network.
- **Boost: Kruskal's algorithm documentation**
- **Wikipedia: Kruskal's algorithm**

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- **Supported versions: Latest (3.2) 3.1 3.0**

pgr_kruskalDFS

`pgr_kruskalDFS` — Kruskal algorithm for Minimum Spanning Tree with Depth First Search ordering.

Boost Graph Inside

Availability

- Version 3.0.0
  - New **Official** function

Description

Visits and extracts the nodes information in Depth First Search ordering of the Minimum Spanning Tree created using Kruskal's algorithm.

The main Characteristics are:

- It's implementation is only on **undirected** graph.
- Process is done only on edges with positive costs.
- The total weight of all the edges in the tree or forest is minimized.
- When the graph is connected
  - The resulting edges make up a tree
- When the graph is not connected,
  - Finds a minimum spanning tree for each connected component.
  - The resulting edges make up a forest.
- Kruskal's running time: \(O(E * log E)\)

- Returned tree nodes from a root vertex are on Depth First Search order
- Depth First Search Running time: \(O(E + V)\)

Signatures

```
pgr_kruskalDFS(Edges SQL, Root vid [, max_depth])
pgr_kruskalDFS(Edges SQL, Root vids [, max_depth])

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Single vertex

```
pgr_kruskalDFS(Edges SQL, Root vid [, max_depth])

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Example:
The Minimum Spanning Tree starting on vertex \(2\)

```
SELECT * FROM pgr_kruskalDFS(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    2
);
 seq | depth | start_vid | node | edge | cost | agg_cost
-----+-------+-----------+------+------+------+----------
   1 |     0 |         2 |    2 |   -1 |    0 |        0
   2 |     1 |         2 |    1 |    1 |    1 |        1
   3 |     1 |         2 |    3 |    2 |    1 |        1
   4 |     2 |         2 |    4 |    3 |    1 |        2
   5 |     3 |         2 |    9 |   16 |    1 |        3
   6 |     4 |         2 |   12 |   15 |    1 |        4
   7 |     5 |         2 |   11 |   13 |    1 |        5
   8 |     6 |         2 |    6 |   11 |    1 |        6
   9 |     6 |         2 |   10 |   12 |    1 |        6
  10 |     7 |         2 |    5 |   10 |    1 |        7
  11 |     8 |         2 |    8 |    7 |    1 |        8
  12 |     9 |         2 |    7 |    6 |    1 |        9
  13 |     7 |         2 |   13 |   14 |    1 |        7
(13 rows)
```

Multiple vertices

```
pgr_kruskalDFS(Edges SQL, Root vids [, max_depth])

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Example:
The Minimum Spanning Tree starting on vertices \(\{13, 2\}\) with \(depth <= 3\)

```
SELECT * FROM pgr_kruskalDFS(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    ARRAY[13,2], max_depth := 3
);
 seq | depth | start_vid | node | edge | cost | agg_cost
-----+-------+-----------+------+------+------+----------
   1 |     0 |         2 |    2 |   -1 |    0 |        0
   2 |     1 |         2 |    1 |    1 |    1 |        1
   3 |     1 |         2 |    3 |    2 |    1 |        1
   4 |     2 |         2 |    4 |    3 |    1 |        2
   5 |     3 |         2 |    9 |   16 |    1 |        3
   6 |     0 |        13 |   13 |   -1 |    0 |        0
   7 |     1 |        13 |   10 |   14 |    1 |        1
   8 |     2 |        13 |    5 |   10 |    1 |        2
   9 |     3 |        13 |    8 |    7 |    1 |        3
  10 |     2 |        13 |   11 |   12 |    1 |        2
  11 |     3 |        13 |    6 |   11 |    1 |        3
  12 |     3 |        13 |   12 |   13 |    1 |        3
(12 rows)
```

Parameters

Parameter	Type	Description
Edges SQL	TEXT	SQL query described in **Inner query**.
Root vid	BIGINT	Identifier of the root vertex of the tree. • Used on **Single vertex** • When value is \(0\) then gets the spanning forest starting in aleatory nodes for each tree in the forest.
Root vids	ARRAY[ANY-INTEGER]	Array of identifiers of the root vertices. • Used on **Multiple vertices** • \(0\) values are ignored • For optimization purposes, any duplicated value is ignored.

Optional Parameters

Parameter	Type	Default	Description
max_depth	BIGINT	\(9223372036854775807\)	Upper limit for depth of node in the tree • When value is Negative then **throws error**

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)

Column	Type	Description
seq	BIGINT	Sequential value starting from \(1\).

Column	Type	Description
depth	BIGINT	Depth of the node. • \(0\) when node = start_vid.
start_vid	BIGINT	Identifier of the root vertex. • I n **Multiple Vertices** results are in ascending order.
node	BIGINT	Identifier of node reached using edge.
edge	BIGINT	Identifier of the edge used to arrive to node. • \(-1\) when node = start_vid.
cost	FLOAT	Cost to traverse edge.
agg_cost	FLOAT	Aggregate cost from start_vid to node.

See Also

- **Spanning Tree - Category**
- **Kruskal - Family of functions**
- The queries use the **Sample Data** network.
- **Boost: Kruskal's algorithm documentation**
- **Wikipedia: Kruskal's algorithm**

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Description

Kruskal's algorithm is a greedy minimum spanning tree algorithm that in each cycle finds and adds the edge of the least possible weight that connects any two trees in the forest.

The main Characteristics are:

- It's implementation is only on **undirected** graph.
- Process is done only on edges with positive costs.
- The total weight of all the edges in the tree or forest is minimized.
- When the graph is connected
  - The resulting edges make up a tree
- When the graph is not connected,
  - Finds a minimum spanning tree for each connected component.
  - The resulting edges make up a forest.
- Kruskal's running time: \(O(E * log E)\)

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

See Also

- **Spanning Tree - Category**

- **Boost: Kruskal’s algorithm documentation**
- **Wikipedia: Kruskal’s algorithm**

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- **Supported versions:** **Latest** (**3.2**) **3.1** **3.0**

Prim - Family of functions

- **pgr_prim**
- **pgr_primBFS**
- **pgr_primDD**
- **pgr_primDFS**

Boost Graph Inside

- **Supported versions:** **Latest** (**3.2**) **3.1** **3.0**

pgr_prim

`pgr_prim` — Minimum spanning forest of graph using Prim algorithm.

Boost Graph Inside

Availability

- Version 3.0.0
  - New **Official** function

Support

- **Supported versions:** current(**3.1**) **3.0**

Description

This algorithm finds the minimum spanning forest in a possibly disconnected graph using Prim’s algorithm.

The main characteristics are:

- It’s implementation is only on **undirected graph**.
- Process is done only on edges with positive costs.
- When the graph is connected
  - The resulting edges make up a tree
- When the graph is not connected,
  - Finds a minimum spanning tree for each connected component.
  - The resulting edges make up a forest.
- Prim’s running time: $O(E*log V)$
- EMPTY SET is returned when there are no edges in the graph.

Signatures

Summary

```
pgr_prim(edges_sql)

RETURNS SET OF (edge, cost)
OR EMPTY SET
```

Example:
Minimum Spanning Forest of a subgraph

```
SELECT edge, cost FROM pgr_prim(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table WHERE id < 14'
) ORDER BY edge;
 edge | cost
------+------
    1 |    1
    2 |    1
    3 |    1
    4 |    1
    5 |    1
    6 |    1
    7 |    1
    9 |    1
   10 |    1
   11 |    1
   13 |    1
(11 rows)
```

Parameters

Parameter	Type	Description
Edges SQL	TEXT	SQL query described in **Inner query**.

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns SET OF (edge, cost)

Column	Type	Description
edge	BIGINT	Identifier of the edge.
cost	FLOAT	Cost to traverse the edge.

See Also

- **Spanning Tree - Category**
- **Prim - Family of functions**
- The queries use the **Sample Data** network.
- **Boost: Prim's algorithm documentation**
- **Wikipedia: Prim's algorithm**

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pgr_primBFS

pgr_primBFS — Prim's algorithm for Minimum Spanning Tree with Depth First Search ordering.

Boost Graph Inside

Availability

- Version 3.0.0
  - New **Official** function

Description

Visits and extracts the nodes information in Breath First Search ordering of the Minimum Spanning Tree created with Prims's algorithm.

The main Characteristics are:

- It's implementation is only on **undirected graph**.
- Process is done only on edges with positive costs.
- When the graph is connected
  - The resulting edges make up a tree
- When the graph is not connected,
  - Finds a minimum spanning tree for each connected component.
  - The resulting edges make up a forest.
- Prim's running time: $O(E*log V)$

- Returned tree nodes from a root vertex are on Breath First Search order
- Breath First Search Running time: $O(E + V)$

Signatures

```
pgr_primBFS(Edges SQL, Root vid [, max_depth])
pgr_primBFS(Edges SQL, Root vids [, max_depth])

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Single vertex

```
pgr_primBFS(Edges SQL, Root vid [, max_depth])

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Example:
The Minimum Spanning Tree having as root vertex 2

```
SELECT * FROM pgr_primBFS(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    2
);
 seq | depth | start_vid | node | edge | cost | agg_cost
-----+-------+-----------+------+------+------+----------
   1 |     0 |         2 |    2 |   -1 |    0 |        0
   2 |     1 |         2 |    1 |    1 |    1 |        1
   3 |     1 |         2 |    3 |    2 |    1 |        1
   4 |     1 |         2 |    5 |    4 |    1 |        1
   5 |     2 |         2 |    4 |    3 |    1 |        2
   6 |     2 |         2 |    6 |    5 |    1 |        2
   7 |     2 |         2 |    8 |    7 |    1 |        2
   8 |     2 |         2 |   10 |   10 |    1 |        2
   9 |     3 |         2 |    9 |    9 |    1 |        3
  10 |     3 |         2 |   11 |   11 |    1 |        3
  11 |     3 |         2 |    7 |    6 |    1 |        3
  12 |     3 |         2 |   13 |   14 |    1 |        3
  13 |     4 |         2 |   12 |   13 |    1 |        4
(13 rows)
```

Multiple vertices

```
pgr_primBFS(Edges SQL, Root vids [, max_depth])

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Example:

The Minimum Spanning Tree starting on vertices \(\{13, 2\}\) with \(depth <= 3\)

```
SELECT * FROM pgr_primBFS(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    ARRAY[13,2], max_depth := 3
);
 seq | depth | start_vid | node | edge | cost | agg_cost
-----+-------+-----------+------+------+------+----------
   1 |     0 |         2 |    2 |   -1 |    0 |        0
   2 |     1 |         2 |    1 |    1 |    1 |        1
   3 |     1 |         2 |    3 |    2 |    1 |        1
   4 |     1 |         2 |    5 |    4 |    1 |        1
   5 |     2 |         2 |    4 |    3 |    1 |        2
   6 |     2 |         2 |    6 |    5 |    1 |        2
   7 |     2 |         2 |    8 |    7 |    1 |        2
   8 |     2 |         2 |   10 |   10 |    1 |        2
   9 |     3 |         2 |    9 |    9 |    1 |        3
  10 |     3 |         2 |   11 |   11 |    1 |        3
  11 |     3 |         2 |    7 |    6 |    1 |        3
  12 |     3 |         2 |   13 |   14 |    1 |        3
  13 |     0 |        13 |   13 |   -1 |    0 |        0
  14 |     1 |        13 |   10 |   14 |    1 |        1
  15 |     2 |        13 |    5 |   10 |    1 |        2
  16 |     3 |        13 |    2 |    4 |    1 |        3
  17 |     3 |        13 |    8 |    7 |    1 |        3
(17 rows)
```

Parameters

Parameter	Type	Description
Edges SQL	TEXT	SQL query described in **Inner query**.
Root vid	BIGINT	Identifier of the root vertex of the tree. • Used on **Single vertex** • When value is \(0\) then gets the spanning forest starting in aleatory nodes for each tree in the forest.
Root vids	ARRAY[ANY-INTEGER]	Array of identifiers of the root vertices. • Used on **Multiple vertices** • \(0\) values are ignored • For optimization purposes, any duplicated value is ignored.

Optional Parameters

Parameter	Type	Default	Description
max_depth	BIGINT	\(9223372036854775807\)	Upper limit for depth of node in the tree • When value is Negative then **throws error**

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)

Column	Type	Description
seq	BIGINT	Sequential value starting from 1.
depth	BIGINT	Depth of the node. • 0 when node = start_vid.
start_vid	BIGINT	Identifier of the root vertex. • In **Multiple Vertices** results are in ascending order.
node	BIGINT	Identifier of node reached using edge.
edge	BIGINT	Identifier of the edge used to arrive to node. • -1 when node = start_vid.
cost	FLOAT	Cost to traverse edge.
agg_cost	FLOAT	Aggregate cost from start_vid to node.

See Also

- **Spanning Tree - Category**
- **Prim - Family of functions**
- The queries use the **Sample Data** network.
- **Boost: Prim's algorithm documentation**
- **Wikipedia: Prim's algorithm**

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- **Supported versions: Latest (3.2) 3.1 3.0**

pgr_primDD

pgr_primDD — Catchament nodes using Prim's algorithm.

Boost Graph Inside

Availability

- Version 3.0.0
  - New **Official** function

Description

Using Prim algorithm, extracts the nodes that have aggregate costs less than or equal to the value `Distance` within the calculated minimum spanning tree.

The main Characteristics are:

- It's implementation is only on **undirected graph**.
- Process is done only on edges with positive costs.
- When the graph is connected
  - The resulting edges make up a tree
- When the graph is not connected,
  - Finds a minimum spanning tree for each connected component.
  - The resulting edges make up a forest.
- Prim's running time: \(O(E*log V)\)

- Returned tree nodes from a root vertex are on Depth First Search order.
- Depth First Search running time: \(O(E + V)\)

Signatures

Summary

```
pgr_prim(Edges SQL, root vid, distance)
pgr_prim(Edges SQL, root vids, distance)

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Single vertex

```
pgr_primDD(Edges SQL, root vid, distance)

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Example:
The Minimum Spanning Tree starting on vertex \(2\) with \(agg_cost <= 3.5\)

```
SELECT * FROM pgr_primDD(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    2, 3.5
);
 seq | depth | start_vid | node | edge | cost | agg_cost
-----+-------+-----------+------+------+------+----------
   1 |     0 |         2 |    2 |   -1 |    0 |        0
   2 |     1 |         2 |    1 |    1 |    1 |        1
   3 |     1 |         2 |    3 |    2 |    1 |        1
   4 |     2 |         2 |    4 |    3 |    1 |        2
   5 |     2 |         2 |    6 |    5 |    1 |        2
   6 |     3 |         2 |    9 |    9 |    1 |        3
   7 |     3 |         2 |   11 |   11 |    1 |        3
   8 |     1 |         2 |    5 |    4 |    1 |        1
   9 |     2 |         2 |    8 |    7 |    1 |        2
  10 |     3 |         2 |    7 |    6 |    1 |        3
  11 |     2 |         2 |   10 |   10 |    1 |        2
  12 |     3 |         2 |   13 |   14 |    1 |        3
(12 rows)
```

Multiple vertices

```
pgr_primDD(Edges SQL, root vids, distance)

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Example:
The Minimum Spanning Tree starting on vertices \(\{13, 2\}\) with \(agg_cost <= 3.5\);

```
SELECT * FROM pgr_primDD(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    ARRAY[13,2], 3.5
);
 seq | depth | start_vid | node | edge | cost | agg_cost
-----+-------+-----------+------+------+------+----------
   1 |     0 |         2 |    2 |   -1 |    0 |        0
   2 |     1 |         2 |    1 |    1 |    1 |        1
   3 |     1 |         2 |    3 |    2 |    1 |        1
   4 |     2 |         2 |    4 |    3 |    1 |        2
   5 |     2 |         2 |    6 |    5 |    1 |        2
   6 |     3 |         2 |    9 |    9 |    1 |        3
   7 |     3 |         2 |   11 |   11 |    1 |        3
   8 |     1 |         2 |    5 |    4 |    1 |        1
   9 |     2 |         2 |    8 |    7 |    1 |        2
  10 |     3 |         2 |    7 |    6 |    1 |        3
  11 |     2 |         2 |   10 |   10 |    1 |        2
  12 |     3 |         2 |   13 |   14 |    1 |        3
  13 |     0 |        13 |   13 |   -1 |    0 |        0
  14 |     1 |        13 |   10 |   14 |    1 |        1
  15 |     2 |        13 |    5 |   10 |    1 |        2
  16 |     3 |        13 |    2 |    4 |    1 |        3
  17 |     3 |        13 |    8 |    7 |    1 |        3
(17 rows)
```

Parameters

Parameter	Type	Description
Edges SQL	TEXT	SQL query described in **Inner query**.
Root vid	BIGINT	Identifier of the root vertex of the tree. • Used on **Single vertex** • When \(0\) gets the spanning forest starting in aleatory nodes for each tree.
Root vids	ARRAY[ANY-INTEGER]	Array of identifiers of the root vertices. • Used on **Multiple vertices** • \(0\) values are ignored • For optimization purposes, any duplicated value is ignored.
Distance	ANY-NUMERIC	Upper limit for the inclusion of the node in the result. • When the value is Negative **throws error**

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERIC:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT, NUMERIC

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)

Column	Type	Description
seq	BIGINT	Sequential value starting from 1.
depth	BIGINT	Depth of the node. • 0 when node = start_vid.
start_vid	BIGINT	Identifier of the root vertex. • In **Multiple Vertices** results are in ascending order.
node	BIGINT	Identifier of node reached using edge.
edge	BIGINT	Identifier of the edge used to arrive to node. • -1 when node = start_vid.
cost	FLOAT	Cost to traverse edge.
agg_cost	FLOAT	Aggregate cost from start_vid to node.

See Also

- **Spanning Tree - Category**
- **Prim - Family of functions**
- The queries use the **Sample Data** network.
- **Boost: Prim's algorithm documentation**
- **Wikipedia: Prim's algorithm**

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- **Supported versions: Latest** (**3.2**) **3.1** **3.0**

pgr_primDFS

pgr_primDFS — Prim algorithm for Minimum Spanning Tree with Depth First Search ordering.

Boost Graph Inside

Availability

- Version 3.0.0
  - New **Official** function

Description

Visits and extracts the nodes information in Depth First Search ordering of the Minimum Spanning Tree created using Prims's algorithm.

The main Characteristics are:

- It's implementation is only on **undirected graph**.
- Process is done only on edges with positive costs.
- When the graph is connected
  - The resulting edges make up a tree
- When the graph is not connected,
  - Finds a minimum spanning tree for each connected component.
  - The resulting edges make up a forest.
- Prim's running time: $O(E*log V)$

- Returned tree nodes from a root vertex are on Depth First Search order
- Depth First Search Running time: $O(E + V)$

Signatures

```
pgr_primDFS(Edges SQL, Root vid [, max_depth])
pgr_primDFS(Edges SQL, Root vids [, max_depth])

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Single vertex

```
pgr_primDFS(Edges SQL, Root vid [, max_depth])

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Example:
The Minimum Spanning Tree having as root vertex 2

```
SELECT * FROM pgr_primDFS(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    2
);
 seq | depth | start_vid | node | edge | cost | agg_cost
-----+-------+-----------+------+------+------+----------
   1 |     0 |         2 |    2 |   -1 |    0 |        0
   2 |     1 |         2 |    1 |    1 |    1 |        1
   3 |     1 |         2 |    3 |    2 |    1 |        1
   4 |     2 |         2 |    4 |    3 |    1 |        2
   5 |     2 |         2 |    6 |    5 |    1 |        2
   6 |     3 |         2 |    9 |    9 |    1 |        3
   7 |     3 |         2 |   11 |   11 |    1 |        3
   8 |     4 |         2 |   12 |   13 |    1 |        4
   9 |     1 |         2 |    5 |    4 |    1 |        1
  10 |     2 |         2 |    8 |    7 |    1 |        2
  11 |     3 |         2 |    7 |    6 |    1 |        3
  12 |     2 |         2 |   10 |   10 |    1 |        2
  13 |     3 |         2 |   13 |   14 |    1 |        3
(13 rows)
```

Multiple vertices

```
pgr_primDFS(Edges SQL, Root vids [, max_depth])

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Example:
The Minimum Spanning Tree starting on vertices $\{13, 2\}$ with $depth <= 3$

```
SELECT * FROM pgr_primDFS(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    ARRAY[13,2], max_depth := 3
);
 seq | depth | start_vid | node | edge | cost | agg_cost
-----+-------+-----------+------+------+------+----------
   1 |     0 |         2 |    2 |   -1 |    0 |        0
   2 |     1 |         2 |    1 |    1 |    1 |        1
   3 |     1 |         2 |    3 |    2 |    1 |        1
   4 |     2 |         2 |    4 |    3 |    1 |        2
   5 |     2 |         2 |    6 |    5 |    1 |        2
   6 |     3 |         2 |    9 |    9 |    1 |        3
   7 |     3 |         2 |   11 |   11 |    1 |        3
   8 |     1 |         2 |    5 |    4 |    1 |        1
   9 |     2 |         2 |    8 |    7 |    1 |        2
  10 |     3 |         2 |    7 |    6 |    1 |        3
  11 |     2 |         2 |   10 |   10 |    1 |        2
  12 |     3 |         2 |   13 |   14 |    1 |        3
  13 |     0 |        13 |   13 |   -1 |    0 |        0
  14 |     1 |        13 |   10 |   14 |    1 |        1
  15 |     2 |        13 |    5 |   10 |    1 |        2
  16 |     3 |        13 |    2 |    4 |    1 |        3
  17 |     3 |        13 |    8 |    7 |    1 |        3
(17 rows)
```

Parameters

Parameter	Type	Description
Edges SQL	TEXT	SQL query described in **Inner query**.
Root vid	BIGINT	Identifier of the root vertex of the tree. • Used on **Single vertex** • When value is 0 then gets the spanning forest starting in aleatory nodes for each tree in the forest.

Parameter	Type	Description
Root vids	ARRAY[ANY-INTEGER]	Array of identifiers of the root vertices. • Used on **Multiple vertices** • \(0\) values are ignored • For optimization purposes, any duplicated value is ignored.

Optional Parameters

Parameter	Type	Default	Description
max_depth	BIGINT	\(9223372036854775807\)	Upper limit for depth of node in the tree • When value is Negative then **throws error**

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)

Column	Type	Description
seq	BIGINT	Sequential value starting from \(1\).
depth	BIGINT	Depth of the node. • \(0\) when node = start_vid.
start_vid	BIGINT	Identifier of the root vertex. • I n **Multiple Vertices** results are in ascending order.
node	BIGINT	Identifier of node reached using edge.
edge	BIGINT	Identifier of the edge used to arrive to node. • \(-1\) when node = start_vid.
cost	FLOAT	Cost to traverse edge.
agg_cost	FLOAT	Aggregate cost from start_vid to node.

See Also

- **Spanning Tree - Category**
- **Prim - Family of functions**
- The queries use the **Sample Data** network.
- **Boost: Prim's algorithm documentation**
- **Wikipedia: Prim's algorithm**

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Description

The prim algorithm was developed in 1930 by Czech mathematician Vojtěch Jarník. It is a greedy algorithm that finds a minimum spanning tree for a weighted undirected graph. This means it finds a subset of the edges that forms a tree that includes every vertex, where the total weight of all the edges in the tree is minimized. The algorithm operates by building this tree one vertex at a time, from an arbitrary starting vertex, at each step adding the cheapest possible connection from the tree to another vertex.

This algorithms find the minimum spanning forest in a possibly disconnected graph; in contrast, the most basic form of Prim's algorithm only finds minimum spanning trees in connected graphs. However, running Prim's algorithm separately for each connected component of the graph, then it is called minimum spanning forest.

The main characteristics are:

- It's implementation is only on **undirected graph**.
- Process is done only on edges with positive costs.
- When the graph is connected
  - The resulting edges make up a tree
- When the graph is not connected,
  - Finds a minimum spanning tree for each connected component.
  - The resulting edges make up a forest.
- Prim's running time: \(O(E*log V)\)

> **Note**
>
> From boost Graph: "The algorithm as implemented in Boost.Graph does not produce correct results on graphs with parallel edges."

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

See Also

- **Spanning Tree - Category**
- **Boost: Prim's algorithm documentation**
- **Wikipedia: Prim's algorithm**

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- **Supported versions: Latest** (**3.2**) **3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2 2.1 2.0**

Topology - Family of Functions

The pgRouting's topology of a network, represented with an edge table with source and target attributes and a vertices table associated with it. Depending on the algorithm, you can create a topology or just reconstruct the vertices table, You can analyze the topology, We also provide a function to node an unoded network.

- **pgr_createTopology** - to create a topology based on the geometry.
- **pgr_createVerticesTable** - to reconstruct the vertices table based on the source and target information.
- **pgr_analyzeGraph** - to analyze the edges and vertices of the edge table.
- **pgr_analyzeOneWay** - to analyze directionality of the edges.
- **pgr_nodeNetwork** -to create nodes to a not noded edge table.

Experimental

> **Warning**
>
> Possible server crash
>
> - These functions might create a server crash

> **Warning**
>
> Experimental functions
>
> - They are not officially of the current release.
> - They likely will not be officially be part of the next release:
>   - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
>   - Name might change.
>   - Signature might change.
>   - Functionality might change.
>   - pgTap tests might be missing.
>   - Might need c/c++ coding.
>   - May lack documentation.
>   - Documentation if any might need to be rewritten.
>   - Documentation examples might need to be automatically generated.
>   - Might need a lot of feedback from the comunity.
>   - Might depend on a proposed function of pgRouting
>   - Might depend on a deprecated function of pgRouting

- **pgr_extractVertices – Experimental** - Extracts vertices information based on the source and target.

- **Supported versions:** **Latest** (**3.2**) **3.1** **3.0**
- **Unsupported versions:** **2.6** **2.5** **2.4** **2.3** **2.2** **2.1** **2.0**

pgr_createTopology

`pgr_createTopology` — Builds a network topology based on the geometry information.

Availability

- Version 2.0.0
  - Renamed from version 1.x
  - **Official** function

Support

- **Supported versions:** current(**3.1**) **3.0** **2.6**
- **Unsupported versions:** **2.5** **2.4** **2.3** **2.2** **2.1** **2.0**

Description

The function returns:

- `OK` after the network topology has been built and the vertices table created.
- `FAIL` when the network topology was not built due to an error.

Signatures

```
varchar pgr_createTopology(text edge_table, double precision tolerance,
                   text the_geom:='the_geom', text id:='id',
                   text source:='source',text target:='target',
                   text rows_where:='true', boolean clean:=false)
```

Parameters

The topology creation function accepts the following parameters:

edge_table:
`text` Network table name. (may contain the schema name AS well)
tolerance:
`float8` Snapping tolerance of disconnected edges. (in projection unit)
the_geom:
`text` Geometry column name of the network table. Default value is `the_geom`.
id:
`text` Primary key column name of the network table. Default value is `id`.
source:
`text` Source column name of the network table. Default value is `source`.
target:
`text` Target column name of the network table. Default value is `target`.
rows_where:
`text` Condition to SELECT a subset or rows. Default value is `true` to indicate all rows that where `source` or `target` have a null value, otherwise the condition is used.
clean:
`boolean` Clean any previous topology. Default value is `false`.

> **Warning**
>
> The `edge_table` will be affected
>
> - The `source` column values will change.
> - The `target` column values will change.
>   - An index will be created, if it doesn't exists, to speed up the process to the following columns:
>   - `id`
>   - `the_geom`
>   - `source`
>   - `target`

The function returns:

- `OK` after the network topology has been built.
    - Creates a vertices table: <edge_table>_vertices_pgr.
    - Fills `id` and `the_geom` columns of the vertices table.
    - Fills the source and target columns of the edge table referencing the `id` of the vertices table.
- `FAIL` when the network topology was not built due to an error:
    - A required column of the Network table is not found or is not of the appropriate type.
    - The condition is not well formed.
    - The names of source , target or id are the same.
    - The SRID of the geometry could not be determined.

The Vertices Table

The vertices table is a requirement of the **pgr_analyzeGraph** and the **pgr_analyzeOneWay** functions.

The structure of the vertices table is:

id:
`bigint` Identifier of the vertex.
cnt:
`integer` Number of vertices in the edge_table that reference this vertex. See **pgr_analyzeGraph**.
chk:
`integer` Indicator that the vertex might have a problem. See **pgr_analyzeGraph**.
ein:
`integer` Number of vertices in the edge_table that reference this vertex AS incoming. See **pgr_analyzeOneWay**.
eout:
`integer` Number of vertices in the edge_table that reference this vertex AS outgoing. See **pgr_analyzeOneWay**.
the_geom:
`geometry` Point geometry of the vertex.

Usage when the edge table's columns MATCH the default values:

The simplest way to use pgr_createTopology is:

```
SELECT  pgr_createTopology('edge_table', 0.001);
NOTICE:  PROCESSING:
NOTICE:  pgr_createTopology('edge_table', 0.001, 'the_geom', 'id', 'source', 'target', rows_where := 'true', clean := f)
NOTICE:  Performing checks, please wait .....
NOTICE:  Creating Topology, Please wait...
NOTICE:  -------------> TOPOLOGY CREATED FOR  18 edges
NOTICE:  Rows with NULL geometry or NULL id: 0
NOTICE:  Vertices table for table public.edge_table is: public.edge_table_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createtopology
--------------------
 OK
(1 row)
```

When the arguments are given in the order described in the parameters:

We get the same result AS the simplest way to use the function.

```
SELECT  pgr_createTopology('edge_table', 0.001,
    'the_geom', 'id', 'source', 'target');
NOTICE:  PROCESSING:
NOTICE:  pgr_createTopology('edge_table', 0.001, 'the_geom', 'id', 'source', 'target', rows_where := 'true', clean := f)
NOTICE:  Performing checks, please wait .....
NOTICE:  Creating Topology, Please wait...
NOTICE:  -------------> TOPOLOGY CREATED FOR  18 edges
NOTICE:  Rows with NULL geometry or NULL id: 0
NOTICE:  Vertices table for table public.edge_table is: public.edge_table_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createtopology
--------------------
 OK
(1 row)
```

Warning

An error would occur when the arguments are not given in the appropriate order:
In this example, the column `id` of the table `ege_table` is passed to the function as the geometry column, and the geometry column `the_geom` is passed to the function as the id column.

```
SELECT  pgr_createTopology('edge_table', 0.001,
    'id', 'the_geom');
NOTICE:  PROCESSING:
NOTICE:  pgr_createTopology('edge_table', 0.001, 'id', 'the_geom', 'source', 'target', rows_where := 'true', clean := f)
NOTICE:  Performing checks, please wait .....
NOTICE:  ----> PGR ERROR in pgr_createTopology: Wrong type of Column id:the_geom
NOTICE:  Unexpected error raise_exception
 pgr_createtopology
--------------------
 FAIL
(1 row)
```

When using the named notation

Parameters defined with a default value can be omitted, as long as the value matches the default And The order of the parameters would not matter.

```
SELECT  pgr_createTopology('edge_table', 0.001,
    the_geom:='the_geom', id:='id', source:='source', target:='target');
 pgr_createtopology
--------------------
 OK
(1 row)
```

```
SELECT  pgr_createTopology('edge_table', 0.001,
    source:='source', id:='id', target:='target', the_geom:='the_geom');
 pgr_createtopology
--------------------
 OK
(1 row)
```

```
SELECT  pgr_createTopology('edge_table', 0.001, source:='source');
 pgr_createtopology
--------------------
 OK
(1 row)
```

Selecting rows using rows_where parameter

Selecting rows based on the id.

```
SELECT  pgr_createTopology('edge_table', 0.001, rows_where:='id < 10');
 pgr_createtopology
--------------------
 OK
(1 row)
```

Selecting the rows where the geometry is near the geometry of row with `id = 5`.

```
SELECT  pgr_createTopology('edge_table', 0.001,
    rows_where:='the_geom && (SELECT st_buffer(the_geom, 0.05) FROM edge_table WHERE id=5)');
 pgr_createtopology
--------------------
 OK
(1 row)
```

Selecting the rows where the geometry is near the geometry of the row with `gid` =100 of the table `othertable`.

```
CREATE TABLE otherTable AS  (SELECT 100 AS gid,  st_point(2.5, 2.5) AS other_geom);
SELECT 1
SELECT  pgr_createTopology('edge_table', 0.001,
    rows_where:='the_geom && (SELECT st_buffer(other_geom, 1) FROM otherTable WHERE gid=100)');
 pgr_createtopology
--------------------
 OK
(1 row)
```

Usage when the edge table's columns DO NOT MATCH the default values:

For the following table

```
CREATE TABLE mytable AS (SELECT id AS gid,  the_geom AS mygeom, source AS src , target AS tgt FROM edge_table) ;
SELECT 18
```

Using positional notation:

The arguments need to be given in the order described in the parameters.

Note that this example uses clean flag. So it recreates the whole vertices table.

```
SELECT  pgr_createTopology('mytable', 0.001, 'mygeom', 'gid', 'src', 'tgt', clean := TRUE);
 pgr_createtopology
--------------------
 OK
(1 row)
```

Warning

An error would occur when the arguments are not given in the appropiriate order:
In this example, the column `gid` of the table `mytable` is passed to the function AS the geometry column, and the geometry column `mygeom` is passed to the function AS the id column.

```
SELECT  pgr_createTopology('mytable', 0.001, 'gid', 'mygeom', 'src', 'tgt');
NOTICE:  PROCESSING:
NOTICE:  pgr_createTopology('mytable', 0.001, 'gid', 'mygeom', 'src', 'tgt', rows_where := 'true', clean := f)
NOTICE:  Performing checks, please wait .....
NOTICE:  ----> PGR ERROR in pgr_createTopology: Wrong type of Column id:mygeom
NOTICE:  Unexpected error raise_exception
 pgr_createtopology
--------------------
 FAIL
(1 row)
```

When using the named notation

In this scenario omitting a parameter would create an error because the default values for the column names do not match the column names of the table. The order of the parameters do not matter:

```
SELECT  pgr_createTopology('mytable', 0.001, the_geom:='mygeom', id:='gid', source:='src', target:='tgt');
 pgr_createtopology
--------------------
 OK
(1 row)
```

```
SELECT  pgr_createTopology('mytable', 0.001, source:='src', id:='gid', target:='tgt', the_geom:='mygeom');
 pgr_createtopology
--------------------
 OK
(1 row)
```

Selecting rows using rows_where parameter

Based on id:

```
SELECT  pgr_createTopology('mytable', 0.001, 'mygeom', 'gid', 'src', 'tgt', rows_where:='gid < 10');
 pgr_createtopology
--------------------
 OK
(1 row)

SELECT  pgr_createTopology('mytable', 0.001, source:='src', id:='gid', target:='tgt', the_geom:='mygeom', rows_where:='gid < 10');
 pgr_createtopology
--------------------
 OK
(1 row)

SELECT  pgr_createTopology('mytable', 0.001, 'mygeom', 'gid', 'src', 'tgt',
    rows_where:='mygeom && (SELECT st_buffer(mygeom, 1) FROM mytable WHERE gid=5)');
 pgr_createtopology
--------------------
 OK
(1 row)

SELECT  pgr_createTopology('mytable', 0.001, source:='src', id:='gid', target:='tgt', the_geom:='mygeom',
    rows_where:='mygeom && (SELECT st_buffer(mygeom, 1) FROM mytable WHERE gid=5)');
 pgr_createtopology
--------------------
 OK
(1 row)
```

Selecting the rows where the geometry is near the geometry of the row with `gid` =100 of the table `othertable`.

```
SELECT  pgr_createTopology('mytable', 0.001, 'mygeom', 'gid', 'src', 'tgt',
    rows_where:='mygeom && (SELECT st_buffer(other_geom, 1) FROM otherTable WHERE gid=100)');
 pgr_createtopology
--------------------
 OK
(1 row)

SELECT  pgr_createTopology('mytable', 0.001, source:='src', id:='gid', target:='tgt', the_geom:='mygeom',
    rows_where:='mygeom && (SELECT st_buffer(other_geom, 1) FROM otherTable WHERE gid=100)');
 pgr_createtopology
--------------------
 OK
(1 row)
```

Additional Examples

Example:
With full output

This example start a clean topology, with 5 edges, and then its incremented to the rest of the edges.

```
SELECT pgr_createTopology('edge_table',  0.001, rows_where:='id < 6', clean := true);
NOTICE:  PROCESSING:
NOTICE:  pgr_createTopology('edge_table', 0.001, 'the_geom', 'id', 'source', 'target', rows_where := 'id < 6', clean := t)
NOTICE:  Performing checks, please wait .....
NOTICE:  Creating Topology, Please wait...
NOTICE:  -------------> TOPOLOGY CREATED FOR  5 edges
NOTICE:  Rows with NULL geometry or NULL id: 0
NOTICE:  Vertices table for table public.edge_table is: public.edge_table_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createtopology
--------------------
 OK
(1 row)

SELECT pgr_createTopology('edge_table',  0.001);
NOTICE:  PROCESSING:
NOTICE:  pgr_createTopology('edge_table', 0.001, 'the_geom', 'id', 'source', 'target', rows_where := 'true', clean := f)
NOTICE:  Performing checks, please wait .....
NOTICE:  Creating Topology, Please wait...
NOTICE:  -------------> TOPOLOGY CREATED FOR  13 edges
NOTICE:  Rows with NULL geometry or NULL id: 0
NOTICE:  Vertices table for table public.edge_table is: public.edge_table_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createtopology
--------------------
 OK
(1 row)
```

The example uses the **Sample Data** network.

See Also

- **Topology - Family of Functions** for an overview of a topology for routing algorithms.
- **pgr_createVerticesTable** to reconstruct the vertices table based on the source and target information.
- **pgr_analyzeGraph** to analyze the edges and vertices of the edge table.

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.1 3.0**

pgr_extractVertices – Experimental

`pgr_extractVertices` — Extracts the vertices information based on the source and target.

Warning

Possible server crash

- These functions might create a server crash

Warning

Experimental functions

- They are not officially of the current release.
- They likely will not be officially be part of the next release:
  - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
  - Name might change.
  - Signature might change.
  - Functionality might change.
  - pgTap tests might be missing.
  - Might need c/c++ coding.
  - May lack documentation.
  - Documentation if any might need to be rewritten.
  - Documentation examples might need to be automatically generated.
  - Might need a lot of feedback from the comunity.
  - Might depend on a proposed function of pgRouting
  - Might depend on a deprecated function of pgRouting

Availability

- Version 3.0.0
  - New **experimental** function

Description

This is an auxiliary function for extracting the vertex information of the set of edges of a graph.

- When the edge identifier is given, then it will also calculate the in and out edges

Signatures

```
pgr_extractVertices(Edges SQL [, dryrun])
RETURNS SETOF (id, in_edges, out_edges, x, y, geom)
```

Example:
Extracting the vertex information

```
SELECT  * FROM pgr_extractVertices(
   'SELECT id, the_geom AS geom
   FROM edge_table');
 id | in_edges | out_edges |       x        |  y  |                    geom
----+----------+-----------+----------------+-----+--------------------------------------------
  1 |          | {6}       |              0 |   2 | 010100000000000000000000000000000000000040
  2 |          | {17}      |            0.5 | 3.5 | 0101000000000000000000E03F0000000000000C40
  3 | {6}      | {7}       |              1 |   2 | 0101000000000000000000F03F0000000000000040
  4 | {17}     |           | 1.999999999999 | 3.5 | 010100000068EEFFFFFFFFFF3F0000000000000C40
  5 |          | {1}       |              2 |   0 | 010100000000000000000000400000000000000000
  6 | {1}      | {2,4}     |              2 |   1 | 01010000000000000000000040000000000000F03F
  7 | {4,7}    | {8,10}    |              2 |   2 | 010100000000000000000000400000000000000040
  8 | {10}     | {12,14}   |              2 |   3 | 010100000000000000000000400000000000000840
  9 | {14}     |           |              2 |   4 | 010100000000000000000000400000000000001040
 10 | {2}      | {3,5}     |              3 |   1 | 01010000000000000000000840000000000000F03F
 11 | {5,8}    | {9,11}    |              3 |   2 | 010100000000000000000008400000000000000040
 12 | {11,12}  | {13}      |              3 |   3 | 010100000000000000000008400000000000000840
 13 |          | {18}      |            3.5 | 2.3 | 01010000000000000000000C406666666666660240
 14 | {18}     |           |            3.5 |   4 | 01010000000000000000000C400000000000001040
 15 | {3}      | {16}      |              4 |   1 | 01010000000000000000001040000000000000F03F
 16 | {9,16}   | {15}      |              4 |   2 | 010100000000000000000010400000000000000040
 17 | {13,15}  |           |              4 |   3 | 010100000000000000000010400000000000000840
(17 rows)
```

Parameters

Parameter	Type	Description
Edges SQL	TEXT	The set of edges of the graph. It is an **Inner Query** as described below.
dryrun	TEXT	Don't process and get in a NOTICE the resulting query.

Inner Query

When line geometry is known

Column	Type	Description
id	BIGINT	(Optional) identifier of the edge.
geom	LINESTRING	LINESTRING geometry of the edge.

This inner query takes precedence over the next two inner query, therefore other columns are ignored when `geom` column appears.

- Ignored columns:
  - `startpoint`
  - `endpoint`
  - `source`
  - `target`

When vertex geometry is known

To use this inner query the column `geom` should not be part of the set of columns.

Column	Type	Description
id	BIGINT	(Optional) identifier of the edge.

Column	Type	Description
startpoint	POINT	POINT geometry of the starting vertex.
endpoint	POINT	POINT geometry of the ending vertex.

This inner query takes precedence over the next inner query, therefore other columns are ignored when startpoint and endpoint columns appears.

- Ignored columns:
  - source
  - target

When identifiers of vertices are known

To use this inner query the columns geom, startpoint and endpoint should not be part of the set of columns.

Column	Type	Description
id	BIGINT	(Optional) identifier of the edge.
source	ANY-INTEGER	Identifier of the first end point vertex of the edge.
target	ANY-INTEGER	Identifier of the second end point vertex of the edge.

Result Columns

Rreturns set of (id, in_edges, out_edges, x, y, geom)

Column	Type	Description
id	BIGINT	Identifier of the first end point vertex of the edge.
in_edges	BIGINT[]	Array of identifiers of the edges that have the vertex id as *first end point*. • NULL When the id is not part of the inner query
out_edges	BIGINT[]	Array of identifiers of the edges that have the vertex id as *second end point*. • NULL When the id is not part of the inner query
x	FLOAT	X value of the POINT geometry • NULL When no geometry is provided
y	FLOAT	Y value of the POINT geometry • NULL When no geometry is provided
geom	POINT	Geometry of the POINT • NULL When no geometry is provided

Additional Examples

Example 1:
Dryrun execution

To get the query generated used to get the vertex information, use dryrun := true.

The results can be used as base code to make a refinement based on the backend development needs.

```
SELECT  * FROM pgr_extractVertices(
    'SELECT id, the_geom AS geom FROM edge_table',
    dryrun := true);
NOTICE:
        WITH

        main_sql AS (
          SELECT id, the_geom AS geom FROM edge_table
        ),

        the_out AS (
          SELECT id::BIGINT AS out_edge, ST_StartPoint(geom) AS geom
          FROM main_sql
        ),

        agg_out AS (
          SELECT array_agg(out_edge ORDER BY out_edge) AS out_edges, ST_x(geom) AS x, ST_Y(geom) AS y, geom
          FROM the_out
          GROUP BY geom
        ),

        the_in AS (
          SELECT id::BIGINT AS in_edge, ST_EndPoint(geom) AS geom
          FROM main_sql
        ),

        agg_in AS (
          SELECT array_agg(in_edge ORDER BY in_edge) AS in_edges, ST_x(geom) AS x, ST_Y(geom) AS y, geom
          FROM the_in
          GROUP BY geom
        ),

        the_points AS (
          SELECT in_edges, out_edges, coalesce(agg_out.geom, agg_in.geom) AS geom
          FROM agg_out
          FULL OUTER JOIN agg_in USING (x, y)
        )

        SELECT row_number() over(ORDER BY ST_X(geom), ST_Y(geom)) AS id, in_edges, out_edges, ST_X(geom), ST_Y(geom), geom
        FROM the_points;
 id | in_edges | out_edges | x | y | geom
----+----------+-----------+---+---+------
(0 rows)
```

Example 2:

Creating a routing topology

1. Making sure the database does not have the`vertices_table`

```
DROP TABLE IF EXISTS vertices_table;
NOTICE:  table "vertices_table" does not exist, skipping
DROP TABLE
```

2. Cleaning up the columns of the rotuing topology to be created

```
UPDATE edge_table
SET source = NULL, target = NULL,
   x1 = NULL, y1 = NULL,
   x2 = NULL, y2 = NULL;
UPDATE 18
```

3. Creating the vertices table

```
SELECT  * INTO vertices_table
FROM pgr_extractVertices('SELECT id, the_geom AS geom FROM edge_table');
SELECT 17
```

4. Inspection of the vertices table

```
SELECT *
FROM vertices_table;
 id | in_edges | out_edges |       x        |  y  |                    geom
----+----------+-----------+----------------+-----+--------------------------------------------
  1 |          | {6}       |              0 |   2 | 010100000000000000000000000000000000000040
  2 |          | {17}      |            0.5 | 3.5 | 0101000000000000000000E03F0000000000000C40
  3 | {6}      | {7}       |              1 |   2 | 0101000000000000000000F03F0000000000000040
  4 | {17}     |           | 1.999999999999 | 3.5 | 010100000068EEFFFFFFFFFF3F0000000000000C40
  5 |          | {1}       |              2 |   0 | 010100000000000000000000400000000000000000
  6 | {1}      | {2,4}     |              2 |   1 | 01010000000000000000000040000000000000F03F
  7 | {4,7}    | {8,10}    |              2 |   2 | 010100000000000000000000400000000000000040
  8 | {10}     | {12,14}   |              2 |   3 | 010100000000000000000000400000000000000840
  9 | {14}     |           |              2 |   4 | 010100000000000000000000400000000000001040
 10 | {2}      | {3,5}     |              3 |   1 | 01010000000000000000000840000000000000F03F
 11 | {5,8}    | {9,11}    |              3 |   2 | 010100000000000000000008400000000000000040
 12 | {11,12}  | {13}      |              3 |   3 | 010100000000000000000008400000000000000840
 13 |          | {18}      |            3.5 | 2.3 | 01010000000000000000000C406666666666660240
 14 | {18}     |           |            3.5 |   4 | 01010000000000000000000C400000000000001040
 15 | {3}      | {16}      |              4 |   1 | 01010000000000000000001040000000000000F03F
 16 | {9,16}   | {15}      |              4 |   2 | 010100000000000000000010400000000000000040
 17 | {13,15}  |           |              4 |   3 | 010100000000000000000010400000000000000840
(17 rows)
```

5. Creating the routing topology on the edge table

   Updating the `source` information

```
WITH
   out_going AS (
      SELECT id AS vid, unnest(out_edges) AS eid, x, y
      FROM vertices_table
   )
UPDATE edge_table
SET source = vid, x1 = x, y1 = y
FROM out_going WHERE id = eid;
UPDATE 18
```

   Updating the `target` information

```
WITH
   in_coming AS (
      SELECT id AS vid, unnest(in_edges) AS eid, x, y
      FROM vertices_table
   )
UPDATE edge_table
SET target = vid, x2 = x, y2 = y
FROM in_coming WHERE id = eid;
UPDATE 18
```

6. Inspection of the routing topology

```
SELECT id, source, target, x1, y1, x2, y2
FROM edge_table;
 id | source | target | x1  | y1  |       x2       | y2
----+--------+--------+-----+-----+----------------+-----
  6 |      1 |      3 |   0 |   2 |              1 |   2
 17 |      2 |      4 | 0.5 | 3.5 | 1.999999999999 | 3.5
  1 |      5 |      6 |   2 |   0 |              2 |   1
  4 |      6 |      7 |   2 |   1 |              2 |   2
  7 |      3 |      7 |   1 |   2 |              2 |   2
 10 |      7 |      8 |   2 |   2 |              2 |   3
 14 |      8 |      9 |   2 |   3 |              2 |   4
  2 |      6 |     10 |   2 |   1 |              3 |   1
  5 |     10 |     11 |   3 |   1 |              3 |   2
  8 |      7 |     11 |   2 |   2 |              3 |   2
 11 |     11 |     12 |   3 |   2 |              3 |   3
 12 |      8 |     12 |   2 |   3 |              3 |   3
 18 |     13 |     14 | 3.5 | 2.3 |            3.5 |   4
  3 |     10 |     15 |   3 |   1 |              4 |   1
  9 |     11 |     16 |   3 |   2 |              4 |   2
 16 |     15 |     16 |   4 |   1 |              4 |   2
 13 |     12 |     17 |   3 |   3 |              4 |   3
 15 |     16 |     17 |   4 |   2 |              4 |   3
(18 rows)
```

See Also

- **Topology - Family of Functions** for an overview of a topology for routing algorithms.
- **pgr_createVerticesTable** to create a topology based on the geometry.

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2 2.1 2.0**

pgr_createVerticesTable

`pgr_createVerticesTable` — Reconstructs the vertices table based on the source and target information.

Availability

- Version 2.0.0
  - Renamed from version 1.x
  - **Official** function

Description

The function returns:

- `OK` after the vertices table has been reconstructed.
- `FAIL` when the vertices table was not reconstructed due to an error.

Signatures

```
pgr_createVerticesTable(edge_table, the_geom, source, target, rows_where)
RETURNS VARCHAR
```

Parameters

The reconstruction of the vertices table function accepts the following parameters:

edge_table:
`text` Network table name. (may contain the schema name as well)
the_geom:
`text` Geometry column name of the network table. Default value is `the_geom`.
source:
`text` Source column name of the network table. Default value is`source`.
target:
`text` Target column name of the network table. Default value is `target`.
rows_where:
`text` Condition to SELECT a subset or rows. Default value is `true` to indicate all rows.

> **Warning**
>
> The `edge_table` will be affected
>
> - An index will be created, if it doesn't exists, to speed up the process to the following columns:
>   - `the_geom`
>   - `source`
>   - `target`

The function returns:

- `OK` after the vertices table has been reconstructed.
  - Creates a vertices table: <edge_table>_vertices_pgr.
  - Fills `id` and `the_geom` columns of the vertices table based on the source and target columns of the edge table.
- `FAIL` when the vertices table was not reconstructed due to an error.
  - A required column of the Network table is not found or is not of the appropriate type.
  - The condition is not well formed.
  - The names of source, target are the same.
  - The SRID of the geometry could not be determined.

The Vertices Table

The vertices table is a requierment of the**pgr_analyzeGraph** and the **pgr_analyzeOneWay** functions.

The structure of the vertices table is:

id:

bigint Identifier of the vertex.

cnt:

integer Number of vertices in the edge_table that reference this vertex. See **pgr_analyzeGraph**.

chk:

integer Indicator that the vertex might have a problem. See **pgr_analyzeGraph**.

ein:

integer Number of vertices in the edge_table that reference this vertex as incoming. See **pgr_analyzeOneWay**.

eout:

integer Number of vertices in the edge_table that reference this vertex as outgoing. See **pgr_analyzeOneWay**.

the_geom:

geometry Point geometry of the vertex.

Example 1:

The simplest way to use pgr_createVerticesTable

```
SELECT  pgr_createVerticesTable('edge_table');
NOTICE:  PROCESSING:
NOTICE:  pgr_createVerticesTable('edge_table','the_geom','source','target','true')
NOTICE:  Performing checks, please wait .....
NOTICE:  Populating public.edge_table_vertices_pgr, please wait...
NOTICE:    ----->   VERTICES TABLE CREATED WITH  17 VERTICES
NOTICE:                                        FOR   18  EDGES
NOTICE:    Edges with NULL geometry,source or target: 0
NOTICE:                                Edges processed: 18
NOTICE:  Vertices table for table public.edge_table is: public.edge_table_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createverticestable
--------------------------
 OK
(1 row)
```

Additional Examples

Example 2:

When the arguments are given in the order described in the parameters:

```
SELECT  pgr_createVerticesTable('edge_table', 'the_geom', 'source', 'target');
NOTICE:  PROCESSING:
NOTICE:  pgr_createVerticesTable('edge_table','the_geom','source','target','true')
NOTICE:  Performing checks, please wait .....
NOTICE:  Populating public.edge_table_vertices_pgr, please wait...
NOTICE:    ----->   VERTICES TABLE CREATED WITH  17 VERTICES
NOTICE:                                        FOR   18  EDGES
NOTICE:    Edges with NULL geometry,source or target: 0
NOTICE:                                Edges processed: 18
NOTICE:  Vertices table for table public.edge_table is: public.edge_table_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createverticestable
--------------------------
 OK
(1 row)
```

We get the same result as the simplest way to use the function.

Warning

An error would occur when the arguments are not given in the appropriate order: In this example, the column source column source of the table mytable is passed to the function as the geometry column, and the geometry column the_geom is passed to the function as the source column.

```
SELECT  pgr_createVerticesTable('edge_table', 'source', 'the_geom', 'target');
NOTICE:  PROCESSING:
NOTICE:  pgr_createVerticesTable('edge_table','source','the_geom','target','true')
NOTICE:  Performing checks, please wait .....
NOTICE:  ----> PGR ERROR in pgr_createVerticesTable: Wrong type of Column source: the_geom
HINT:    ----> Expected type of the_geom is integer, smallint or bigint but USER-DEFINED was found
NOTICE:  Unexpected error raise_exception
 pgr_createverticestable
--------------------------
 FAIL
(1 row)
```

When using the named notation

Example 3:

The order of the parameters do not matter:

```
SELECT  pgr_createVerticesTable('edge_table', the_geom:='the_geom', source:='source', target:='target');
NOTICE:  PROCESSING:
NOTICE:  pgr_createVerticesTable('edge_table','the_geom','source','target','true')
NOTICE:  Performing checks, please wait .....
NOTICE:  Populating public.edge_table_vertices_pgr, please wait...
NOTICE:    ----->   VERTICES TABLE CREATED WITH  17 VERTICES
NOTICE:                                        FOR   18  EDGES
NOTICE:    Edges with NULL geometry,source or target: 0
NOTICE:                                Edges processed: 18
NOTICE:  Vertices table for table public.edge_table is: public.edge_table_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createverticestable
--------------------------
 OK
(1 row)
```

Example 4:
Using a different ordering

```
SELECT  pgr_createVerticesTable('edge_table', source:='source', target:='target', the_geom:='the_geom');
NOTICE:  PROCESSING:
NOTICE:  pgr_createVerticesTable('edge_table','the_geom','source','target','true')
NOTICE:  Performing checks, please wait .....
NOTICE:  Populating public.edge_table_vertices_pgr, please wait...
NOTICE:    ----->   VERTICES TABLE CREATED WITH  17 VERTICES
NOTICE:                                        FOR   18  EDGES
NOTICE:    Edges with NULL geometry,source or target: 0
NOTICE:                                Edges processed: 18
NOTICE:  Vertices table for table public.edge_table is: public.edge_table_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createverticestable
--------------------------
 OK
(1 row)
```

Example 5:
Parameters defined with a default value can be omitted, as long as the value matches the default:

```
SELECT  pgr_createVerticesTable('edge_table',source:='source');
NOTICE:  PROCESSING:
NOTICE:  pgr_createVerticesTable('edge_table','the_geom','source','target','true')
NOTICE:  Performing checks, please wait .....
NOTICE:  Populating public.edge_table_vertices_pgr, please wait...
NOTICE:    ----->   VERTICES TABLE CREATED WITH  17 VERTICES
NOTICE:                                        FOR   18  EDGES
NOTICE:    Edges with NULL geometry,source or target: 0
NOTICE:                                Edges processed: 18
NOTICE:  Vertices table for table public.edge_table is: public.edge_table_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createverticestable
--------------------------
 OK
(1 row)
```

Selecting rows using rows_where parameter

Example 6:
Selecting rows based on the id.

```
SELECT  pgr_createVerticesTable('edge_table',rows_where:='id < 10');
NOTICE:  PROCESSING:
NOTICE:  pgr_createVerticesTable('edge_table','the_geom','source','target','id < 10')
NOTICE:  Performing checks, please wait .....
NOTICE:  Populating public.edge_table_vertices_pgr, please wait...
NOTICE:    ----->   VERTICES TABLE CREATED WITH  9 VERTICES
NOTICE:                                        FOR   10  EDGES
NOTICE:    Edges with NULL geometry,source or target: 0
NOTICE:                                Edges processed: 10
NOTICE:  Vertices table for table public.edge_table is: public.edge_table_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createverticestable
--------------------------
 OK
(1 row)
```

Example 7:
Selecting the rows where the geometry is near the geometry of row with `id` =5 .

```
SELECT  pgr_createVerticesTable('edge_table',
    rows_where:='the_geom && (select st_buffer(the_geom,0.5) FROM edge_table WHERE id=5)');
NOTICE:  PROCESSING:
NOTICE:  pgr_createVerticesTable('edge_table','the_geom','source','target','the_geom && (select st_buffer(the_geom,0.5) FROM edge_table WHERE id=5)')
NOTICE:  Performing checks, please wait .....
NOTICE:  Populating public.edge_table_vertices_pgr, please wait...
NOTICE:    -----> VERTICES TABLE CREATED WITH  9 VERTICES
NOTICE:                                        FOR   9  EDGES
NOTICE:    Edges with NULL geometry,source or target: 0
NOTICE:                                Edges processed: 9
NOTICE:  Vertices table for table public.edge_table is: public.edge_table_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createverticestable
-------------------------
 OK
(1 row)
```

Example 8:

Selecting the rows where the geometry is near the geometry of the row with `gid` =100 of the table `othertable`.

```
DROP TABLE IF EXISTS otherTable;
NOTICE:  table "othertable" does not exist, skipping
DROP TABLE
CREATE TABLE otherTable AS  (SELECT 100 AS gid, st_point(2.5,2.5) AS other_geom) ;
SELECT 1
SELECT  pgr_createVerticesTable('edge_table',
    rows_where:='the_geom && (select st_buffer(other_geom,0.5) FROM otherTable WHERE gid=100)');
NOTICE:  PROCESSING:
NOTICE:  pgr_createVerticesTable('edge_table','the_geom','source','target','the_geom && (select st_buffer(other_geom,0.5) FROM otherTable WHERE gid=100)')
NOTICE:  Performing checks, please wait .....
NOTICE:  Populating public.edge_table_vertices_pgr, please wait...
NOTICE:    -----> VERTICES TABLE CREATED WITH  10 VERTICES
NOTICE:                                        FOR   12  EDGES
NOTICE:    Edges with NULL geometry,source or target: 0
NOTICE:                                Edges processed: 12
NOTICE:  Vertices table for table public.edge_table is: public.edge_table_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createverticestable
-------------------------
 OK
(1 row)
```

Usage when the edge table's columns DO NOT MATCH the default values:

Using the following table

```
DROP TABLE IF EXISTS mytable;
NOTICE:  table "mytable" does not exist, skipping
DROP TABLE
CREATE TABLE mytable AS (SELECT id AS gid, the_geom AS mygeom, source AS src ,target AS tgt FROM edge_table) ;
SELECT 18
```

Using positional notation:

Example 9:

The arguments need to be given in the order described in the parameters:

```
SELECT  pgr_createVerticesTable('mytable', 'mygeom', 'src', 'tgt');
NOTICE:  PROCESSING:
NOTICE:  pgr_createVerticesTable('mytable','mygeom','src','tgt','true')
NOTICE:  Performing checks, please wait .....
NOTICE:  Populating public.mytable_vertices_pgr, please wait...
NOTICE:    -----> VERTICES TABLE CREATED WITH  17 VERTICES
NOTICE:                                        FOR   18  EDGES
NOTICE:    Edges with NULL geometry,source or target: 0
NOTICE:                                Edges processed: 18
NOTICE:  Vertices table for table public.mytable is: public.mytable_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createverticestable
-------------------------
 OK
(1 row)
```

Warning

An error would occur when the arguments are not given in the appropriate order: In this example, the column `src` of the table `mytable` is passed to the function as the geometry column, and the geometry column `mygeom` is passed to the function as the source column.

```
SELECT  pgr_createVerticesTable('mytable', 'src', 'mygeom', 'tgt');
NOTICE:  PROCESSING:
NOTICE:  pgr_createVerticesTable('mytable','src','mygeom','tgt','true')
NOTICE:  Performing checks, please wait .....
NOTICE:  ----> PGR ERROR in pgr_createVerticesTable: Wrong type of Column source: mygeom
HINT:    ----> Expected type of mygeom is integer, smallint or bigint but USER-DEFINED was found
NOTICE:  Unexpected error raise_exception
 pgr_createverticestable
-------------------------
 FAIL
(1 row)
```

When using the named notation

Example 10:
The order of the parameters do not matter:

```
SELECT  pgr_createVerticesTable('mytable',the_geom:='mygeom',source:='src',target:='tgt');
NOTICE:  PROCESSING:
NOTICE:  pgr_createVerticesTable('mytable','mygeom','src','tgt','true')
NOTICE:  Performing checks, please wait .....
NOTICE:  Populating public.mytable_vertices_pgr, please wait...
NOTICE:    ----->   VERTICES TABLE CREATED WITH  17 VERTICES
NOTICE:                                        FOR   18  EDGES
NOTICE:    Edges with NULL geometry,source or target: 0
NOTICE:                              Edges processed: 18
NOTICE:  Vertices table for table public.mytable is: public.mytable_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createverticestable
-------------------------
 OK
(1 row)
```

Example 11:
Using a different ordering

In this scenario omitting a parameter would create an error because the default values for the column names do not match the column names of the table.

```
SELECT  pgr_createVerticesTable(
    'mytable', source:='src', target:='tgt',
    the_geom:='mygeom');
NOTICE:  PROCESSING:
NOTICE:  pgr_createVerticesTable('mytable','mygeom','src','tgt','true')
NOTICE:  Performing checks, please wait .....
NOTICE:  Populating public.mytable_vertices_pgr, please wait...
NOTICE:    ----->   VERTICES TABLE CREATED WITH  17 VERTICES
NOTICE:                                        FOR   18  EDGES
NOTICE:    Edges with NULL geometry,source or target: 0
NOTICE:                              Edges processed: 18
NOTICE:  Vertices table for table public.mytable is: public.mytable_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createverticestable
-------------------------
 OK
(1 row)
```

Selecting rows using rows_where parameter

Example 12:
Selecting rows based on the gid. (positional notation)

```
SELECT  pgr_createVerticesTable(
    'mytable', 'mygeom', 'src', 'tgt',
    rows_where:='gid < 10');
NOTICE:  PROCESSING:
NOTICE:  pgr_createVerticesTable('mytable','mygeom','src','tgt','gid < 10')
NOTICE:  Performing checks, please wait .....
NOTICE:  Populating public.mytable_vertices_pgr, please wait...
NOTICE:    ----->   VERTICES TABLE CREATED WITH  9 VERTICES
NOTICE:                                        FOR   10  EDGES
NOTICE:    Edges with NULL geometry,source or target: 0
NOTICE:                              Edges processed: 10
NOTICE:  Vertices table for table public.mytable is: public.mytable_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createverticestable
-------------------------
 OK
(1 row)
```

Example 13:

Selecting rows based on the gid. (named notation)

```
SELECT  pgr_createVerticesTable(
    'mytable', source:='src', target:='tgt', the_geom:='mygeom',
    rows_where:='gid < 10');
NOTICE:  PROCESSING:
NOTICE:  pgr_createVerticesTable('mytable','mygeom','src','tgt','gid < 10')
NOTICE:  Performing checks, please wait .....
NOTICE:  Populating public.mytable_vertices_pgr, please wait...
NOTICE:    -----> VERTICES TABLE CREATED WITH 9 VERTICES
NOTICE:                                    FOR 10 EDGES
NOTICE:    Edges with NULL geometry,source or target: 0
NOTICE:                              Edges processed: 10
NOTICE:  Vertices table for table public.mytable is: public.mytable_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createverticestable
-------------------------
 OK
(1 row)
```

Example 14:

Selecting the rows where the geometry is near the geometry of row with`gid` = 5.

```
SELECT  pgr_createVerticesTable(
    'mytable', 'mygeom', 'src', 'tgt',
    rows_where := 'the_geom && (SELECT st_buffer(mygeom,0.5) FROM mytable WHERE gid=5)');
NOTICE:  PROCESSING:
NOTICE:  pgr_createVerticesTable('mytable','mygeom','src','tgt','the_geom && (SELECT st_buffer(mygeom,0.5) FROM mytable WHERE gid=5)')
NOTICE:  Performing checks, please wait .....
NOTICE:  Got column "the_geom" does not exist
NOTICE:  ERROR: Condition is not correct, please execute the following query to test your condition
NOTICE:  select * from public.mytable WHERE true AND (the_geom && (SELECT st_buffer(mygeom,0.5) FROM mytable WHERE gid=5)) limit 1
 pgr_createverticestable
-------------------------
 FAIL
(1 row)
```

Example 15:

TBD

```
SELECT  pgr_createVerticesTable(
    'mytable', source:='src', target:='tgt', the_geom:='mygeom',
    rows_where:='mygeom && (SELECT st_buffer(mygeom,0.5) FROM mytable WHERE id=5)');
NOTICE:  PROCESSING:
NOTICE:  pgr_createVerticesTable('mytable','mygeom','src','tgt','mygeom && (SELECT st_buffer(mygeom,0.5) FROM mytable WHERE id=5)')
NOTICE:  Performing checks, please wait .....
NOTICE:  Got column "id" does not exist
NOTICE:  ERROR: Condition is not correct, please execute the following query to test your condition
NOTICE:  select * from public.mytable WHERE true AND (mygeom && (SELECT st_buffer(mygeom,0.5) FROM mytable WHERE id=5)) limit 1
 pgr_createverticestable
-------------------------
 FAIL
(1 row)
```

Example 16:

Selecting the rows where the geometry is near the geometry of the row with`gid` =100 of the table`othertable`.

```
DROP TABLE IF EXISTS otherTable;
DROP TABLE
CREATE TABLE otherTable AS  (SELECT 100 AS gid, st_point(2.5,2.5) AS other_geom) ;
SELECT 1
```

```
SELECT pgr_createVerticesTable(
    'mytable', 'mygeom', 'src', 'tgt',
    rows_where:='the_geom && (SELECT st_buffer(othergeom,0.5) FROM otherTable WHERE gid=100)');
NOTICE:  PROCESSING:
NOTICE:  pgr_createVerticesTable('mytable','mygeom','src','tgt','the_geom && (SELECT st_buffer(othergeom,0.5) FROM otherTable WHERE gid=100)')
NOTICE:  Performing checks, please wait .....
NOTICE:  Got column "the_geom" does not exist
NOTICE:  ERROR: Condition is not correct, please execute the following query to test your condition
NOTICE:  select * from public.mytable WHERE true AND (the_geom && (SELECT st_buffer(othergeom,0.5) FROM otherTable WHERE gid=100)) limit 1
 pgr_createverticestable
-------------------------
 FAIL
(1 row)
```

Example 17:

TBD

```
SELECT  pgr_createVerticesTable(
    'mytable',source:='src',target:='tgt',the_geom:='mygeom',
    rows_where:='the_geom && (SELECT st_buffer(othergeom,0.5) FROM otherTable WHERE gid=100)');
NOTICE:  PROCESSING:
NOTICE:  pgr_createVerticesTable('mytable','mygeom','src','tgt','the_geom && (SELECT st_buffer(othergeom,0.5) FROM otherTable WHERE gid=100)')
NOTICE:  Performing checks, please wait .....
NOTICE:  Got column "the_geom" does not exist
NOTICE:  ERROR: Condition is not correct, please execute the following query to test your condition
NOTICE:  select * from public.mytable WHERE true AND (the_geom && (SELECT st_buffer(othergeom,0.5) FROM otherTable WHERE gid=100)) limit 1
 pgr_createverticestable
-------------------------
 FAIL
(1 row)
```

The example uses the **Sample Data** network.

See Also

- **Topology - Family of Functions** for an overview of a topology for routing algorithms.
- **pgr_createTopology** <pgr_create_topology>` to create a topology based on the geometry.
- **pgr_analyzeGraph** to analyze the edges and vertices of the edge table.
- **pgr_analyzeOneWay** to analyze directionality of the edges.

Indices and tables

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- **Supported versions: Latest** (**3.2**) **3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2 2.1 2.0**

pgr_analyzeGraph

`pgr_analyzeGraph` — Analyzes the network topology.

Availability

- Version 2.0.0
  - **Official** function

Description

The function returns:

- `OK` after the analysis has finished.
- `FAIL` when the analysis was not completed due to an error.

```
varchar pgr_analyzeGraph(text edge_table, double precision tolerance,
                text the_geom:='the_geom', text id:='id',
                text source:='source',text target:='target',text rows_where:='true')
```

Prerequisites

The edge table to be analyzed must contain a source column and a target column filled with id's of the vertices of the segments and the corresponding vertices table <edge_table>_vertices_pgr that stores the vertices information.

- Use **pgr_createVerticesTable** to create the vertices table.
- Use **pgr_createTopology** to create the topology and the vertices table.

Parameters

The analyze graph function accepts the following parameters:

edge_table:
`text` Network table name. (may contain the schema name as well)

tolerance:
`float8` Snapping tolerance of disconnected edges. (in projection unit)

the_geom:
`text` Geometry column name of the network table. Default value is `the_geom`.

id:
`text` Primary key column name of the network table. Default value is `id`.

source:
`text` Source column name of the network table. Default value is `source`.

target:
`text` Target column name of the network table. Default value is `target`.

rows_where:
`text` Condition to select a subset or rows. Default value is `true` to indicate all rows.

The function returns:

- `OK` after the analysis has finished.
  - Uses the vertices table: <edge_table>_vertices_pgr.
  - Fills completely the `cnt` and `chk` columns of the vertices table.
  - Returns the analysis of the section of the network defined by `rows_where`
- `FAIL` when the analysis was not completed due to an error.
  - The vertices table is not found.
  - A required column of the Network table is not found or is not of the appropriate type.
  - The condition is not well formed.
  - The names of source , target or id are the same.
  - The SRID of the geometry could not be determined.

The Vertices Table

The vertices table can be created with **pgr_createVerticesTable** or **pgr_createTopology**

The structure of the vertices table is:

id:
`bigint` Identifier of the vertex.

cnt:
`integer` Number of vertices in the edge_table that reference this vertex.

chk:
`integer` Indicator that the vertex might have a problem.

ein:
`integer` Number of vertices in the edge_table that reference this vertex as incoming. See **pgr_analyzeOneWay**.

eout:
`integer` Number of vertices in the edge_table that reference this vertex as outgoing. See **pgr_analyzeOneWay**.

the_geom:
`geometry` Point geometry of the vertex.

Usage when the edge table's columns MATCH the default values:

The simplest way to use pgr_analyzeGraph is:

```
SELECT  pgr_createTopology('edge_table',0.001, clean := true);
NOTICE:  PROCESSING:
NOTICE:  pgr_createTopology('edge_table', 0.001, 'the_geom', 'id', 'source', 'target', rows_where := 'true', clean := t)
NOTICE:  Performing checks, please wait .....
NOTICE:  Creating Topology, Please wait...
NOTICE:  -------------> TOPOLOGY CREATED FOR  18 edges
NOTICE:  Rows with NULL geometry or NULL id: 0
NOTICE:  Vertices table for table public.edge_table is: public.edge_table_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createtopology
--------------------
 OK
(1 row)

SELECT  pgr_analyzeGraph('edge_table',0.001);
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('edge_table',0.001,'the_geom','id','source','target','true')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 2
NOTICE:                            Dead ends: 7
NOTICE:  Potential gaps found near dead ends: 1
NOTICE:               Intersections detected: 1
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

When the arguments are given in the order described in the parameters:

```
SELECT  pgr_analyzeGraph('edge_table',0.001,'the_geom','id','source','target');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('edge_table',0.001,'the_geom','id','source','target','true')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:            ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                  Isolated segments: 2
NOTICE:                          Dead ends: 7
NOTICE:  Potential gaps found near dead ends: 1
NOTICE:               Intersections detected: 1
NOTICE:                    Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

We get the same result as the simplest way to use the function.

Warning

An error would occur when the arguments are not given in the appropriate order: In this example, the column `id` of the table `mytable` is passed to the function as the geometry column, and the geometry column `the_geom` is passed to the function as the id column.

```
SELECT  pgr_analyzeGraph('edge_table',0.001,'id','the_geom','source','target');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('edge_table',0.001,'id','the_geom','source','target','true')
NOTICE:  Performing checks, please wait ...
NOTICE:  Got function st_srid(bigint) does not exist
NOTICE:  ERROR: something went wrong when checking for SRID of id in table public.edge_table
 pgr_analyzegraph
------------------
 FAIL
(1 row)
```

When using the named notation

The order of the parameters do not matter:

```
SELECT  pgr_analyzeGraph('edge_table',0.001,the_geom:='the_geom',id:='id',source:='source',target:='target');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('edge_table',0.001,'the_geom','id','source','target','true')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:            ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                  Isolated segments: 2
NOTICE:                          Dead ends: 7
NOTICE:  Potential gaps found near dead ends: 1
NOTICE:               Intersections detected: 1
NOTICE:                    Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

```
SELECT  pgr_analyzeGraph('edge_table',0.001,source:='source',id:='id',target:='target',the_geom:='the_geom');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('edge_table',0.001,'the_geom','id','source','target','true')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 2
NOTICE:                            Dead ends: 7
NOTICE:  Potential gaps found near dead ends: 1
NOTICE:               Intersections detected: 1
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

Parameters defined with a default value can be omitted, as long as the value matches the default:

```
SELECT  pgr_analyzeGraph('edge_table',0.001,source:='source');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('edge_table',0.001,'the_geom','id','source','target','true')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 2
NOTICE:                            Dead ends: 7
NOTICE:  Potential gaps found near dead ends: 1
NOTICE:               Intersections detected: 1
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

Selecting rows using rows_where parameter

Selecting rows based on the id. Displays the analysis a the section of the network.

```
SELECT  pgr_analyzeGraph('edge_table',0.001,rows_where:='id < 10');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('edge_table',0.001,'the_geom','id','source','target','id < 10')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 0
NOTICE:                            Dead ends: 4
NOTICE:  Potential gaps found near dead ends: 0
NOTICE:               Intersections detected: 0
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

Selecting the rows where the geometry is near the geometry of row with `id` =5 .

```
SELECT  pgr_analyzeGraph('edge_table',0.001,rows_where:='the_geom && (SELECT st_buffer(the_geom,0.05) FROM edge_table WHERE id=5)');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('edge_table',0.001,'the_geom','id','source','target','the_geom && (SELECT st_buffer(the_geom,0.05) FROM edge_table WHERE id=5)')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 0
NOTICE:                            Dead ends: 5
NOTICE:  Potential gaps found near dead ends: 0
NOTICE:               Intersections detected: 0
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

Selecting the rows where the geometry is near the geometry of the row with `gid` =100 of the table `othertable`.

```
CREATE TABLE otherTable AS  (SELECT 100 AS gid, st_point(2.5,2.5) AS other_geom) ;
SELECT 1
SELECT  pgr_analyzeGraph('edge_table',0.001,rows_where:='the_geom && (SELECT st_buffer(other_geom,1) FROM otherTable WHERE gid=100)');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('edge_table',0.001,'the_geom','id','source','target','the_geom && (SELECT st_buffer(other_geom,1) FROM otherTable WHERE gid=100)')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 2
NOTICE:                            Dead ends: 10
NOTICE:  Potential gaps found near dead ends: 1
NOTICE:               Intersections detected: 1
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

Usage when the edge table's columns DO NOT MATCH the default values:

For the following table

```
CREATE TABLE mytable AS (SELECT id AS gid, source AS src ,target AS tgt , the_geom AS mygeom FROM edge_table);
SELECT 18
SELECT pgr_createTopology('mytable',0.001,'mygeom','gid','src','tgt', clean := true);
NOTICE:  PROCESSING:
NOTICE:  pgr_createTopology('mytable', 0.001, 'mygeom', 'gid', 'src', 'tgt', rows_where := 'true', clean := t)
NOTICE:  Performing checks, please wait .....
NOTICE:  Creating Topology, Please wait...
NOTICE:  -------------> TOPOLOGY CREATED FOR  18 edges
NOTICE:  Rows with NULL geometry or NULL id: 0
NOTICE:  Vertices table for table public.mytable is: public.mytable_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createtopology
--------------------
 OK
(1 row)
```

Using positional notation:

The arguments need to be given in the order described in the parameters:

```
SELECT  pgr_analyzeGraph('mytable',0.001,'mygeom','gid','src','tgt');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('mytable',0.001,'mygeom','gid','src','tgt','true')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 2
NOTICE:                            Dead ends: 7
NOTICE:  Potential gaps found near dead ends: 1
NOTICE:               Intersections detected: 1
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

Warning

An error would occur when the arguments are not given in the appropriate order: In this example, the column gid of the table mytable is passed to the function as the geometry column, and the geometry column mygeom is passed to the function as the id column.

```
SELECT  pgr_analyzeGraph('mytable',0.0001,'gid','mygeom','src','tgt');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('mytable',0.0001,'gid','mygeom','src','tgt','true')
NOTICE:  Performing checks, please wait ...
NOTICE:  Got function st_srid(bigint) does not exist
NOTICE:  ERROR: something went wrong when checking for SRID of gid in table public.mytable
 pgr_analyzegraph
------------------
 FAIL
(1 row)
```

When using the named notation

The order of the parameters do not matter:

```
SELECT  pgr_analyzeGraph('mytable',0.001,the_geom:='mygeom',id:='gid',source:='src',target:='tgt');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('mytable',0.001,'mygeom','gid','src','tgt','true')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 2
NOTICE:                            Dead ends: 7
NOTICE:  Potential gaps found near dead ends: 1
NOTICE:               Intersections detected: 1
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

```
SELECT  pgr_analyzeGraph('mytable',0.001,source:='src',id:='gid',target:='tgt',the_geom:='mygeom');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('mytable',0.001,'mygeom','gid','src','tgt','true')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 2
NOTICE:                            Dead ends: 7
NOTICE:  Potential gaps found near dead ends: 1
NOTICE:               Intersections detected: 1
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

In this scenario omitting a parameter would create an error because the default values for the column names do not match the column names of the table.

Selecting rows using rows_where parameter

Selecting rows based on the id.

```
SELECT  pgr_analyzeGraph('mytable',0.001,'mygeom','gid','src','tgt',rows_where:='gid < 10');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('mytable',0.001,'mygeom','gid','src','tgt','gid < 10')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 0
NOTICE:                            Dead ends: 4
NOTICE:  Potential gaps found near dead ends: 0
NOTICE:               Intersections detected: 0
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
--------------------
 OK
(1 row)
```

```
SELECT  pgr_analyzeGraph('mytable',0.001,source:='src',id:='gid',target:='tgt',the_geom:='mygeom',rows_where:='gid < 10');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('mytable',0.001,'mygeom','gid','src','tgt','gid < 10')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 0
NOTICE:                            Dead ends: 4
NOTICE:  Potential gaps found near dead ends: 0
NOTICE:               Intersections detected: 0
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
--------------------
 OK
(1 row)
```

Selecting the rows WHERE the geometry is near the geometry of row with `id` =5 .

```
SELECT  pgr_analyzeGraph('mytable',0.001,'mygeom','gid','src','tgt',
    rows_where:='mygeom && (SELECT st_buffer(mygeom,1) FROM mytable WHERE gid=5)');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('mytable',0.001,'mygeom','gid','src','tgt','mygeom && (SELECT st_buffer(mygeom,1) FROM mytable WHERE gid=5)')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 1
NOTICE:                            Dead ends: 5
NOTICE:  Potential gaps found near dead ends: 0
NOTICE:               Intersections detected: 1
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
--------------------
 OK
(1 row)
```

```
SELECT  pgr_analyzeGraph('mytable',0.001,source:='src',id:='gid',target:='tgt',the_geom:='mygeom',
    rows_where:='mygeom && (SELECT st_buffer(mygeom,1) FROM mytable WHERE gid=5)');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('mytable',0.001,'mygeom','gid','src','tgt','mygeom && (SELECT st_buffer(mygeom,1) FROM mytable WHERE gid=5)')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 1
NOTICE:                            Dead ends: 5
NOTICE:  Potential gaps found near dead ends: 0
NOTICE:               Intersections detected: 1
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

Selecting the rows WHERE the geometry is near the place='myhouse' of the table`othertable`. (note the use of quote_literal)

```
DROP TABLE IF EXISTS otherTable;
DROP TABLE
CREATE TABLE otherTable AS  (SELECT 'myhouse'::text AS place, st_point(2.5,2.5) AS other_geom) ;
SELECT 1
SELECT  pgr_analyzeGraph('mytable',0.001,'mygeom','gid','src','tgt',
    rows_where:='mygeom && (SELECT st_buffer(other_geom,1) FROM otherTable WHERE place='||quote_literal('myhouse')||')');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('mytable',0.001,'mygeom','gid','src','tgt','mygeom && (SELECT st_buffer(other_geom,1) FROM otherTable WHERE place='myhouse')')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 2
NOTICE:                            Dead ends: 10
NOTICE:  Potential gaps found near dead ends: 1
NOTICE:               Intersections detected: 1
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

```
SELECT  pgr_analyzeGraph('mytable',0.001,source:='src',id:='gid',target:='tgt',the_geom:='mygeom',
    rows_where:='mygeom && (SELECT st_buffer(other_geom,1) FROM otherTable WHERE place='||quote_literal('myhouse')||')');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('mytable',0.001,'mygeom','gid','src','tgt','mygeom && (SELECT st_buffer(other_geom,1) FROM otherTable WHERE place='myhouse')')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 2
NOTICE:                            Dead ends: 10
NOTICE:  Potential gaps found near dead ends: 1
NOTICE:               Intersections detected: 1
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

Additional Examples

```
SELECT  pgr_createTopology('edge_table',0.001, clean := true);
NOTICE:  PROCESSING:
NOTICE:  pgr_createTopology('edge_table', 0.001, 'the_geom', 'id', 'source', 'target', rows_where := 'true', clean := t)
NOTICE:  Performing checks, please wait .....
NOTICE:  Creating Topology, Please wait...
NOTICE:  -------------> TOPOLOGY CREATED FOR  18 edges
NOTICE:  Rows with NULL geometry or NULL id: 0
NOTICE:  Vertices table for table public.edge_table is: public.edge_table_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createtopology
--------------------
 OK
(1 row)

SELECT pgr_analyzeGraph('edge_table', 0.001);
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('edge_table',0.001,'the_geom','id','source','target','true')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 2
NOTICE:                            Dead ends: 7
NOTICE:  Potential gaps found near dead ends: 1
NOTICE:               Intersections detected: 1
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

```
SELECT  pgr_analyzeGraph('edge_table',0.001,rows_where:='id < 10');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('edge_table',0.001,'the_geom','id','source','target','id < 10')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 0
NOTICE:                            Dead ends: 4
NOTICE:  Potential gaps found near dead ends: 0
NOTICE:               Intersections detected: 0
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

```
SELECT  pgr_analyzeGraph('edge_table',0.001,rows_where:='id >= 10');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('edge_table',0.001,'the_geom','id','source','target','id >= 10')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 2
NOTICE:                            Dead ends: 8
NOTICE:  Potential gaps found near dead ends: 1
NOTICE:               Intersections detected: 1
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

```
SELECT  pgr_analyzeGraph('edge_table',0.001,rows_where:='id < 17');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('edge_table',0.001,'the_geom','id','source','target','id < 17')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 0
NOTICE:                            Dead ends: 3
NOTICE:  Potential gaps found near dead ends: 0
NOTICE:               Intersections detected: 0
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

```
SELECT pgr_createTopology('edge_table', 0.001,rows_where:='id <17', clean := true);
NOTICE:  PROCESSING:
NOTICE:  pgr_createTopology('edge_table', 0.001, 'the_geom', 'id', 'source', 'target', rows_where := 'id <17', clean := t)
NOTICE:  Performing checks, please wait .....
NOTICE:  Creating Topology, Please wait...
NOTICE:  -------------> TOPOLOGY CREATED FOR  16 edges
NOTICE:  Rows with NULL geometry or NULL id: 0
NOTICE:  Vertices table for table public.edge_table is: public.edge_table_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createtopology
--------------------
 OK
(1 row)
```

```
SELECT pgr_analyzeGraph('edge_table', 0.001);
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('edge_table',0.001,'the_geom','id','source','target','true')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 0
NOTICE:                            Dead ends: 3
NOTICE:  Potential gaps found near dead ends: 0
NOTICE:               Intersections detected: 0
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

The examples use the **Sample Data** network.

See Also

- **Topology - Family of Functions** for an overview of a topology for routing algorithms.
- **pgr_analyzeOneWay** to analyze directionality of the edges.
- **pgr_createVerticesTable** to reconstruct the vertices table based on the source and target information.
- **pgr_nodeNetwork** to create nodes to a not noded edge table.

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2 2.1 2.0**

pgr_analyzeOneWay

`pgr_analyzeOneWay` — Analyzes oneway Sstreets and identifies flipped segments.

This function analyzes oneway streets in a graph and identifies any flipped segments.

Availability

- Version 2.0.0
  - **Official** function

Description

The analyses of one way segments is pretty simple but can be a powerful tools to identifying some the potential problems created by setting the direction of a segment the wrong way. A node is a *source* if it has edges the exit from that node and no edges enter that node. Conversely, a node is a *sink* if all edges enter the node but none exit that node. For a *source* type node it is logically impossible to exist because no vehicle can exit the node if no vehicle and enter the node. Likewise, if you had a *sink* node you would have an infinite number of vehicle piling up on this node because you can enter it but not leave it.

So why do we care if the are not feasible? Well if the direction of an edge was reversed by mistake we could generate exactly these conditions. Think about a divided highway and on the north bound lane one segment got entered wrong or maybe a sequence of multiple segments got entered wrong or maybe this happened on a round-about. The result would be potentially a *source* and/or a *sink* node.

So by counting the number of edges entering and exiting each node we can identify both *source* and *sink* nodes so that you can look at those areas of your network to make repairs and/or report the problem back to your data vendor.

Prerequisites

The edge table to be analyzed must contain a source column and a target column filled with id's of the vertices of the segments and the corresponding vertices table <edge_table>_vertices_pgr that stores the vertices information.

- Use **pgr_createVerticesTable** to create the vertices table.
- Use **pgr_createTopology** to create the topology and the vertices table.

Signatures

```
text pgr_analyzeOneWay(geom_table text,
                    text[] s_in_rules, text[] s_out_rules,
                    text[] t_in_rules, text[] t_out_rules,
                    text oneway='oneway', text source='source', text target='target',
                    boolean two_way_if_null=true);
```

Parameters

edge_table:
`text` Network table name. (may contain the schema name as well)
s_in_rules:
`text[]` source node **in** rules
s_out_rules:
`text[]` source node **out** rules
t_in_rules:
`text[]` target node **in** rules
t_out_rules:
`text[]` target node **out** rules
oneway:
`text` oneway column name name of the network table. Default value is `oneway`.
source:
`text` Source column name of the network table. Default value is `source`.
target:
`text` Target column name of the network table. Default value is `target`.
two_way_if_null:
`boolean` flag to treat oneway NULL values as bi-directional. Default value is `true`.

> **Note**
>
> It is strongly recommended to use the named notation. See **pgr_createVerticesTable** or **pgr_createTopology** for examples.

The function returns:

- `OK` after the analysis has finished.
  - Uses the vertices table: <edge_table>_vertices_pgr.
  - Fills completely the `ein` and `eout` columns of the vertices table.
- `FAIL` when the analysis was not completed due to an error.
  - The vertices table is not found.

- A required column of the Network table is not found or is not of the appropriate type.
- The names of source , target or oneway are the same.

The rules are defined as an array of text strings that if match the `oneway` value would be counted as `true` for the source or target **in** or **out** condition.

The Vertices Table

The vertices table can be created with **pgr_createVerticesTable** or **pgr_createTopology**

The structure of the vertices table is:

id:
`bigint` Identifier of the vertex.
cnt:
`integer` Number of vertices in the edge_table that reference this vertex. See **pgr_analyzeGgraph**.
chk:
`integer` Indicator that the vertex might have a problem. See **pgr_analyzeGraph**.
ein:
`integer` Number of vertices in the edge_table that reference this vertex as incoming.
eout:
`integer` Number of vertices in the edge_table that reference this vertex as outgoing.
the_geom:
`geometry` Point geometry of the vertex.

Additional Examples

```
SELECT pgr_analyzeOneWay('edge_table',
        ARRAY['', 'B', 'TF'],
        ARRAY['', 'B', 'FT'],
        ARRAY['', 'B', 'FT'],
        ARRAY['', 'B', 'TF'],
        oneway:='dir');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeOneway('edge_table','{"",B,TF}','{"",B,FT}','{"",B,FT}','{"",B,TF}','dir','source','target',t)
NOTICE:  Analyzing graph for one way street errors.
NOTICE:  Analysis 25% complete ...
NOTICE:  Analysis 50% complete ...
NOTICE:  Analysis 75% complete ...
NOTICE:  Analysis 100% complete ...
NOTICE:  Found 0 potential problems in directionality
 pgr_analyzeoneway
-------------------
 OK
(1 row)
```

The queries use the **Sample Data** network.

See Also

- **Topology - Family of Functions** for an overview of a topology for routing algorithms.
- **Graph Analytics** for an overview of the analysis of a graph.
- **pgr_analyzeGraph** to analyze the edges and vertices of the edge table.
- **pgr_createVerticesTable** to reconstruct the vertices table based on the source and target information.

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest** (**3.2**) **3.1** **3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2 2.1 2.0**

pgr_nodeNetwork

`pgr_nodeNetwork` - Nodes an network edge table.

Author:
Nicolas Ribot
Copyright:
Nicolas Ribot, The source code is released under the MIT-X license.

The function reads edges from a not “noded” network table and writes the “noded” edges into a new table.

```
pgr_nodenetwork(edge_table, tolerance, id, text the_geom, table_ending, rows_where, outall)
RETURNS TEXT
```

Availability

- Version 2.0.0
  - **Official** function

Description

The main characteristics are:

A common problem associated with bringing GIS data into pgRouting is the fact that the data is often not “noded” correctly. This will create invalid topologies, which will result in routes that are incorrect.

What we mean by “noded” is that at every intersection in the road network all the edges will be broken into separate road segments. There are cases like an over-pass and under-pass intersection where you can not traverse from the over-pass to the under-pass, but this function does not have the ability to detect and accommodate those situations.

This function reads the `edge_table` table, that has a primary key column `id` and geometry column named `the_geom` and intersect all the segments in it against all the other segments and then creates a table `edge_table_noded`. It uses the `tolerance` for deciding that multiple nodes within the tolerance are considered the same node.

Parameters

edge_table:
`text` Network table name. (may contain the schema name as well)
tolerance:
`float8` tolerance for coincident points (in projection unit)dd
id:
`text` Primary key column name of the network table. Default value is `id`.
the_geom:
`text` Geometry column name of the network table. Default value is `the_geom`.
table_ending:
`text` Suffix for the new table’s. Default value is `noded`.

The output table will have for `edge_table_noded`

id:
`bigint` Unique identifier for the table
old_id:
`bigint` Identifier of the edge in original table
sub_id:
`integer` Segment number of the original edge
source:
`integer` Empty source column to be used with **pgr_createTopology** function
target:
`integer` Empty target column to be used with **pgr_createTopology** function
the geom:
`geometry` Geometry column of the noded network

Examples

Let’s create the topology for the data in **Sample Data**

```
SELECT pgr_createTopology('edge_table', 0.001, clean := TRUE);
NOTICE:  PROCESSING:
NOTICE:  pgr_createTopology('edge_table', 0.001, 'the_geom', 'id', 'source', 'target', rows_where := 'true', clean := t)
NOTICE:  Performing checks, please wait .....
NOTICE:  Creating Topology, Please wait...
NOTICE:  -------------> TOPOLOGY CREATED FOR  18 edges
NOTICE:  Rows with NULL geometry or NULL id: 0
NOTICE:  Vertices table for table public.edge_table is: public.edge_table_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createtopology
--------------------
 OK
(1 row)
```

Now we can analyze the network.

```
SELECT pgr_analyzegraph('edge_table', 0.001);
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('edge_table',0.001,'the_geom','id','source','target','true')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 2
NOTICE:                            Dead ends: 7
NOTICE:  Potential gaps found near dead ends: 1
NOTICE:               Intersections detected: 1
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

The analysis tell us that the network has a gap and an intersection. We try to fix the problem using:

```
SELECT pgr_nodeNetwork('edge_table', 0.001);
NOTICE:  PROCESSING:
NOTICE:  id: id
NOTICE:  the_geom: the_geom
NOTICE:  table_ending: noded
NOTICE:  rows_where:
NOTICE:  outall: f
NOTICE:  pgr_nodeNetwork('edge_table', 0.001, 'id', 'the_geom', 'noded', '',  f)
NOTICE:  Performing checks, please wait .....
NOTICE:  Processing, please wait .....
NOTICE:    Split Edges: 3
NOTICE:   Untouched Edges: 15
NOTICE:       Total original Edges: 18
NOTICE:   Edges generated: 6
NOTICE:   Untouched Edges: 15
NOTICE:         Total New segments: 21
NOTICE:   New Table: public.edge_table_noded
NOTICE:  ----------------------------------
 pgr_nodenetwork
-----------------
 OK
(1 row)
```

Inspecting the generated table, we can see that edges 13,14 and 18 has been segmented

```
SELECT old_id, sub_id FROM edge_table_noded ORDER BY old_id, sub_id;
 old_id | sub_id
--------+--------
      1 |      1
      2 |      1
      3 |      1
      4 |      1
      5 |      1
      6 |      1
      7 |      1
      8 |      1
      9 |      1
     10 |      1
     11 |      1
     12 |      1
     13 |      1
     13 |      2
     14 |      1
     14 |      2
     15 |      1
     16 |      1
     17 |      1
     18 |      1
     18 |      2
(21 rows)
```

We can create the topology of the new network

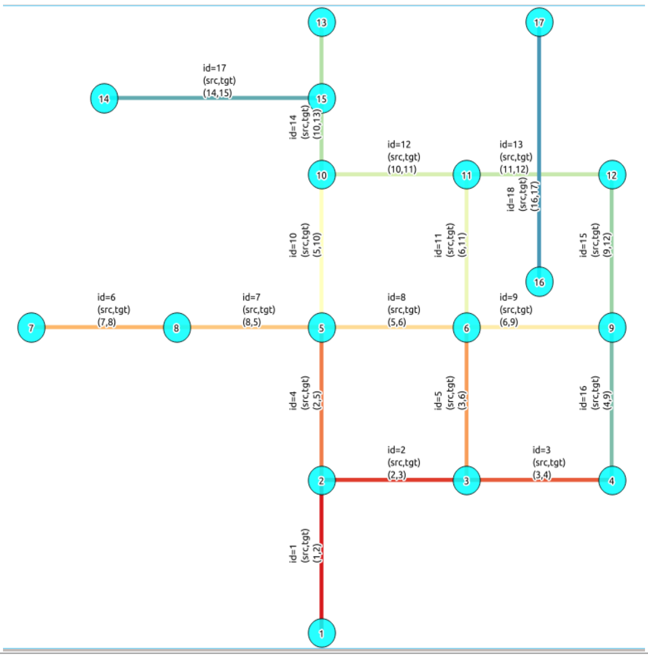
```
SELECT pgr_createTopology('edge_table_noded', 0.001);
NOTICE:  PROCESSING:
NOTICE:  pgr_createTopology('edge_table_noded', 0.001, 'the_geom', 'id', 'source', 'target', rows_where := 'true', clean := f)
NOTICE:  Performing checks, please wait .....
NOTICE:  Creating Topology, Please wait...
NOTICE:  -------------> TOPOLOGY CREATED FOR  21 edges
NOTICE:  Rows with NULL geometry or NULL id: 0
NOTICE:  Vertices table for table public.edge_table_noded is: public.edge_table_noded_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createtopology
--------------------
 OK
(1 row)
```

Now let’s analyze the new topology

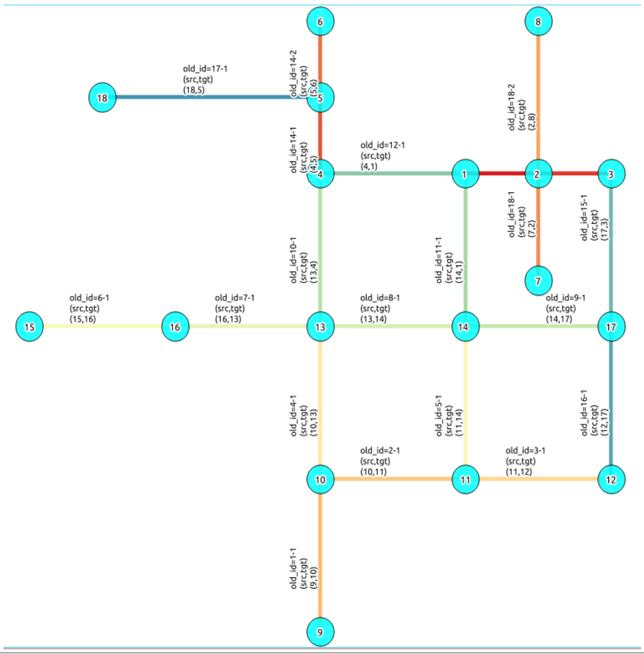
```
SELECT pgr_analyzegraph('edge_table_noded', 0.001);
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('edge_table_noded',0.001,'the_geom','id','source','target','true')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 0
NOTICE:                            Dead ends: 6
NOTICE:  Potential gaps found near dead ends: 0
NOTICE:               Intersections detected: 0
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

Images

Before Image



After Image



Comparing the results

Comparing with the Analysis in the original edge_table, we see that.

	Before	After
Table name	edge_table	edge_table_noded
Fields	All original fields	Has only basic fields to do a topology analysis
Dead ends	• Edges with 1 dead end: 1,6,24 • Edges with 2 dead ends 17,18 Edge 17’s right node is a dead end because there is no other edge sharing that same node. (cnt=1)	Edges with 1 dead end: 1-1 ,6-1,14-2, 18-1 17-1 18-2

	Before	After
Isolated segments	two isolated segments: 17 and 18 both they have 2 dead ends	No Isolated segments • Edge 17 now shares a node with edges 14-1 and 14-2 • Edges 18-1 and 18-2 share a node with edges 13-1 and 13-2
Gaps	There is a gap between edge 17 and 14 because edge 14 is near to the right node of edge 17	Edge 14 was segmented Now edges: 14-1 14-2 17 share the same node The tolerance value was taken in account
Intersections	Edges 13 and 18 were intersecting	Edges were segmented, So, now in the interection's point there is a node and the following edges share it: 13-1 13-2 18-1 18-2

Now, we are going to include the segments 13-1, 13-2 14-1, 14-2 ,18-1 and 18-2 into our edge-table, copying the data for dir,cost,and reverse cost with tho following steps:

- Add a column old_id into edge_table, this column is going to keep track the id of the original edge
- Insert only the segmented edges, that is, the ones whose max(sub_id) >1

```
alter table edge_table drop column if exists old_id;
NOTICE:  column "old_id" of relation "edge_table" does not exist, skipping
ALTER TABLE
alter table edge_table add column old_id integer;
ALTER TABLE
insert into edge_table (old_id, dir, cost, reverse_cost, the_geom)
   (with
      segmented as (select old_id,count(*) as i from edge_table_noded group by old_id)
   select  segments.old_id, dir, cost, reverse_cost, segments.the_geom
      from edge_table as edges join edge_table_noded as segments on (edges.id = segments.old_id)
      where edges.id in (select old_id from segmented where i>1) );
INSERT 0 6
```

We recreate the topology:

```
SELECT pgr_createTopology('edge_table', 0.001);
NOTICE:  PROCESSING:
NOTICE:  pgr_createTopology('edge_table', 0.001, 'the_geom', 'id', 'source', 'target', rows_where := 'true', clean := f)
NOTICE:  Performing checks, please wait .....
NOTICE:  Creating Topology, Please wait...
NOTICE:  -------------> TOPOLOGY CREATED FOR  6 edges
NOTICE:  Rows with NULL geometry or NULL id: 0
NOTICE:  Vertices table for table public.edge_table is: public.edge_table_vertices_pgr
NOTICE:  ----------------------------------------------
 pgr_createtopology
--------------------
 OK
(1 row)
```

To get the same analysis results as the topology of edge_table_noded, we do the following query:

```
SELECT pgr_analyzegraph('edge_table', 0.001, rows_where:='id not in (select old_id from edge_table where old_id is not null)');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('edge_table',0.001,'the_geom','id','source','target','id not in (select old_id from edge_table where old_id is not null)')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 0
NOTICE:                            Dead ends: 6
NOTICE:  Potential gaps found near dead ends: 0
NOTICE:               Intersections detected: 0
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

To get the same analysis results as the original edge_table, we do the following query:

```
SELECT pgr_analyzegraph('edge_table', 0.001, rows_where:='old_id is null');
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('edge_table',0.001,'the_geom','id','source','target','old_id is null')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 2
NOTICE:                            Dead ends: 7
NOTICE:  Potential gaps found near dead ends: 1
NOTICE:               Intersections detected: 1
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

Or we can analyze everything because, maybe edge 18 is an overpass, edge 14 is an under pass and there is also a street level juction, and the same happens with edges 17 and 13.

```
SELECT pgr_analyzegraph('edge_table', 0.001);
NOTICE:  PROCESSING:
NOTICE:  pgr_analyzeGraph('edge_table',0.001,'the_geom','id','source','target','true')
NOTICE:  Performing checks, please wait ...
NOTICE:  Analyzing for dead ends. Please wait...
NOTICE:  Analyzing for gaps. Please wait...
NOTICE:  Analyzing for isolated edges. Please wait...
NOTICE:  Analyzing for ring geometries. Please wait...
NOTICE:  Analyzing for intersections. Please wait...
NOTICE:              ANALYSIS RESULTS FOR SELECTED EDGES:
NOTICE:                    Isolated segments: 0
NOTICE:                            Dead ends: 3
NOTICE:  Potential gaps found near dead ends: 0
NOTICE:               Intersections detected: 5
NOTICE:                      Ring geometries: 0
 pgr_analyzegraph
------------------
 OK
(1 row)
```

See Also

Topology - Family of Functions for an overview of a topology for routing algorithms.**pgr_analyzeOneWay** to analyze directionality of the edges. **pgr_createTopology** to create a topology based on the geometry. **pgr_analyzeGraph** to analyze the edges and vertices of the edge table.

Indices and tables

- **Index**
- **Search Page**

See Also

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3**

Traveling Sales Person - Family of functions

- **pgr_TSP** - When input is given as matrix cell information.
- **pgr_TSPeuclidean** - When input are coordinates.

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2 2.1 2.0**

pgr_TSP

- `pgr_TSP` - Aproximation using *metric* algorithm.

Boost Graph Inside

Availability:

- Version 3.2.1
  - Metric Algorithm from **Boost library**
  - Simulated Annealing Algorithm no longer supported
    - The Simulated Annealing Algorithm related parameters are ignored: max_processing_time, tries_per_temperature, max_changes_per_temperature, max_consecutive_non_changes, initial_temperature, final_temperature, cooling_factor, randomize
- Version 2.3.0
  - Signature change
    - Old signature no longer supported
- Version 2.0.0
  - **Official** function

Description

Problem Definition

The travelling salesperson problem (TSP) asks the following question:

Given a list of cities and the distances between each pair of cities, which is the shortest possible route that visits each city exactly once and returns to the origin city?

General Characteristics

- This problem is an NP-hard optimization problem.
- Metric Algorithm is used
- Implementation generates solutions that *are twice as long as the optimal tour in the worst case* when:
  - Graph is undirected
  - Graph is fully connected
  - Graph where traveling costs on edges obey the triangle inequality.
- On an undirected graph:
  - The traveling costs are symmetric:
  - Traveling costs from `u` to `v` are just as much as traveling from `v` to `u`

Characteristics

- Can be Used with **Cost Matrix - Category** functions preferably with *directed => false*.
  - With `directed => false`
    - Will generate a graph that:
      - is undirected
      - is fully connected (As long as the graph has one component)
      - all traveling costs on edges obey the triangle inequality.
    - When `start_vid = 0 OR end_vid = 0`
      - The solutions generated is garanteed to be *twice as long as the optimal tour in the worst case*
    - When `start_vid != 0 AND end_vid != 0 AND start_vid != end_vid`
      - It is **not garanteed** that the solution will be, in the worse case, twice as long as the optimal tour, due to the fact that *end_vid* is forced to be in a fixed position.
  - With `directed => true`
    - It is **not garanteed** that the solution will be, in the worse case, twice as long as the optimal tour
    - Will generate a graph that:
      - is directed
      - is fully connected (As long as the graph has one component)
      - some (or all) traveling costs on edges might not obey the triangle inequality.
    - As an undirected graph is required, the directed graph is transformed as follows:
      - edges *(u, v)* and *(v, u)* is considered to be the same edge (denoted *(u, v)*
      - if `agg_cost` differs between one or more instances of edge *(u, v)*
      - The minimum value of the `agg_cost` all instances of edge *(u, v)* is going to be considered as the `agg_cost` of edge *(u, v)*
      - Some (or all) traveling costs on edges will still might not obey the triangle inequality.
- When the data is incomplete, but it is a connected graph, the missing values will be calculated with dijkstra algorithm.

Signatures

Summary

```
pgr_TSP(Matrix SQL, [start_id], [end_id])
RETURNS SETOF (seq, node, cost, agg_cost)
```

Example: Using pgr_dijkstraCostMatrix to generate the matrix information

- **Line 5** Vertices 15 to 18 are not included because they are not connected.

```
1 SELECT * FROM pgr_TSP(
2   $$
3   SELECT * FROM pgr_dijkstraCostMatrix(
4     'SELECT id, source, target, cost, reverse_cost FROM edge_table',
5     (SELECT array_agg(id) FROM edge_table_vertices_pgr WHERE id < 14),
6     directed => false)
7   $$);
8  seq | node | cost | agg_cost
9 -----+------+------+----------
10   1 |    1 |    0 |        0
11   2 |    2 |    1 |        1
12   3 |    3 |    1 |        2
13   4 |    4 |    1 |        3
14   5 |    9 |    1 |        4
15   6 |   12 |    1 |        5
16   7 |    6 |    2 |        7
17   8 |    5 |    1 |        8
18   9 |    8 |    1 |        9
19  10 |    7 |    1 |       10
20  11 |   10 |    3 |       13
21  12 |   11 |    1 |       14
22  13 |   13 |    2 |       16
23  14 |    1 |    4 |       20
24 (14 rows)
25
```

Parameters

Parameter	Type	Default	Description
Matrix SQL	TEXT		An SQL query, described in the **Matrix SQL** section.
start_vid	BIGINT	0	The first visiting vertex • When *0* any vertex can become the first visiting vertex.
end_vid	BIGINT	0	Last visiting vertex before returning to start_vid. • When 0 any vertex can become the last visiting vertex before returning to start_vid. • When NOT 0 and start_vid = 0 then it is the first and last vertex

Inner query

Matrix SQL

Matrix SQL: an SQL query, which should return a set of rows with the following columns:

Column	Type	Description
start_vid	ANY-INTEGER	Identifier of the starting vertex.
end_vid	ANY-INTEGER	Identifier of the ending vertex.
agg_cost	ANY-NUMERICAL	Cost for going from start_vid to end_vid

Result Columns

Returns SET OF (seq, node, cost, agg_cost)

Column	Type	Description
seq	INTEGER	Row sequence.
node	BIGINT	Identifier of the node/coordinate/point.
cost	FLOAT	Cost to traverse from the current node to the next node in the path sequence. • 0 for the last row in the tour sequence.
agg_cost	FLOAT	Aggregate cost from the node at seq = 1 to the current node. • 0 for the first row in the tour sequence.

Example:
Start from vertex \(7\)

- **Line 9** `start_vid => 7`

```
1  SELECT * FROM pgr_TSP(
2    $$
3    SELECT * FROM pgr_dijkstraCostMatrix(
4      'SELECT id, source, target, cost, reverse_cost FROM edge_table',
5      (SELECT array_agg(id) FROM edge_table_vertices_pgr WHERE id < 14),
6      directed => false
7    )
8    $$,
9    start_id => 7
10 );
11  seq | node | cost | agg_cost
12 -----+------+------+----------
13    1 |    7 |    0 |        0
14    2 |    8 |    1 |        1
15    3 |    5 |    1 |        2
16    4 |    2 |    1 |        3
17    5 |    1 |    1 |        4
18    6 |    3 |    2 |        6
19    7 |    4 |    1 |        7
20    8 |    9 |    1 |        8
21    9 |   12 |    1 |        9
22   10 |   11 |    1 |       10
23   11 |    6 |    1 |       11
24   12 |   10 |    2 |       13
25   13 |   13 |    1 |       14
26   14 |    7 |    4 |       18
27 (14 rows)
28
```

Example:
Using points of interest to generate an asymetric matrix.

To generate an asymmetric matrix:

- **Line 5** The `side` information of pointsOfInterset is ignored by not including it in the query
- **Line 7** Generating an asymetric matrix with `directed => true`
  - \(min(agg_cost(u, v), agg_cost(v, u))\) is going to be considered as the `agg_cost`
  - The solution that can be larger than *twice as long as the optimal tour* because:
    - Triangle inequality might not be satisfied.
    - `start_id != 0 AND end_id != 0`

```
1  SELECT * FROM pgr_TSP(
2    $$
3    SELECT * FROM pgr_withPointsCostMatrix(
4      'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
5      'SELECT pid, edge_id, fraction from pointsOfInterest',
6      array[-1, 3, 5, 6, -6],
7      directed => true)
8    $$,
9    start_id => 5,
10   end_id => 6
11 );
12  seq | node | cost | agg_cost
13 -----+------+------+----------
14    1 |    5 |    0 |        0
15    2 |   -6 |  0.3 |      0.3
16    3 |   -1 |  1.3 |      1.6
17    4 |    3 |  1.6 |      3.2
18    5 |    6 |    1 |      4.2
19    6 |    5 |    1 |      5.2
20 (6 rows)
21
```

Example:
Connected incomplete data

Using selected edges (2, 4, 5, 8, 9, 15) the matrix is not complete but it is connected

```
SELECT source AS start_vid, target AS end_vid, 1 AS agg_cost
FROM edge_table WHERE id IN (2,4,5,8, 9, 15);
 start_vid | end_vid | agg_cost
-----------+---------+----------
         2 |       3 |        1
         2 |       5 |        1
         3 |       6 |        1
         5 |       6 |        1
         6 |       9 |        1
         9 |      12 |        1
(6 rows)

```

Edge *(5,12)* does not exist on the initial data, but it is calculated internally.

```
SELECT * FROM pgr_TSP(
  $$
  SELECT source AS start_vid, target AS end_vid, 1 AS agg_cost
  FROM edge_table
  WHERE id IN (2,4,5,8,9,15)
  $$);
 seq | node | cost | agg_cost
-----+------+------+----------
   1 |    2 |    0 |        0
   2 |    3 |    1 |        1
   3 |    6 |    1 |        2
   4 |   12 |    1 |        3
   5 |    9 |    1 |        4
   6 |    5 |    1 |        5
   7 |    2 |    1 |        6
(7 rows)

```

The queries use the **Sample Data** network.

See Also

- **Traveling Sales Person - Family of functions**
- Metric Algorithm from **Boost library**
- **Boost library**
- **Wikipedia: Traveling Salesman Problem**

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest** (**3.2**) **3.1 3.0**
- **Unsupported versions: 2.5 2.4 2.3**

pgr_TSPeuclidean

- `pgr_TSPeuclidean` - Aproximation using *metric* algorithm.

Boost Graph Inside

Availability:

- Version 3.2.1
  - Metric Algorithm from **Boost library**
  - Simulated Annealing Algorithm no longer supported
    - The Simulated Annealing Algorithm related parameters are ignored: max_processing_time, tries_per_temperature, max_changes_per_temperature, max_consecutive_non_changes, initial_temperature, final_temperature, cooling_factor, randomize
- Version 3.0.0
  - Name change from pgr_eucledianTSP
- Version 2.3.0
  - New **Official** function

Description

Problem Definition

The travelling salesperson problem (TSP) asks the following question:

Given a list of cities and the distances between each pair of cities, which is the shortest possible route that visits each city exactly once and returns to the origin city?

General Characteristics

- This problem is an NP-hard optimization problem.
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- Implementation generates solutions that *are twice as long as the optimal tour in the worst case* when:
  - Graph is undirected
  - Graph is fully connected
  - Graph where traveling costs on edges obey the triangle inequality.
- On an undirected graph:
  - The traveling costs are symmetric:
  - Traveling costs from `u` to `v` are just as much as traveling from `v` to `u`

Characteristics

- Duplicated identifiers with different coordinates are not allowed
  - The coordinates are quite the same for the same identifier, for example

```
1, 3.5, 1
1, 3.499999999999 0.9999999
```

  - The coordinates are quite different for the same identifier, for example

```
2 , 3.5, 1.0
2 , 3.6, 1.1
```

  - Any duplicated identifier will be ignored. The coordinates that will be kept is arbitrarly.

Signatures

Summary

```
pgr_TSPeuclidean(Coordinates SQL, [start_id], [end_id])
RETURNS SETOF (seq, node, cost, agg_cost)
```

Example:
With default values

```
SELECT * FROM pgr_TSPeuclidean(
    $$
    SELECT id, st_X(the_geom) AS x, st_Y(the_geom)AS y  FROM edge_table_vertices_pgr
    $$);
 seq | node |      cost      |   agg_cost
-----+------+----------------+---------------
   1 |    1 |              0 |             0
   2 |    2 |              1 |             1
   3 |    8 |  1.41421356237 | 2.41421356237
   4 |    7 |              1 | 3.41421356237
   5 |   14 |  1.58113883008 | 4.99535239246
   6 |   15 |            1.5 | 6.49535239246
   7 |   13 |            0.5 | 6.99535239246
   8 |   17 |            1.5 | 8.49535239246
   9 |   12 |  1.11803398875 | 9.61338638121
  10 |    9 |              1 | 10.6133863812
  11 |   16 | 0.583095189485 | 11.1964815707
  12 |    6 | 0.583095189485 | 11.7795767602
  13 |   11 |              1 | 12.7795767602
  14 |   10 |              1 | 13.7795767602
  15 |    5 |              1 | 14.7795767602
  16 |    4 |  2.2360679775 | 17.0156447377
  17 |    3 |              1 | 18.0156447377
  18 |    1 |  1.41421356237 |    19.4298583
(18 rows)
```

Parameters

Parameter	Type	Default	Description
Coordinates SQL	`TEXT`		An SQL query, described in the **Coordinates SQL** section

Parameter	Type	Default	Description
start_vid	BIGINT	0	The first visiting vertex • When *0* any vertex can become the first visiting vertex.
end_vid	BIGINT	0	Last visiting vertex before returning to start_vid. • When 0 any vertex can become the last visiting vertex before returning to start_vid. • When NOT 0 and start_vid = 0 then it is the first and last vertex

Inner query

Coordinates SQL

Coordinates SQL: an SQL query, which should return a set of rows with the following columns:

Column	Type	Description
id	ANY-INTEGER	Identifier of the starting vertex.
x	ANY-NUMERICAL	X value of the coordinate.
y	ANY-NUMERICAL	Y value of the coordinate.

Result Columns

Returns SET OF (seq, node, cost, agg_cost)

Column	Type	Description
seq	INTEGER	Row sequence.
node	BIGINT	Identifier of the node/coordinate/point.
cost	FLOAT	Cost to traverse from the current node to the next node in the path sequence. • 0 for the last row in the tour sequence.
agg_cost	FLOAT	Aggregate cost from the node at seq = 1 to the current node. • 0 for the first row in the tour sequence.

Additional Examples

Example:
Test 29 cities of Western Sahara

This example shows how to make performance tests using University of Waterloo's **example data** using the 29 cities of **Western Sahara dataset**

Creating a table for the data and storing the data

```
CREATE TABLE wi29 (id BIGINT, x FLOAT, y FLOAT, geom geometry);
INSERT INTO wi29 (id, x, y) VALUES
(1,20833.3333,17100.0000),
(2,20900.0000,17066.6667),
(3,21300.0000,13016.6667),
(4,21600.0000,14150.0000),
(5,21600.0000,14966.6667),
(6,21600.0000,16500.0000),
(7,22183.3333,13133.3333),
(8,22583.3333,14300.0000),
(9,22683.3333,12716.6667),
(10,23616.6667,15866.6667),
(11,23700.0000,15933.3333),
(12,23883.3333,14533.3333),
(13,24166.6667,13250.0000),
(14,25149.1667,12365.8333),
(15,26133.3333,14500.0000),
(16,26150.0000,10550.0000),
(17,26283.3333,12766.6667),
(18,26433.3333,13433.3333),
(19,26550.0000,13850.0000),
(20,26733.3333,11683.3333),
(21,27026.1111,13051.9444),
(22,27096.1111,13415.8333),
(23,27153.6111,13203.3333),
(24,27166.6667,9833.3333),
(25,27233.3333,10450.0000),
(26,27233.3333,11783.3333),
(27,27266.6667,10383.3333),
(28,27433.3333,12400.0000),
(29,27462.5000,12992.2222);
```

Adding a geometry (for visual purposes)

```
UPDATE wi29 SET geom = ST_makePoint(x,y);
```

Getting a total cost of the tour, compare the value with the length of an optimal tour is 27603, given on the dataset

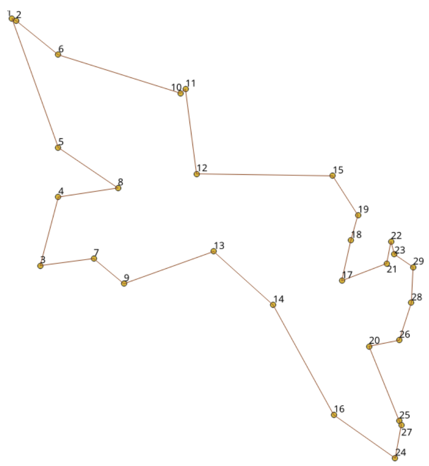
```
SELECT *
FROM pgr_TSPeuclidean($$SELECT * FROM wi29$$)
WHERE seq = 30;
 seq | node |      cost      |   agg_cost
-----+------+---------------+---------------
  30 |    1 | 2266.91173136 | 28777.4854127
(1 row)
```

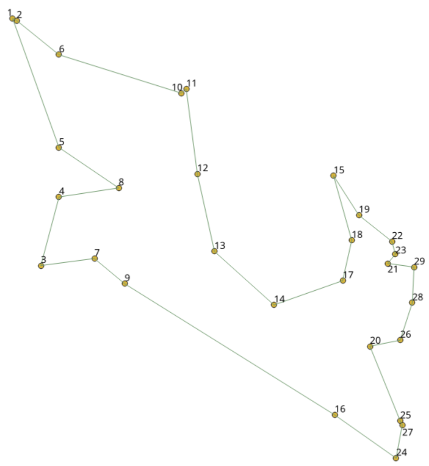
Getting a geometry of the tour

```
WITH
tsp_results AS (SELECT seq, geom FROM pgr_TSPeuclidean($$SELECT * FROM wi29$$) JOIN wi29 ON (node = id))
SELECT ST_MakeLine(ARRAY(SELECT geom FROM tsp_results ORDER BY seq));

--------------------------------------------------------------------------------------------------------------------------------------
 01020000001E000000F085C9545558D4400000000000B3D040000000000069D440107A36ABAAAAD040000000000018D54000000000001DD040107A36AB2A10D
(1 row)
```

Visualy, The first image is the **optimal solution** and the second image is the solution obtained with `pgr_TSPeuclidean`.





See Also

- **Traveling Sales Person - Family of functions**

- **Sample Data** network.
- Metric Algorithm from **Boost library**
- **University of Waterloo TSP**
- **Wikipedia: Traveling Salesman Problem**

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Table of Contents

General Information

Problem Definition

The travelling salesperson problem (TSP) asks the following question:

Given a list of cities and the distances between each pair of cities, which is the shortest possible route that visits each city exactly once and returns to the origin city?

Origin

The traveling sales person problem was studied in the 18th century by mathematicians

Sir William Rowam Hamilton and **Thomas Penyngton Kirkman**.

A discussion about the work of Hamilton & Kirkman can be found in the book **Graph Theory (Biggs et al. 1976)**.

- ISBN-13: 978-0198539162
- ISBN-10: 0198539169

It is believed that the general form of the TSP have been first studied by Kalr Menger in Vienna and Harvard. The problem was later promoted by Hassler, Whitney & Merrill at Princeton. A detailed description about the connection between Menger & Whitney, and the development of the TSP can be found in **On the history of combinatorial optimization (till 1960)**

To calculate the number of different tours through \(n\) cities:

- Given a starting city,
- There are \(n-1\) choices for the second city,
- And \(n-2\) choices for the third city, etc.
- Multiplying these together we get \((n-1)! = (n-1) (n-2) . . 1\).
- Now since the travel costs do not depend on the direction taken around the tour:
  - this number by 2
  - \((n-1)!/2\).

General Characteristics

- This problem is an NP-hard optimization problem.
- Metric Algorithm is used
- Implementation generates solutions that *are twice as long as the optimal tour in the worst case* when:
  - Graph is undirected
  - Graph is fully connected
  - Graph where traveling costs on edges obey the triangle inequality.
- On an undirected graph:
  - The traveling costs are symmetric:
  - Traveling costs from `u` to `v` are just as much as traveling from `v` to `u`

See Also

References

- Metric Algorithm from **Boost library**
- **University of Waterloo TSP**
- **Wikipedia: Traveling Salesman Problem**

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.1 3.0**

Spanning Tree - Category

- **Kruskal - Family of functions**
- **Prim - Family of functions**

A spanning tree of an undirected graph is a tree that includes all the vertices of G with the minimum possible number of edges.

For a disconnected graph, there there is no single tree, but a spanning forest, consisting of a spanning tree of each connected component.

See Also

- **Boost: Prim's algorithm documentation**
- **Wikipedia: Prim's algorithm**

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.1) 3.0**
- **Unsupported versions: 2.5 2.4 2.6**

K shortest paths - Category

- **pgr_KSP** - Yen's algorithm based on pgr_dijkstra

Proposed

> **Warning**
>
> Proposed functions for next mayor release.
>
> - They are not officially in the current release.
> - They will likely officially be part of the next mayor release:
>   - The functions make use of ANY-INTEGER and ANY-NUMERICAL
>   - Name might not change. (But still can)
>   - Signature might not change. (But still can)
>   - Functionality might not change. (But still can)
>   - pgTap tests have being done. But might need more.
>   - Documentation might need refinement.

- **pgr_withPointsKSP - Proposed** - Yen's algorithm based on pgr_withPoints

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2 2.1 2.0**

pgr_trsp - Turn Restriction Shortest Path (TRSP)

`pgr_trsp` — Returns the shortest path with support for turn restrictions.

Availability

- Version 2.1.0
  - New *Via* **prototypes**

        - pgr_trspViaVertices
        - pgr_trspViaEdges
- Version 2.0.0
    - **Official** function

Description

The turn restricted shortest path (TRSP) is a shortest path algorithm that can optionally take into account complicated turn restrictions like those found in real world navigable road networks. Performamnce wise it is nearly as fast as the A* search but has many additional features like it works with edges rather than the nodes of the network. Returns a set of (seq, id1, id2, cost) or (seq, id1, id2, id3, cost) rows, that make up a path.

```
pgr_trsp(sql text, source integer, target integer,
            directed boolean, has_rcost boolean [,restrict_sql text]);
RETURNS SETOF (seq, id1, id2, cost)
```

```
pgr_trsp(sql text, source_edge integer, source_pos float8,
              target_edge integer, target_pos float8,
            directed boolean, has_rcost boolean [,restrict_sql text]);
RETURNS SETOF (seq, id1, id2, cost)
```

```
pgr_trspViaVertices(sql text, vids integer[],
            directed boolean, has_rcost boolean
            [, turn_restrict_sql text]);
RETURNS SETOF (seq, id1, id2, id3, cost)
```

```
pgr_trspViaEdges(sql text, eids integer[], pcts float8[],
            directed boolean, has_rcost boolean
            [, turn_restrict_sql text]);
RETURNS SETOF (seq, id1, id2, id3, cost)
```

The main characteristics are:

The Turn Restricted Shortest Path algorithm (TRSP) is similar to the shooting star in that you can specify turn restrictions.

The TRSP setup is mostly the same as **Dijkstra shortest path** with the addition of an optional turn restriction table. This provides an easy way of adding turn restrictions to a road network by placing them in a separate table.

sql:
a SQL query, which should return a set of rows with the following columns:

```
SELECT id, source, target, cost, [,reverse_cost] FROM edge_table
```

id:
`int4` identifier of the edge
source:
`int4` identifier of the source vertex
target:
`int4` identifier of the target vertex
cost:
`float8` value, of the edge traversal cost. A negative cost will prevent the edge from being inserted in the graph.
reverse_cost:
(optional) the cost for the reverse traversal of the edge. This is only used when the `directed` and `has_rcost` parameters are `true` (see the above remark about negative costs).

source:
`int4` **NODE id** of the start point
target:
`int4` **NODE id** of the end point
directed:
`true` if the graph is directed
has_rcost:
if `true`, the `reverse_cost` column of the SQL generated set of rows will be used for the cost of the traversal of the edge in the opposite direction.
restrict_sql:
(optional) a SQL query, which should return a set of rows with the following columns:

```
SELECT to_cost, target_id, via_path FROM restrictions
```

to_cost:
`float8` turn restriction cost

target_id:
`int4` target id
via_path:
`text` comma separated list of edges in the reverse order of `rule`

Another variant of TRSP allows to specify **EDGE id** of source and target together with a fraction to interpolate the position:

source_edge:
`int4` **EDGE id** of the start edge
source_pos:
`float8` fraction of 1 defines the position on the start edge
target_edge:
`int4` **EDGE id** of the end edge
target_pos:
`float8` fraction of 1 defines the position on the end edge

Returns set of:

seq:
row sequence
id1:
node ID
id2:
edge ID (`-1` for the last row)
cost:
cost to traverse from `id1` using `id2`

Support for Vias

Warning

The Support for Vias functions are prototypes. Not all corner cases are being considered.

We also have support for vias where you can say generate a from A to B to C, etc. We support both methods above only you pass an array of vertices or and array of edges and percentage position along the edge in two arrays.

sql:
a SQL query, which should return a set of rows with the following columns:

```
SELECT id, source, target, cost, [,reverse_cost] FROM edge_table
```

id:
`int4` identifier of the edge
source:
`int4` identifier of the source vertex
target:
`int4` identifier of the target vertex
cost:
`float8` value, of the edge traversal cost. A negative cost will prevent the edge from being inserted in the graph.
reverse_cost:
(optional) the cost for the reverse traversal of the edge. This is only used when the `directed` and `has_rcost` parameters are `true` (see the above remark about negative costs).

vids:
`int4[]` An ordered array of **NODE id** the path will go through from start to end.
directed:
`true` if the graph is directed
has_rcost:
if `true`, the `reverse_cost` column of the SQL generated set of rows will be used for the cost of the traversal of the edge in the opposite direction.
restrict_sql:
(optional) a SQL query, which should return a set of rows with the following columns:

```
SELECT to_cost, target_id, via_path FROM restrictions
```

to_cost:
`float8` turn restriction cost
target_id:

`int4` target id

via_path:

`text` commar separated list of edges in the reverse order of`rule`

Another variant of TRSP allows to specify **EDGE id** together with a fraction to interpolate the position:

eids:
`int4` An ordered array of **EDGE id** that the path has to traverse

pcts:
`float8` An array of fractional positions along the respective edges in`eids`, where 0.0 is the start of the edge and 1.0 is the end of the eadge.

Returns set of:

seq:
row sequence

id1:
route ID

id2:
node ID

id3:
edge ID (`-1` for the last row)

cost:
cost to traverse from `id2` using `id3`

Additional Examples

Example:
Without turn restrictions

```
SELECT * FROM pgr_trsp(
        'SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost FROM edge_table',
        7, 12, false, false
    );
 seq | id1 | id2 | cost
-----+-----+-----+------
   0 |   7 |   6 |    1
   1 |   8 |   7 |    1
   2 |   5 |   8 |    1
   3 |   6 |   9 |    1
   4 |   9 |  15 |    1
   5 |  12 |  -1 |    0
(6 rows)
```

Example:
With turn restrictions

Then a query with turn restrictions is created as:

```
SELECT * FROM pgr_trsp(
        'SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost FROM edge_table',
        2, 7, false, false,
        'SELECT to_cost, target_id::int4,
        from_edge || coalesce('','' || via_path, '''') AS via_path
        FROM restrictions'
    );
 seq | id1 | id2 | cost
-----+-----+-----+------
   0 |   2 |   4 |    1
   1 |   5 |  10 |    1
   2 |  10 |  12 |    1
   3 |  11 |  11 |    1
   4 |   6 |   8 |    1
   5 |   5 |   7 |    1
   6 |   8 |   6 |    1
   7 |   7 |  -1 |    0
(8 rows)

SELECT * FROM pgr_trsp(
        'SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost FROM edge_table',
        7, 11, false, false,
        'SELECT to_cost, target_id::int4,
        from_edge || coalesce('','' || via_path, '''') AS via_path
        FROM restrictions'
    );
 seq | id1 | id2 | cost
-----+-----+-----+------
   0 |   7 |   6 |    1
   1 |   8 |   7 |    1
   2 |   5 |   8 |    1
   3 |   6 |   9 |    1
   4 |   9 |  15 |    1
   5 |  12 |  13 |    1
   6 |  11 |  -1 |    0
(7 rows)
```

An example query using vertex ids and via points:

```
SELECT * FROM pgr_trspViaVertices(
        'SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost FROM edge_table',
        ARRAY[2,7,11]::INTEGER[],
        false,  false,
        'SELECT to_cost, target_id::int4, from_edge ||
        coalesce('',''||via_path,'''') AS via_path FROM restrictions');
 seq | id1 | id2 | id3 | cost
-----+-----+-----+-----+------
   1 |   1 |   2 |   4 |    1
   2 |   1 |   5 |  10 |    1
   3 |   1 |  10 |  12 |    1
   4 |   1 |  11 |  11 |    1
   5 |   1 |   6 |   8 |    1
   6 |   1 |   5 |   7 |    1
   7 |   1 |   8 |   6 |    1
   8 |   2 |   7 |   6 |    1
   9 |   2 |   8 |   7 |    1
  10 |   2 |   5 |   8 |    1
  11 |   2 |   6 |   9 |    1
  12 |   2 |   9 |  15 |    1
  13 |   2 |  12 |  13 |    1
  14 |   2 |  11 |  -1 |    0
(14 rows)
```

An example query using edge ids and vias:

```
SELECT * FROM pgr_trspViaEdges(
        'SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost,
        reverse_cost FROM edge_table',
        ARRAY[2,7,11]::INTEGER[],
        ARRAY[0.5, 0.5, 0.5]::FLOAT[],
        true,
        true,
        'SELECT to_cost, target_id::int4, FROM_edge ||
        coalesce(','||via_path,'') AS via_path FROM restrictions');
 seq | id1 | id2 | id3 | cost
-----+-----+-----+-----+------
   1 |   1 |  -1 |   2 |  0.5
   2 |   1 |   2 |   4 |    1
   3 |   1 |   5 |   8 |    1
   4 |   1 |   6 |   9 |    1
   5 |   1 |   9 |  16 |    1
   6 |   1 |   4 |   3 |    1
   7 |   1 |   3 |   5 |    1
   8 |   1 |   6 |   8 |    1
   9 |   1 |   5 |   7 |    1
  10 |   2 |   5 |   8 |    1
  11 |   2 |   6 |   9 |    1
  12 |   2 |   9 |  16 |    1
  13 |   2 |   4 |   3 |    1
  14 |   2 |   3 |   5 |    1
  15 |   2 |   6 |  11 |  0.5
(15 rows)
```

The queries use the **Sample Data** network.

Known Issues

Introduction

pgr_trsp code has issues that are not being fixed yet, but as time passes and new functionality is added to pgRouting with wrappers to **hide** the issues, not to fix them.

For clarity on the queries:

- _pgr_trsp (internal_function) is the original code
- pgr_trsp (lower case) represents the wrapper calling the original code
- pgr_TRSP (upper case) represents the wrapper calling the replacement function, depending on the function, it can be:
  - pgr_dijkstra
  - pgr_dijkstraVia
  - pgr_withPoints
  - _pgr_withPointsVia (internal function)

The restrictions

The restriction used in the examples does not have to do anything with the graph:

- No vertex has id: 25, 32 or 33
- No edge has id: 25, 32 or 33

A restriction is assigned as:

```
SELECT 100::float AS to_cost, 25::INTEGER AS target_id, '32, 33'::TEXT AS via_path;
 to_cost | target_id | via_path
---------+-----------+----------
     100 |        25 | 32, 33
(1 row)
```

The back end code has that same restriction as follows

```
SELECT 1 AS id, 100::float AS cost, 25::INTEGER AS target_id, ARRAY[33, 32, 25] AS path;
 id | cost | target_id |    path
----+------+-----------+------------
  1 |  100 |        25 | {33,32,25}
(1 row)
```

therefore the shortest path expected are as if there was no restriction involved

The “Vertices” signature version

```
pgr_trsp(sql text, source integer, target integer,
        directed boolean, has_rcost boolean [,restrict_sql text]);
```

Different ways to represent 'no path found`

- Sometimes represents with EMPTY SET a no path found
- Sometimes represents with Error a no path found

Returning EMPTY SET to represent no path found

```
SELECT * FROM pgr_trsp(
    $$SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost, reverse_cost  FROM edge_table$$,
    1, 15, true, true
);
 seq | id1 | id2 | cost
-----+-----+-----+------
(0 rows)
```

pgr_trsp calls **pgr_dijkstra** when there are no restrictions which returns *EMPTY SET* when a path is not found

```
SELECT * FROM pgr_dijkstra(
    $$SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost, reverse_cost  FROM edge_table$$,
    1, 15
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
(0 rows)
```

Throwing EXCEPTION to represent no path found

```
SELECT * FROM pgr_trsp(
     $$SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost, reverse_cost  FROM edge_table$$,
     1, 15, true, true,
     $$SELECT 100::float AS to_cost, 25::INTEGER AS target_id, '32, 33'::TEXT AS via_path$$
);
ERROR:  Error computing path: Path Not Found
```

pgr_trsp use the original code when there are restrictions, even if they have nothing to do with the graph, which will throw an EXCEPTION to represent no path found.

Routing from/to same location

When routing from location\(1\) to the same location\(1\), no path is needed to reach the destination, its already there. Therefore is expected to return an *EMPTY SET* or an *EXCEPTION* depending on the parameters

- Sometimes represents with EMPTY SET no path found (expected)
- Sometimes represents with EXCEPTION no path found (expected)
- Sometimes finds a path (not expected)

Returning expected EMPTY SET to represent no path found

```
SELECT * FROM pgr_trsp(
    $$SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost, reverse_cost FROM edge_table$$,
    1, 1,  true, true
);
 seq | id1 | id2 | cost
-----+-----+-----+------
(0 rows)
```

`pgr_trsp` calls **pgr_dijkstra** when there are no restrictions which returns the expected to return *EMPTY SET* to represent no path found.

Returning expected EXCEPTION to represent no path found

```
SELECT * FROM pgr_trsp(
    $$SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost, reverse_cost FROM edge_table$$,
    14, 14, true, true,
    $$SELECT 100::float AS to_cost, 25::INTEGER AS target_id, '32, 33'::TEXT AS via_path$$
);
ERROR:  Error computing path: Path Not Found
```

In this case `pgr_trsp` calls the original code when there are restrictions, even if they have nothing to do with the graph, in this case that code throws the expected EXCEPTION

Returning unexpected path

```
SELECT * FROM pgr_trsp(
    $$SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost, reverse_cost FROM edge_table$$,
    1, 1, true, true,
    $$SELECT 100::float AS to_cost, 25::INTEGER AS target_id, '32, 33'::TEXT AS via_path$$
);
 seq | id1 | id2 | cost
-----+-----+-----+------
   0 |   1 |   1 |    1
   1 |   2 |   4 |    1
   2 |   5 |   8 |    1
   3 |   6 |   9 |    1
   4 |   9 |  16 |    1
   5 |   4 |   3 |    1
   6 |   3 |   2 |    1
   7 |   2 |   1 |    1
   8 |   1 |  -1 |    0
(9 rows)
```

In this case `pgr_trsp` calls the original code when there are restrictions, even if they have nothing to do with the graph, in this case that code finds an unexpected path.

User contradictions

`pgr_trsp` unlike other pgRouting functions does not autodectect the existence of`reverse_cost` column. Therefor it has`has_rcost` parameter to check the existence of `reverse_cost` column. Contradictions happen:

- When the reverse_cost is missing, and the flag*has_rcost* is set to true
- When the reverse_cost exists, and the flag*has_rcost* is set to false

When the reverse_cost is missing, and the flag *has_rcost* is set to true.

```
SELECT * FROM pgr_trsp(
    $$SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost FROM edge_table$$,
    2, 3, false, true,
    $$SELECT 100::float AS to_cost, 25::INTEGER AS target_id, '32, 33'::TEXT AS via_path$$
);
ERROR:  Error, reverse_cost is used, but query did't return 'reverse_cost' column
```

An EXCEPTION is thrown.

When the reverse_cost exists, and the flag *has_rcost* is set to false

```
SELECT * FROM pgr_trsp(
    $$SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost, reverse_cost FROM edge_table$$,
    2, 3, false, false,
    $$SELECT 100::float AS to_cost, 25::INTEGER AS target_id, '32, 33'::TEXT AS via_path$$
);
 seq | id1 | id2 | cost
-----+-----+-----+------
   0 |   2 |   4 |    1
   1 |   5 |   8 |    1
   2 |   6 |   5 |    1
   3 |   3 |  -1 |    0
(4 rows)
```

The `reverse_cost` column will be effectively removed and will cost execution time

The “Edges” signature version

```
pgr_trsp(sql text, source_edge integer, source_pos float8,
         target_edge integer, target_pos float8,
         directed boolean, has_rcost boolean [,restrict_sql text]);
```

Different ways to represent ‘no path found`

- Sometimes represents with EMPTY SET a no path found
- Sometimes represents with EXCEPTION a no path found

Returning EMPTY SET to represent no path found

```
SELECT * FROM pgr_trsp(
    $$SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost, reverse_cost  FROM edge_table$$,
    1, 0.5, 17, 0.5, true, true
);
 seq | id1 | id2 | cost
-----+-----+-----+------
(0 rows)
```

pgr_trsp calls **pgr_withPoints - Proposed** when there are no restrictions which returns *EMPTY SET* when a path is not found

Throwing EXCEPTION to represent no path found

```
SELECT * FROM _pgr_trsp(
    $$SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost, reverse_cost  FROM edge_table$$,
    1, 0.5, 17, 0.5, true, true,
    $$SELECT 100::float AS to_cost, 25::INTEGER AS target_id, '32, 33'::TEXT AS via_path$$
);
ERROR:  Error computing path: Path Not Found
```

pgr_trsp use the original code when there are restrictions, even if they have nothing to do with the graph, which will throw an EXCEPTION to represent no path found.

Paths with equal number of vertices and edges

A path is made of *N* vertices and *N - 1* edges.

- Sometimes returns *N* vertices and *N - 1* edges.
- Sometimes returns *N - 1* vertices and *N - 1* edges.

Returning *N* vertices and *N - 1* edges.

```
SELECT * FROM pgr_TRSP(
    $$SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost, reverse_cost  FROM edge_table$$,
    1, 0.5, 1, 0.8, true, true
);
 seq | id1 | id2 | cost
-----+-----+-----+------
   0 |  -1 |   1 |  0.3
   1 |  -2 |  -1 |    0
(2 rows)
```

pgr_trsp calls **pgr_withPoints - Proposed** when there are no restrictions which returns the correct number of rows that will include all the vertices. The last row will have a `-1` on the edge column to indicate the edge number is invalidu for that row.

Returning *N - 1* vertices and *N - 1* edges.

```
SELECT * FROM pgr_TRSP(
    $$SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost, reverse_cost  FROM edge_table$$,
    1, 0.5, 1, 0.8, true, true,
    $$SELECT 100::float AS to_cost, 25::INTEGER AS target_id, '32, 33'::TEXT AS via_path$$
);
 seq | id1 | id2 | cost
-----+-----+-----+------
   0 |  -1 |   1 |  0.3
(1 row)
```

pgr_trsp use the original code when there are restrictions, even if they have nothing to do with the graph, and will not return the last vertex of the path.

Routing from/to same location

When routing from the same edge and position to the same edge and position, no path is needed to reach the destination, its already there. Therefore is expected to return an *EMPTY SET* or an *EXCEPTION* depending on the parameters, non of which is happening.

A path with 2 vertices and edge cost 0

```
SELECT * FROM pgr_TRSP(
    $$SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost, reverse_cost  FROM edge_table$$,
    1, 0.5, 1, 0.5, true, true
);
 seq | id1 | id2 | cost
-----+-----+-----+------
   0 |  -1 |   1 |    0
   1 |  -2 |  -1 |    0
(2 rows)
```

pgr_trsp calls **pgr_withPoints - Proposed** setting the first\((edge, position)\) with a differenct point id from the second\((edge, position)\) making them different points. But the cost using the edge, is\(0\).

A path with 1 vertices and edge cost 0

```
SELECT * FROM pgr_TRSP(
    $$SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost, reverse_cost  FROM edge_table$$,
    1, 0.5, 1, 0.5, true, true,
    $$SELECT 100::float AS to_cost, 25::INTEGER AS target_id, '32, 33'::TEXT AS via_path$$
);
 seq | id1 | id2 | cost
-----+-----+-----+------
   0 |  -1 |   1 |    0
(1 row)
```

pgr_trsp use the original code when there are restrictions, even if they have nothing to do with the graph, and will not have the row for the vertex \(-2\).

User contradictions

`pgr_trsp` unlike other pgRouting functions does not autodectect the existence of`reverse_cost` column. Therefor it has`has_rcost` parameter to check the existence of `reverse_cost` column. Contradictions happen:

- When the reverse_cost is missing, and the flag*has_rcost* is set to true
- When the reverse_cost exists, and the flag*has_rcost* is set to false

When the reverse_cost is missing, and the flag *has_rcost* is set to true.

```
SELECT * FROM pgr_trsp(
    $$SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost FROM edge_table$$,
    1, 0.5, 1, 0.8, false, true,
    $$SELECT 100::float AS to_cost, 25::INTEGER AS target_id, '32, 33'::TEXT AS via_path$$
);
ERROR:  Error, reverse_cost is used, but query did't return 'reverse_cost' column
```

An EXCEPTION is thrown.

When the reverse_cost exists, and the flag *has_rcost* is set to false

```
SELECT * FROM pgr_trsp(
    $$SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost, reverse_cost FROM edge_table$$,
    1, 0.5, 1, 0.8, false, false,
    $$SELECT 100::float AS to_cost, 25::INTEGER AS target_id, '32, 33'::TEXT AS via_path$$
);
 seq | id1 | id2 | cost
-----+-----+-----+------
   0 |  -1 |   1 |  0.3
(1 row)
```

The `reverse_cost` column will be effectively removed and will cost execution time

Using a points of interest table

Given a set of points of interest:

```
SELECT * FROM pointsOfInterest;
 pid |  x  |  y  | edge_id | side | fraction |                 the_geom                   |                  newpoint
-----+-----+-----+---------+------+----------+--------------------------------------------+--------------------------------------------
   1 | 1.8 | 0.4 |       1 | l    |      0.4 | 0101000000CDCCCCCCCCCCFC3F9A9999999999D93F | 010100000000000000000000409A9999999999D93F
   2 | 4.2 | 2.4 |      15 | r    |      0.4 | 0101000000CDCCCCCCCCCC10403333333333330340 | 010100000000000000000010403333333333330340
   3 | 2.6 | 3.2 |      12 | l    |      0.6 | 0101000000CDCCCCCCCCCC04409A99999999990940 | 0101000000CDCCCCCCCCCC04400000000000000840
   4 | 0.3 | 1.8 |       6 | r    |      0.3 | 0101000000333333333333D33FCDCCCCCCCCCCFC3F | 0101000000333333333333D33F0000000000000040
   5 | 2.9 | 1.8 |       5 | l    |      0.8 | 01010000003333333333330740CDCCCCCCCCCCFC3F | 01010000000000000000000840CDCCCCCCCCCCFC3F
   6 | 2.2 | 1.7 |       4 | b    |      0.7 | 01010000009A99999999990140333333333333FB3F | 01010000000000000000000040333333333333FB3F
(6 rows)
```

Using pgr_trsp

```
SELECT * FROM pgr_TRSP(
    $$SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost, reverse_cost  FROM edge_table$$,
    (SELECT edge_id::INTEGER  FROM pointsOfInterest WHERE pid = 1),
    (SELECT fraction  FROM pointsOfInterest WHERE pid = 1),
    (SELECT edge_id::INTEGER  FROM pointsOfInterest WHERE pid = 6),
    (SELECT fraction  FROM pointsOfInterest WHERE pid = 6),
    true, true,
    $$SELECT 100::float AS to_cost, 25::INTEGER AS target_id, '32, 33'::TEXT AS via_path$$
);
 seq | id1 | id2 | cost
-----+-----+-----+------
   0 |  -1 |   1 |  0.6
   1 |   2 |   4 |  0.7
(2 rows)
```

On *pgr_trsp*, to be able to use the table information:

- Each parameter has to be extracted explicitly from the table
- Regardles of the point pid original value
  - will always be -1 for the first point
  - will always be -2 for the second point
    - the row reaching point -2 will not be shown

Using **pgr_withPoints - Proposed**

```
SELECT * FROM pgr_withPoints(
    $$SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost, reverse_cost  FROM edge_table$$,
    $$SELECT pid, edge_id, fraction FROM pointsOfInterest$$,
    -1, -6
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |   -1 |    1 |  0.6 |        0
   2 |        2 |    2 |    4 |  0.7 |      0.6
   3 |        3 |   -6 |   -1 |    0 |      1.3
(3 rows)
```

Suggestion: use **pgr_withPoints - Proposed** when there are no turn restrictions:

- Results are more complete
- Column names are meaningful

Routing from a vertex to a point

Solving a shortest path from vertex \(6\) to pid 1 using a points of interest table

Using pgr_trsp

```
SELECT * FROM pgr_trsp(
    $$SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost, reverse_cost FROM edge_table$$,
    8, 1,
    (SELECT edge_id::INTEGER  FROM pointsOfInterest WHERE pid = 1),
    (SELECT fraction  FROM pointsOfInterest WHERE pid = 1),
    true, true,
    $$SELECT 100::float AS to_cost, 25::INTEGER AS target_id, '32, 33'::TEXT AS via_path$$
);
 seq | id1 | id2 | cost
-----+-----+-----+------
   0 |   6 |   8 |    1
   1 |   5 |   4 |    1
   2 |   2 |   1 |  0.6
(3 rows)
```

- Vertex 6 is on edge 8 at 1 fraction

```
SELECT * FROM pgr_trsp(
    $$SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost, reverse_cost FROM edge_table$$,
    11, 0,
    (SELECT edge_id::INTEGER  FROM pointsOfInterest WHERE pid = 1),
    (SELECT fraction  FROM pointsOfInterest WHERE pid = 1),
    true, true,
    $$SELECT 100::float AS to_cost, 25::INTEGER AS target_id, '32, 33'::TEXT AS via_path$$
);
 seq | id1 | id2 | cost
-----+-----+-----+------
   0 |   6 |   8 |    1
   1 |   5 |   4 |    1
   2 |   2 |   1 |  0.6
(3 rows)
```

- Vertex 6 is also edge 11 at 0 fraction

Using **pgr_withPoints - Proposed**

```
SELECT * FROM pgr_withPoints(
    $$SELECT id::INTEGER, source::INTEGER, target::INTEGER, cost, reverse_cost  FROM edge_table$$,
    $$SELECT pid, edge_id, fraction FROM pointsOfInterest$$,
    6, -1
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    6 |    8 |    1 |        0
   2 |        2 |    5 |    4 |    1 |        1
   3 |        3 |    2 |    1 |  0.6 |        2
   4 |        4 |   -1 |   -1 |    0 |      2.6
(4 rows)
```

Suggestion: use **pgr_withPoints - Proposed** when there are no turn restrictions:

- No need to choose where the vertex is located.
- Results are more complete
- Column names are meaningful

prototypes

`pgr_trspViaVertices` and `pgr_trspViaEdges` were added to pgRouting as prototypes

These functions use the pgr_trsp functions inheriting all the problems mentioned above. When there are no restrictions and have a routing “via” problem with vertices:

- **pgr_dijkstraVia - Proposed**

See Also

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.5 2.4 2.6**

Cost - Category

- **pgr_aStarCost**
- **pgr_dijkstraCost**

Proposed

Warning

Proposed functions for next mayor release.

- They are not officially in the current release.
- They will likely officially be part of the next mayor release:
    - The functions make use of ANY-INTEGER and ANY-NUMERICAL
    - Name might not change. (But still can)
    - Signature might not change. (But still can)

- Functionality might not change. (But still can)
- pgTap tests have being done. But might need more.
- Documentation might need refinement.

- **pgr_withPointsCost - Proposed**

General Information

Characteristics

The main Characteristics are:

- Each function works as part of the family it belongs to.
- It does not return a path.
- Returns the sum of the costs of the resulting path(s) for pair combination of nodes in the graph.
- Process is done only on edges with positive costs.
- Values are returned when there is a path.
    - The returned values are in the form of a set of *(start_vid, end_vid, agg_cost)*.
    - When the starting vertex and ending vertex are the same, there is no path.
        - The *agg_cost* int the non included values *(v, v)* is *0*.
    - When the starting vertex and ending vertex are the different and there is no path.
        - The *agg_cost* in the non included values *(u, v)* is \(\infty\).
- Let be the case the values returned are stored in a table, so the unique index would be the pair: *(start_vid, end_vid)*.
- Depending on the function and its parameters, the results can be symmetric.
    - The *agg_cost* of *(u, v)* is the same as for *(v, u)*.
- Any duplicated value in the *start_vids* or in *end_vids* are ignored.
- The returned values are ordered:
    - *start_vid* ascending
    - *end_vid* ascending

See Also

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4**

Cost Matrix - Category

- **pgr_aStarCostMatrix**
- **pgr_dijkstraCostMatrix**

proposed

Warning

Proposed functions for next mayor release.

- They are not officially in the current release.
- They will likely officially be part of the next mayor release:
    - The functions make use of ANY-INTEGER and ANY-NUMERICAL
    - Name might not change. (But still can)
    - Signature might not change. (But still can)
    - Functionality might not change. (But still can)
    - pgTap tests have being done. But might need more.
    - Documentation might need refinement.

- **pgr_withPointsCostMatrix - proposed**

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3**

pgr_withPointsCostMatrix - proposed

pgr_withPointsCostMatrix - Calculates the shortest path and returns only the aggregate cost of the shortest path(s) found, for the combination of points given.

Warning

Proposed functions for next mayor release.

- They are not officially in the current release.
- They will likely officially be part of the next mayor release:
  - The functions make use of ANY-INTEGER and ANY-NUMERICAL
  - Name might not change. (But still can)
  - Signature might not change. (But still can)
  - Functionality might not change. (But still can)
  - pgTap tests have being done. But might need more.
  - Documentation might need refinement.

Boost Graph Inside

Availability

- Version 2.2.0
  - New **proposed** function

Description

- **TBD**

Signatures

Summary

```
pgr_withPointsCostMatrix(edges_sql, points_sql, start_vids [, directed] [, driving_side])
RETURNS SET OF (start_vid, end_vid, agg_cost)
```

Note

There is no **details** flag, unlike the other members of the withPoints family of functions.

Using default

The minimal signature:

- Is for a **directed** graph.
- The driving side is set as **b** both. So arriving/departing to/from the point(s) can be in any direction.

```
pgr_withPointsCostMatrix(edges_sql, points_sql, start_vid)
RETURNS SET OF (start_vid, end_vid, agg_cost)
```

Example:
Cost matrix for points \\(\\{1, 6\\}\\) and vertices \\(\\{3, 6\\}\\) on a **directed** graph

```
SELECT * FROM pgr_withPointsCostMatrix(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction from pointsOfInterest',
    array[-1, 3, 6, -6]);
 start_vid | end_vid | agg_cost
-----------+---------+----------
        -6 |      -1 |      1.3
        -6 |       3 |      4.3
        -6 |       6 |      1.3
        -1 |      -6 |      1.3
        -1 |       3 |      5.6
        -1 |       6 |      2.6
         3 |      -6 |      1.7
         3 |      -1 |      1.6
         3 |       6 |        1
         6 |      -6 |      1.3
         6 |      -1 |      2.6
         6 |       3 |        3
(12 rows)
```

Complete Signature

```
pgr_withPointsCostMatrix(edges_sql, points_sql, start_vids,
    directed:=true, driving_side:='b')
RETURNS SET OF (start_vid, end_vid, agg_cost)
```

Example:
Cost matrix for points \(\{1, 6\}\) and vertices \(\{3, 6\}\) on an **undirected** graph

- Returning a **symmetrical** cost matrix
- Using the default **side** value on the **points_sql** query
- Using the default **driving_side** value

```
SELECT * FROM pgr_withPointsCostMatrix(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction from pointsOfInterest',
    array[-1, 3, 6, -6], directed := false);
 start_vid | end_vid | agg_cost
-----------+---------+----------
        -6 |      -1 |      1.3
        -6 |       3 |      1.7
        -6 |       6 |      1.3
        -1 |      -6 |      1.3
        -1 |       3 |      1.6
        -1 |       6 |      2.6
         3 |      -6 |      1.7
         3 |      -1 |      1.6
         3 |       6 |        1
         6 |      -6 |      1.3
         6 |      -1 |      2.6
         6 |       3 |        1
(12 rows)
```

Parameters

Parameter	Type	Description
edges_sql	TEXT	Edges SQL query as described above.
points_sql	TEXT	Points SQL query as described above.
start_vids	ARRAY[ANY-INTEGER]	Array of identifiers of starting vertices. When negative: is a point's pid.
directed	BOOLEAN	(optional). When false the graph is considered as Undirected. Default is true which considers the graph as Directed.
driving_side	CHAR	(optional) Value in ['b', 'r', 'l', NULL] indicating if the driving side is: • In the right or left or • If it doesn't matter with 'b' or NULL. • If column not present 'b' is considered.

Returns SET OF (start_vid, end_vid, agg_cost)

Column	Type	Description
start_vid	BIGINT	Identifier of the starting vertex.
end_vid	BIGINT	Identifier of the ending vertex.
agg_cost	FLOAT	Aggregate cost from start_vid to end_vid.

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Description of the Points SQL query

points_sql:
an SQL query, which should return a set of rows with the following columns:

Column	Type	Description
pid	ANY-INTEGER	(optional) Identifier of the point. • If column present, it can not be NULL. • If column not present, a sequential identifier will be given automatically.
edge_id	ANY-INTEGER	Identifier of the "closest" edge to the point.
fraction	ANY-NUMERICAL	Value in <0,1> that indicates the relative postition from the first end point of the edge.
side	CHAR	(optional) Value in ['b', 'r', 'l', NULL] indicating if the point is: • In the right, left of the edge or • If it doesn't matter with 'b' or NULL. • If column not present 'b' is considered.

Where:

ANY-INTEGER:
smallint, int, bigint
ANY-NUMERICAL:
smallint, int, bigint, real, float

Additional Examples

Example:
pgr_TSP using `pgr_withPointsCostMatrix` for points \(\{1, 6\}\) and vertices \(\{3, 6\}\) on an **undirected** graph

```
SELECT * FROM pgr_TSP(
    $$
    SELECT * FROM pgr_withPointsCostMatrix(
        'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
        'SELECT pid, edge_id, fraction from pointsOfInterest',
        array[-1, 3, 6, -6], directed := false);
    $$,
    randomize := false
);
 seq | node | cost | agg_cost
-----+------+------+----------
   1 |   -6 |    0 |        0
   2 |   -1 |  1.3 |      1.3
   3 |    3 |  1.6 |      2.9
   4 |    6 |    1 |      3.9
   5 |   -6 |  1.3 |      5.2
(5 rows)
```

See Also

- **pgr_withPoints - Proposed**
- **Cost Matrix - Category**

- **pgr_TSP**
- *sampledata* network.

Indices and tables

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General Information

Synopsis

Traveling Sales Person - Family of functions needs as input a symmetric cost matrix and no edge*(u, v)* must value \(\infty\).

This collection of functions will return a cost matrix in form of a table.

Characteristics

The main Characteristics are:

- Can be used as input to **pgr_TSP**.
  - **directly:**
    when the resulting matrix is symmetric and there is no \(\infty\) value.
  - It will be the users responsibility to make the matrix symmetric.
    - By using geometric or harmonic average of the non symmetric values.
    - By using max or min the non symmetric values.
    - By setting the upper triangle to be the mirror image of the lower triangle.
    - By setting the lower triangle to be the mirror image of the upper triangle.
  - It is also the users responsibility to fix an \(\infty\) value.
- Each function works as part of the family it belongs to.
- It does not return a path.
- Returns the sum of the costs of the shortest path for pair combination of nodes in the graph.
- Process is done only on edges with positive costs.
- Values are returned when there is a path.
  - The returned values are in the form of a set of *(start_vid, end_vid, agg_cost)*.
  - When the starting vertex and ending vertex are the same, there is no path.
    - The *agg_cost* int the non included values *(v, v)* is *0*.
  - When the starting vertex and ending vertex are the different and there is no path.
    - The *agg_cost* in the non included values *(u, v)* is \(\infty\).
- Let be the case the values returned are stored in a table, so the unique index would be the pair: *(start_vid, end_vid)*.
- Depending on the function and its parameters, the results can be symmetric.
  - The *agg_cost* of *(u, v)* is the same as for *(v, u)*.
- Any duplicated value in the *start_vids* are ignored.
- The returned values are ordered:
  - *start_vid* ascending
  - *end_vid* ascending
- Running time: approximately \(O(| start_vids | * (V \log V + E))\)

See Also

- **Traveling Sales Person - Family of functions**

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest** (**3.2**) **3.1**) **3.0**
- **Unsupported versions: 2.6 2.5 2.4**

Driving Distance - Category

- **pgr_drivingDistance** - Driving Distance based on Dijkstra's algorithm
- **pgr_primDD** - Driving Distance based on Prim's algorithm
- **pgr_kruskalDD** - Driving Distance based on Kruskal's algorithm
- Post pocessing
  - **pgr_alphaShape** - Alpha shape computation

Proposed

> **Warning**
>
> Proposed functions for next mayor release.
>
> - They are not officially in the current release.
> - They will likely officially be part of the next mayor release:
>   - The functions make use of ANY-INTEGER and ANY-NUMERICAL
>   - Name might not change. (But still can)
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>   - Functionality might not change. (But still can)
>   - pgTap tests have being done. But might need more.
>   - Documentation might need refinement.

- **pgr_withPointsDD - Proposed** - Driving Distance based on pgr_withPoints

- **Supported versions:** **Latest** (**3.2**) **3.1** **3.0**
- **Unsupported versions:** **2.6** **2.5** **2.4** **2.3** **2.2** **2.1** **2.0**

pgr_alphaShape

`pgr_alphaShape` — Polygon part of an alpha shape.

Availability

- Version 3.0.0
  - Breaking change on signature
  - Old signature no longer supported
  - **Boost 1.54** & **Boost 1.55** are supported
  - **Boost 1.56+** is preferable
    - Boost Geometry is stable on Boost 1.56
- Version 2.1.0
  - Added alpha argument with default 0 (use optimal value)
  - Support to return multiple outer/inner ring
- Version 2.0.0
  - **Official** function
  - Renamed from version 1.x

Support

- **Supported versions:** current(**3.1**) **3.0**
- **Unsupported versions:** **2.6** **2.5** **2.4** **2.3** **2.2** **2.1** **2.0**

Description

Returns the polygon part of an alpha shape.

Characteristics

- Input is a *geometry* and returns a *geometry*
- Uses PostGis ST_DelaunyTriangles
- Instead of using CGAL's definition of *alpha* it use the `spoon_radius`
  - \(spoon_radius = \sqrt alpha\)
- A Triangle area is considered part of the alpha shape when\(circumcenter\ radius < spoon_radius\)
- When the total number of points is less than 3, returns an EMPTY geometry

Signatures

Summary

```
pgr_alphaShape(geometry,   [spoon_radius])
RETURNS geometry
```

Example: passing a geometry collection with spoon radius \(1.5\) using the return variable `geom`

```
SELECT ST_Area(pgr_alphaShape((SELECT ST_Collect(the_geom) FROM edge_table_vertices_pgr), 1.5));
 st_area
---------
    9.75
(1 row)
```

Parameters

Parameter	Type	Default	Description
geometry	geometry		Geometry with at least \(3\) points
spoon_radius	FLOAT		The radius of the spoon

Return Value

Kind of geometry	Description
GEOMETRY COLLECTION	A Geometry collection of Polygons

See Also

- **pgr_drivingDistance**
- **Sample Data** network.
- **ST_ConcaveHull**

Indices and tables

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- **Search Page**

See Also

Indices and tables

- **Index**
- **Search Page**

See Also

Indices and tables

- **Index**
- **Search Page**

All Pairs - Family of Functions

- **pgr_floydWarshall** - Floyd-Warshall’s algorithm.
- **pgr_johnson** - Johnson’s algorithm

aStar - Family of functions

- **pgr_aStar** - A* algorithm for the shortest path.
- **pgr_aStarCost** - Get the aggregate cost of the shortest paths.
- **pgr_aStarCostMatrix** - Get the cost matrix of the shortest paths.

Bidirectional A* - Family of functions

- **pgr_bdAstar** - Bidirectional A* algorithm for obtaining paths.
- **pgr_bdAstarCost** - Bidirectional A* algorithm to calculate the cost of the paths.
- **pgr_bdAstarCostMatrix** - Bidirectional A* algorithm to calculate a cost matrix of paths.

Bidirectional Dijkstra - Family of functions

- **pgr_bdDijkstra** - Bidirectional Dijkstra algorithm for the shortest paths.
- **pgr_bdDijkstraCost** - Bidirectional Dijkstra to calculate the cost of the shortest paths
- **pgr_bdDijkstraCostMatrix** - Bidirectional Dijkstra algorithm to create a matrix of costs of the shortest paths.

Components - Family of functions

- **pgr_connectedComponents** - Connected components of an undirected graph.
- **pgr_strongComponents** - Strongly connected components of a directed graph.
- **pgr_biconnectedComponents** - Biconnected components of an undirected graph.

- **pgr_articulationPoints** - Articulation points of an undirected graph.
- **pgr_bridges** - Bridges of an undirected graph.

Contraction - Family of functions

- **pgr_contraction**

Dijkstra - Family of functions

- **pgr_dijkstra** - Dijkstra's algorithm for the shortest paths.
- **pgr_dijkstraCost** - Get the aggregate cost of the shortest paths.
- **pgr_dijkstraCostMatrix** - Use pgr_dijkstra to create a costs matrix.
- **pgr_drivingDistance** - Use pgr_dijkstra to calculate catchament information.
- **pgr_KSP** - Use Yen algorithm with pgr_dijkstra to get the K shortest paths.

Flow - Family of functions

- **pgr_maxFlow** - Only the Max flow calculation using Push and Relabel algorithm.
- **pgr_boykovKolmogorov** - Boykov and Kolmogorov with details of flow on edges.
- **pgr_edmondsKarp** - Edmonds and Karp algorithm with details of flow on edges.
- **pgr_pushRelabel** - Push and relabel algorithm with details of flow on edges.
- Applications
  - **pgr_edgeDisjointPaths** - Calculates edge disjoint paths between two groups of vertices.
  - **pgr_maxCardinalityMatch** - Calculates a maximum cardinality matching in a graph.

Kruskal - Family of functions

- **pgr_kruskal**
- **pgr_kruskalBFS**
- **pgr_kruskalDD**
- **pgr_kruskalDFS**

Prim - Family of functions

- **pgr_prim**
- **pgr_primBFS**
- **pgr_primDD**
- **pgr_primDFS**

Topology - Family of Functions

- **pgr_createTopology** - to create a topology based on the geometry.
- **pgr_createVerticesTable** - to reconstruct the vertices table based on the source and target information.
- **pgr_analyzeGraph** - to analyze the edges and vertices of the edge table.
- **pgr_analyzeOneWay** - to analyze directionality of the edges.
- **pgr_nodeNetwork** -to create nodes to a not noded edge table.

Traveling Sales Person - Family of functions

- **pgr_TSP** - When input is given as matrix cell information.
- **pgr_TSPeuclidean** - When input are coordinates.

pgr_trsp - Turn Restriction Shortest Path (TRSP) - Turn Restriction Shortest Path (TRSP)

Functions by categories

Cost - Category

- **pgr_aStarCost**
- **pgr_dijkstraCost**

Cost Matrix - Category

- **pgr_aStarCostMatrix**
- **pgr_dijkstraCostMatrix**

Driving Distance - Category

- **pgr_drivingDistance** - Driving Distance based on Dijkstra's algorithm
- **pgr_primDD** - Driving Distance based on Prim's algorithm
- **pgr_kruskalDD** - Driving Distance based on Kruskal's algorithm
- Post pocessing
  - **pgr_alphaShape** - Alpha shape computation

K shortest paths - Category

- **pgr_KSP** - Yen's algorithm based on pgr_dijkstra

Spanning Tree - Category

- **Kruskal - Family of functions**
- **Prim - Family of functions**

Available Functions but not official pgRouting functions

- **Proposed Functions**
- **Experimental Functions**

- **Supported versions: Latest** (**3.2**) **3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2**

Proposed Functions

> **Warning**
>
> Proposed functions for next mayor release.
>
> - They are not officially in the current release.
> - They will likely officially be part of the next mayor release:
>   - The functions make use of ANY-INTEGER and ANY-NUMERICAL
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>   - pgTap tests have being done. But might need more.
>   - Documentation might need refinement.

Families

Dijkstra - Family of functions

- **pgr_dijkstraVia - Proposed** - Get a route of a seuence of vertices.

withPoints - Family of functions

- **pgr_withPoints - Proposed** - Route from/to points anywhere on the graph.
- **pgr_withPointsCost - Proposed** - Costs of the shortest paths.
- **pgr_withPointsCostMatrix - proposed** - Costs of the shortest paths.
- **pgr_withPointsKSP - Proposed** - K shortest paths.
- **pgr_withPointsDD - Proposed** - Driving distance.

categories

Cost - Category

- **pgr_withPointsCost - Proposed**

Cost Matrix - Category

- **pgr_withPointsCostMatrix - proposed**

Driving Distance - Category

- **pgr_withPointsDD - Proposed** - Driving Distance based on pgr_withPoints

K shortest paths - Category

- **pgr_withPointsKSP - Proposed** - Yen's algorithm based on pgr_withPoints

- **Supported versions: Latest** (**3.2**) **3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2**

withPoints - Family of functions

When points are also given as input:

Warning

Proposed functions for next mayor release.

- They are not officially in the current release.
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  - The functions make use of ANY-INTEGER and ANY-NUMERICAL
  - Name might not change. (But still can)
  - Signature might not change. (But still can)
  - Functionality might not change. (But still can)
  - pgTap tests have being done. But might need more.
  - Documentation might need refinement.

- **pgr_withPoints - Proposed** - Route from/to points anywhere on the graph.
- **pgr_withPointsCost - Proposed** - Costs of the shortest paths.
- **pgr_withPointsCostMatrix - proposed** - Costs of the shortest paths.
- **pgr_withPointsKSP - Proposed** - K shortest paths.
- **pgr_withPointsDD - Proposed** - Driving distance.

- **Supported versions:** **Latest** (**3.2**) **3.1** **3.0**
- **Unsupported versions:** **2.6** **2.5** **2.4** **2.3** **2.2**

pgr_withPoints - Proposed

`pgr_withPoints` - Returns the shortest path in a graph with additional temporary vertices.

Warning

Proposed functions for next mayor release.

- They are not officially in the current release.
- They will likely officially be part of the next mayor release:
  - The functions make use of ANY-INTEGER and ANY-NUMERICAL
  - Name might not change. (But still can)
  - Signature might not change. (But still can)
  - Functionality might not change. (But still can)
  - pgTap tests have being done. But might need more.
  - Documentation might need refinement.

Boost Graph Inside

Availability

- Version 3.2.0
  - New **proposed** function:
    - pgr_withPoints(Combinations)
- Version 2.2.0
  - New **proposed** function

Support

- **Supported versions:** current(**3.2**) **3.1**) **3.0**
- **Unsupported versions:** **2.6** **2.5** **2.4** **2.3** **2.2**

Description

Modify the graph to include points defined by points_sql. Using Dijkstra algorithm, find the shortest path(s)

The main characteristics are:

- Process is done only on edges with positive costs.
- Vertices of the graph are:
  - **positive** when it belongs to the edges_sql

- **negative** when it belongs to the points_sql
- Values are returned when there is a path.
  - When the starting vertex and ending vertex are the same, there is no path. - The agg_cost the non included values (v, v) is 0
  - When the starting vertex and ending vertex are the different and there is no path: - The agg_cost the non included values (u, v) is ∞
- For optimization purposes, any duplicated value in the start_vids or end_vids are ignored.
- The returned values are ordered: - start_vid ascending - end_vid ascending
- Running time: $O(|start\_vids|\times(V \log V + E))$

Signatures

Summary

```
pgr_withPoints(edges_sql, points_sql, from_vid,  to_vid  [, directed] [, driving_side] [, details])
pgr_withPoints(edges_sql, points_sql, from_vid,  to_vids [, directed] [, driving_side] [, details])
pgr_withPoints(edges_sql, points_sql, from_vids, to_vid  [, directed] [, driving_side] [, details])
pgr_withPoints(edges_sql, points_sql, from_vids, to_vids [, directed] [, driving_side] [, details])
pgr_withPoints(Edges SQL, Points SQL, Combinations SQL  [, directed] [, driving_side] [, details])
RETURNS SET OF (seq, path_seq, [start_vid,] [end_vid,] node, edge, cost, agg_cost)
```

Using defaults

```
pgr_withPoints(edges_sql, points_sql, from_vid, to_vid)
RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost)
```

Example:

From point 1 to point 3

- For a **directed** graph.
- The driving side is set as **b** both. So arriving/departing to/from the point(s) can be in any direction.
- No **details** are given about distance of other points of points_sql query.

```
SELECT * FROM pgr_withPoints(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    -1, -3);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |   -1 |    1 |  0.6 |        0
   2 |        2 |    2 |    4 |    1 |      0.6
   3 |        3 |    5 |   10 |    1 |      1.6
   4 |        4 |   10 |   12 |  0.6 |      2.6
   5 |        5 |   -3 |   -1 |    0 |      3.2
(5 rows)
```

One to One

```
pgr_withPoints(edges_sql, points_sql, from_vid,  to_vid  [, directed] [, driving_side] [, details])
RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost)
```

Example:

From point 1 to vertex 3 with details of passing points

```
SELECT * FROM pgr_withPoints(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    -1, 3,
    details := true);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |   -1 |    1 |  0.6 |        0
   2 |        2 |    2 |    4 |  0.7 |      0.6
   3 |        3 |   -6 |    4 |  0.3 |      1.3
   4 |        4 |    5 |    8 |    1 |      1.6
   5 |        5 |    6 |    9 |    1 |      2.6
   6 |        6 |    9 |   16 |    1 |      3.6
   7 |        7 |    4 |    3 |    1 |      4.6
   8 |        8 |    3 |   -1 |    0 |      5.6
(8 rows)
```

One to Many

```
pgr_withPoints(edges_sql, points_sql, from_vid,  to_vids [, directed] [, driving_side] [, details])
RETURNS SET OF (seq, path_seq, end_vid, node, edge, cost, agg_cost)
```

Example:

From point \(1\) to point \(3\) and vertex \(5\)

```
SELECT * FROM pgr_withPoints(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    -1, ARRAY[-3,5]);
 seq | path_seq | end_pid | node | edge | cost | agg_cost
-----+----------+---------+------+------+------+----------
   1 |        1 |      -3 |   -1 |    1 |  0.6 |        0
   2 |        2 |      -3 |    2 |    4 |    1 |      0.6
   3 |        3 |      -3 |    5 |   10 |    1 |      1.6
   4 |        4 |      -3 |   10 |   12 |  0.6 |      2.6
   5 |        5 |      -3 |   -3 |   -1 |    0 |      3.2
   6 |        1 |       5 |   -1 |    1 |  0.6 |        0
   7 |        2 |       5 |    2 |    4 |    1 |      0.6
   8 |        3 |       5 |    5 |   -1 |    0 |      1.6
(8 rows)
```

Many to One

```
pgr_withPoints(edges_sql, points_sql, from_vids, to_vid  [, directed] [, driving_side] [, details])
RETURNS SET OF (seq, path_seq, start_vid, node, edge, cost, agg_cost)
```

Example:

From point \(1\) and vertex \(2\) to point \(3\)

```
SELECT * FROM pgr_withPoints(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    ARRAY[-1,2], -3);
 seq | path_seq | start_pid | node | edge | cost | agg_cost
-----+----------+-----------+------+------+------+----------
   1 |        1 |        -1 |   -1 |    1 |  0.6 |        0
   2 |        2 |        -1 |    2 |    4 |    1 |      0.6
   3 |        3 |        -1 |    5 |   10 |    1 |      1.6
   4 |        4 |        -1 |   10 |   12 |  0.6 |      2.6
   5 |        5 |        -1 |   -3 |   -1 |    0 |      3.2
   6 |        1 |         2 |    2 |    4 |    1 |        0
   7 |        2 |         2 |    5 |   10 |    1 |        1
   8 |        3 |         2 |   10 |   12 |  0.6 |        2
   9 |        4 |         2 |   -3 |   -1 |    0 |      2.6
(9 rows)
```

Many to Many

```
pgr_withPoints(edges_sql, points_sql, from_vids, to_vids [, directed] [, driving_side] [, details])
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
```

Example:

From point \(1\) and vertex \(2\) to point \(3\) and vertex \(7\)

```
SELECT * FROM pgr_withPoints(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    ARRAY[-1,2], ARRAY[-3,7]);
 seq | path_seq | start_pid | end_pid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |        -1 |      -3 |   -1 |    1 |  0.6 |        0
   2 |        2 |        -1 |      -3 |    2 |    4 |    1 |      0.6
   3 |        3 |        -1 |      -3 |    5 |   10 |    1 |      1.6
   4 |        4 |        -1 |      -3 |   10 |   12 |  0.6 |      2.6
   5 |        5 |        -1 |      -3 |   -3 |   -1 |    0 |      3.2
   6 |        1 |        -1 |       7 |   -1 |    1 |  0.6 |        0
   7 |        2 |        -1 |       7 |    2 |    4 |    1 |      0.6
   8 |        3 |        -1 |       7 |    5 |    7 |    1 |      1.6
   9 |        4 |        -1 |       7 |    8 |    6 |    1 |      2.6
  10 |        5 |        -1 |       7 |    7 |   -1 |    0 |      3.6
  11 |        1 |         2 |      -3 |    2 |    4 |    1 |        0
  12 |        2 |         2 |      -3 |    5 |   10 |    1 |        1
  13 |        3 |         2 |      -3 |   10 |   12 |  0.6 |        2
  14 |        4 |         2 |      -3 |   -3 |   -1 |    0 |      2.6
  15 |        1 |         2 |       7 |    2 |    4 |    1 |        0
  16 |        2 |         2 |       7 |    5 |    7 |    1 |        1
  17 |        3 |         2 |       7 |    8 |    6 |    1 |        2
  18 |        4 |         2 |       7 |    7 |   -1 |    0 |        3
(18 rows)
```

Combinations SQL

```
pgr_withPoints(Edges SQL, Points SQL, Combinations SQL [, directed] [, driving_side] [, details])
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
```

Example:
Two (source, target) combinations: (from point \(1\) to vertex \(3\)), and (from vertex \(2\) to point \(3\)) with **right** side driving topology.

```
SELECT * FROM pgr_withPoints(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    'SELECT * FROM ( VALUES (-1, 3), (2, -3) ) AS t(source, target)',
    driving_side => 'r',
    details => true);
 seq | path_seq | start_pid | end_pid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |        -1 |       3 |   -1 |    1 |  0.4 |        0
   2 |        2 |        -1 |       3 |    1 |    1 |    1 |      0.4
   3 |        3 |        -1 |       3 |    2 |    4 |  0.7 |      1.4
   4 |        4 |        -1 |       3 |   -6 |    4 |  0.3 |      2.1
   5 |        5 |        -1 |       3 |    5 |    8 |    1 |      2.4
   6 |        6 |        -1 |       3 |    6 |    9 |    1 |      3.4
   7 |        7 |        -1 |       3 |    9 |   16 |    1 |      4.4
   8 |        8 |        -1 |       3 |    4 |    3 |    1 |      5.4
   9 |        9 |        -1 |       3 |    3 |   -1 |    0 |      6.4
  10 |        1 |         2 |      -3 |    2 |    4 |  0.7 |        0
  11 |        2 |         2 |      -3 |   -6 |    4 |  0.3 |      0.7
  12 |        3 |         2 |      -3 |    5 |   10 |    1 |        1
  13 |        4 |         2 |      -3 |   10 |   12 |  0.6 |        2
  14 |        5 |         2 |      -3 |   -3 |   -1 |    0 |      2.6
(14 rows)
```

Parameters

Parameter	Type	Description
Edges SQL	TEXT	*Edges query* as described above.
Points SQL	TEXT	*Points query* as described above.
Combinations SQL	TEXT	*Combinations query* as described below.
start_vid	ANY-INTEGER	Starting vertex identifier. When negative: is a point's pid.
end_vid	ANY-INTEGER	Ending vertex identifier. When negative: is a point's pid.
start_vids	ARRAY[ANY-INTEGER]	Array of identifiers of starting vertices. When negative: is a point's pid.
end_vids	ARRAY[ANY-INTEGER]	Array of identifiers of ending vertices. When negative: is a point's pid.
directed	BOOLEAN	(optional). When false the graph is considered as Undirected. Default is true which considers the graph as Directed.
driving_side	CHAR	(optional) Value in ['b', 'r', 'l', NULL] indicating if the driving side is: • In the right or left or • If it doesn't matter with 'b' or NULL. • If column not present 'b' is considered.
details	BOOLEAN	(optional). When true the results will include the points in points_sql that are in the path. Default is false which ignores other points of the points_sql.

Inner query

Edges query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Points query

Description of the Points SQL query

points_sql:
an SQL query, which should return a set of rows with the following columns:

Column	Type	Description
pid	ANY-INTEGER	(optional) Identifier of the point. • If column present, it can not be NULL. • If column not present, a sequential identifier will be given automatically.
edge_id	ANY-INTEGER	Identifier of the “closest” edge to the point.
fraction	ANY-NUMERICAL	Value in <0,1> that indicates the relative postition from the first end point of the edge.
side	CHAR	(optional) Value in [‘b’, ‘r’, ‘l’, NULL] indicating if the point is: • In the right, left of the edge or • If it doesn’t matter with ‘b’ or NULL. • If column not present ‘b’ is considered.

Where:

ANY-INTEGER:
smallint, int, bigint
ANY-NUMERICAL:
smallint, int, bigint, real, float

Combinations query

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

Result Columns

Column	Type	Description
seq	INTEGER	Row sequence.
path_seq	INTEGER	Path sequence that indicates the relative position on the path.
start_vid	BIGINT	Identifier of the starting vertex. When negative: is a point’s pid.
end_vid	BIGINT	Identifier of the ending vertex. When negative: is a point’s pid.
node	BIGINT	Identifier of the node: • A positive value indicates the node is a vertex of edges_sql. • A negative value indicates the node is a point of points_sql.
edge	BIGINT	Identifier of the edge used to go from `node` to the next node in the path sequence. • `-1` for the last row in the path sequence.
cost	FLOAT	Cost to traverse from `node` using `edge` to the next `node` in the path sequence. • `0` for the last row in the path sequence.
agg_cost	FLOAT	Aggregate cost from `start_pid` to `node`. • `0` for the first row in the path sequence.

Additional Examples

Example:
Which path (if any) passes in front of point\(6\) or vertex \(6\) with **right** side driving topology.

```
SELECT ('(' || start_pid || ' => ' || end_pid ||') at ' || path_seq || 'th step:')::TEXT AS path_at,
       CASE WHEN edge = -1 THEN ' visits'
          ELSE ' passes in front of'
       END as status,
       CASE WHEN node < 0 THEN 'Point'
          ELSE 'Vertex'
       END as is_a,
       abs(node) as id
   FROM pgr_withPoints(
       'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
       'SELECT pid, edge_id, fraction, side from pointsOfInterest',
       ARRAY[1,-1], ARRAY[-2,-3,-6,3,6],
       driving_side := 'r',
       details := true)
   WHERE node IN (-6,6);
       path_at        |       status        | is_a  | id
-------------------------+---------------------+--------+----
 (-1 => -6) at 4th step: |  visits             | Point  |  6
 (-1 => -3) at 4th step: |  passes in front of | Point  |  6
 (-1 => -2) at 4th step: |  passes in front of | Point  |  6
 (-1 => -2) at 6th step: |  passes in front of | Vertex |  6
 (-1 => 3) at 4th step:  |  passes in front of | Point  |  6
 (-1 => 3) at 6th step:  |  passes in front of | Vertex |  6
 (-1 => 6) at 4th step:  |  passes in front of | Point  |  6
 (-1 => 6) at 6th step:  |  visits             | Vertex |  6
 (1 => -6) at 3th step:  |  visits             | Point  |  6
 (1 => -3) at 3th step:  |  passes in front of | Point  |  6
 (1 => -2) at 3th step:  |  passes in front of | Point  |  6
 (1 => -2) at 5th step:  |  passes in front of | Vertex |  6
 (1 => 3) at 3th step:   |  passes in front of | Point  |  6
 (1 => 3) at 5th step:   |  passes in front of | Vertex |  6
 (1 => 6) at 3th step:   |  passes in front of | Point  |  6
 (1 => 6) at 5th step:   |  visits             | Vertex |  6
(16 rows)
```

Example:

Which path (if any) passes in front of point\(6\) or vertex \(6\) with **left** side driving topology.

```
SELECT ('(' || start_pid || ' => ' || end_pid ||') at ' || path_seq || 'th step:')::TEXT AS path_at,
       CASE WHEN edge = -1 THEN ' visits'
          ELSE ' passes in front of'
       END as status,
       CASE WHEN node < 0 THEN 'Point'
          ELSE 'Vertex'
       END as is_a,
       abs(node) as id
   FROM pgr_withPoints(
       'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
       'SELECT pid, edge_id, fraction, side from pointsOfInterest',
       ARRAY[1,-1], ARRAY[-2,-3,-6,3,6],
       driving_side := 'l',
       details := true)
   WHERE node IN (-6,6);
       path_at        |       status        | is_a  | id
-------------------------+---------------------+--------+----
 (-1 => -6) at 3th step: |  visits             | Point  |  6
 (-1 => -3) at 3th step: |  passes in front of | Point  |  6
 (-1 => -2) at 3th step: |  passes in front of | Point  |  6
 (-1 => -2) at 5th step: |  passes in front of | Vertex |  6
 (-1 => 3) at 3th step:  |  passes in front of | Point  |  6
 (-1 => 3) at 5th step:  |  passes in front of | Vertex |  6
 (-1 => 6) at 3th step:  |  passes in front of | Point  |  6
 (-1 => 6) at 5th step:  |  visits             | Vertex |  6
 (1 => -6) at 4th step:  |  visits             | Point  |  6
 (1 => -3) at 4th step:  |  passes in front of | Point  |  6
 (1 => -2) at 4th step:  |  passes in front of | Point  |  6
 (1 => -2) at 6th step:  |  passes in front of | Vertex |  6
 (1 => 3) at 4th step:   |  passes in front of | Point  |  6
 (1 => 3) at 6th step:   |  passes in front of | Vertex |  6
 (1 => 6) at 4th step:   |  passes in front of | Point  |  6
 (1 => 6) at 6th step:   |  visits             | Vertex |  6
(16 rows)
```

Example:

From point \(1\) and vertex \(2\) to point \(3\) to vertex \(7\) on an **undirected** graph, with details.

```
SELECT * FROM pgr_withPoints(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    ARRAY[-1,2], ARRAY[-3,7],
    directed := false,
    details := true);
 seq | path_seq | start_pid | end_pid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |        -1 |      -3 |   -1 |    1 |  0.6 |        0
   2 |        2 |        -1 |      -3 |    2 |    4 |  0.7 |      0.6
   3 |        3 |        -1 |      -3 |   -6 |    4 |  0.3 |      1.3
   4 |        4 |        -1 |      -3 |    5 |   10 |    1 |      1.6
   5 |        5 |        -1 |      -3 |   10 |   12 |  0.6 |      2.6
   6 |        6 |        -1 |      -3 |   -3 |   -1 |    0 |      3.2
   7 |        1 |        -1 |       7 |   -1 |    1 |  0.6 |        0
   8 |        2 |        -1 |       7 |    2 |    4 |  0.7 |      0.6
   9 |        3 |        -1 |       7 |   -6 |    4 |  0.3 |      1.3
  10 |        4 |        -1 |       7 |    5 |    7 |    1 |      1.6
  11 |        5 |        -1 |       7 |    8 |    6 |  0.7 |      2.6
  12 |        6 |        -1 |       7 |   -4 |    6 |  0.3 |      3.3
  13 |        7 |        -1 |       7 |    7 |   -1 |    0 |      3.6
  14 |        1 |         2 |      -3 |    2 |    4 |  0.7 |        0
  15 |        2 |         2 |      -3 |   -6 |    4 |  0.3 |      0.7
  16 |        3 |         2 |      -3 |    5 |   10 |    1 |        1
  17 |        4 |         2 |      -3 |   10 |   12 |  0.6 |        2
  18 |        5 |         2 |      -3 |   -3 |   -1 |    0 |      2.6
  19 |        1 |         2 |       7 |    2 |    4 |  0.7 |        0
  20 |        2 |         2 |       7 |   -6 |    4 |  0.3 |      0.7
  21 |        3 |         2 |       7 |    5 |    7 |    1 |        1
  22 |        4 |         2 |       7 |    8 |    6 |  0.7 |        2
  23 |        5 |         2 |       7 |   -4 |    6 |  0.3 |      2.7
  24 |        6 |         2 |       7 |    7 |   -1 |    0 |        3
(24 rows)
```

The queries use the **Sample Data** network

See Also

- **withPoints - Family of functions**

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.2 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2**

pgr_withPointsCost - Proposed

pgr_withPointsCost - Calculates the shortest path and returns only the aggregate cost of the shortest path(s) found, for the combination of points given.

> **Warning**
>
> Proposed functions for next mayor release.
>
> - They are not officially in the current release.
> - They will likely officially be part of the next mayor release:
>   - The functions make use of ANY-INTEGER and ANY-NUMERICAL
>   - Name might not change. (But still can)
>   - Signature might not change. (But still can)
>   - Functionality might not change. (But still can)
>   - pgTap tests have being done. But might need more.
>   - Documentation might need refinement.

Boost Graph Inside

Availability

- Version 3.2.0
  - New **proposed** function:
    - pgr_withPointsCost(Combinations)
- Version 2.2.0
  - New **proposed** function

Description

Modify the graph to include points defined by points_sql. Using Dijkstra algorithm, return only the aggregate cost of the shortest path(s) found.

The main characteristics are:

- It does not return a path.
- Returns the sum of the costs of the shortest path for pair combination of vertices in the modified graph.
- Vertices of the graph are:
  - **positive** when it belongs to the edges_sql
  - **negative** when it belongs to the points_sql
- Process is done only on edges with positive costs.
- Values are returned when there is a path.
  - The returned values are in the form of a set of *(start_vid, end_vid, agg_cost)*.
  - When the starting vertex and ending vertex are the same, there is no path.
    - The *agg_cost* in the non included values *(v, v)* is *0*
  - When the starting vertex and ending vertex are the different and there is no path.
    - The *agg_cost* in the non included values *(u, v)* is ∞
- If the values returned are stored in a table, the unique index would be the pair: *(start_vid, end_vid)*.
- For **undirected** graphs, the results are **symmetric**.
  - The *agg_cost* of *(u, v)* is the same as for *(v, u)*.
- For optimization purposes, any duplicated value in the *start_vids* or *end_vids* is ignored.
- The returned values are ordered:
  - *start_vid* ascending
  - *end_vid* ascending
- Running time: $O(| start\_vids | * (V \log V + E))$

Signatures

Summary

```
pgr_withPointsCost(edges_sql, points_sql, from_vid,  to_vid  [, directed] [, driving_side])
pgr_withPointsCost(edges_sql, points_sql, from_vid,  to_vids [, directed] [, driving_side])
pgr_withPointsCost(edges_sql, points_sql, from_vids, to_vid  [, directed] [, driving_side])
pgr_withPointsCost(edges_sql, points_sql, from_vids, to_vids [, directed] [, driving_side])
pgr_withPointsCost(Edges SQL, Points SQL, Combinations SQL  [, directed] [, driving_side] [, details])
RETURNS SET OF (start_vid, end_vid, agg_cost)
```

Note

There is no **details** flag, unlike the other members of the withPoints family of functions.

Using defaults

```
pgr_withPointsCost(edges_sql, points_sql, start_vid, end_vid)
RETURNS SET OF (start_vid, end_vid, agg_cost)
```

Example:
From point 1 to point 3

- For a **directed** graph.
- The driving side is set as **b** both. So arriving/departing to/from the point(s) can be in any direction.

```
SELECT * FROM pgr_withPointsCost(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    -1, -3);
 start_pid | end_pid | agg_cost
-----------+---------+----------
        -1 |      -3 |      3.2
(1 row)
```

One to One

```
pgr_withPointsCost(edges_sql, points_sql, from_vid,  to_vid  [, directed] [, driving_side])
RETURNS SET OF (seq, node, edge, cost, agg_cost)
```

Example:
From point \(1\) to vertex \(3\) on an **undirected** graph.

```
SELECT * FROM pgr_withPointsCost(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    -1, 3,
    directed := false);
 start_pid | end_pid | agg_cost
-----------+---------+----------
        -1 |       3 |      1.6
(1 row)
```

One to Many

```
pgr_withPointsCost(edges_sql, points_sql, from_vid,  to_vids [, directed] [, driving_side])
RETURNS SET OF (start_vid, end_vid, agg_cost)
```

Example:
From point \(1\) to point \(3\) and vertex \(5\) on a **directed** graph.

```
SELECT * FROM pgr_withPointsCost(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    -1, ARRAY[-3,5]);
 start_pid | end_pid | agg_cost
-----------+---------+----------
        -1 |      -3 |      3.2
        -1 |       5 |      1.6
(2 rows)
```

Many to One

```
pgr_withPointsCost(edges_sql, points_sql, from_vids, to_vid  [, directed] [, driving_side])
RETURNS SET OF (start_vid, end_vid, agg_cost)
```

Example:
From point \(1\) and vertex \(2\) to point \(3\) on a **directed** graph.

```
SELECT * FROM pgr_withPointsCost(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    ARRAY[-1,2], -3);
 start_pid | end_pid | agg_cost
-----------+---------+----------
        -1 |      -3 |      3.2
         2 |      -3 |      2.6
(2 rows)
```

Many to Many

```
pgr_withPointsCost(edges_sql, points_sql, from_vids, to_vids [, directed] [, driving_side])
RETURNS SET OF (start_vid, end_vid, agg_cost)
```

Example:
From point \(1\) and vertex \(2\) to point \(3\) and vertex \(7\) on a **directed** graph.

```
SELECT * FROM pgr_withPointsCost(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    ARRAY[-1,2], ARRAY[-3,7]);
 start_pid | end_pid | agg_cost
-----------+---------+----------
        -1 |      -3 |      3.2
        -1 |       7 |      3.6
         2 |      -3 |      2.6
         2 |       7 |        3
(4 rows)
```

Combinations SQL

```
pgr_withPointsCost(Edges SQL, Points SQL, Combinations SQL [, directed] [, driving_side] [, details])
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
```

Example:
Two (source, target) combinations: (from point \(1\) to vertex \(3\)), and (from vertex \(2\) to point \(3\)) with **right** side driving topology.

```
SELECT * FROM pgr_withPointsCost(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    'SELECT * FROM ( VALUES (-1, 3), (2, -3) ) AS t(source, target)',
    driving_side => 'r');
 start_pid | end_pid | agg_cost
-----------+---------+----------
        -1 |       3 |      6.4
         2 |      -3 |      2.6
(2 rows)
```

Parameters

Parameter	Type	Description
Edges SQL	TEXT	*Edges query* as described above.
Points SQL	TEXT	*Points query* as described above.
Combinations SQL	TEXT	*Combinations query* as described below.
start_vid	ANY-INTEGER	Starting vertex identifier. When negative: is a point's pid.
end_vid	ANY-INTEGER	Ending vertex identifier. When negative: is a point's pid.
start_vids	ARRAY[ANY-INTEGER]	Array of identifiers of starting vertices. When negative: is a point's pid.
end_vids	ARRAY[ANY-INTEGER]	Array of identifiers of ending vertices. When negative: is a point's pid.
directed	BOOLEAN	(optional). When false the graph is considered as Undirected. Default is true which considers the graph as Directed.
driving_side	CHAR	(optional) Value in ['b', 'r', 'l', NULL] indicating if the driving side is: • In the right or left or • If it doesn't matter with 'b' or NULL. • If column not present 'b' is considered.

Inner query

Edges query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Points query

Description of the Points SQL query

points_sql:
an SQL query, which should return a set of rows with the following columns:

Column	Type	Description
pid	ANY-INTEGER	(optional) Identifier of the point. • If column present, it can not be NULL. • If column not present, a sequential identifier will be given automatically.
edge_id	ANY-INTEGER	Identifier of the "closest" edge to the point.
fraction	ANY-NUMERICAL	Value in <0,1> that indicates the relative postition from the first end point of the edge.
side	CHAR	(optional) Value in ['b', 'r', 'l', NULL] indicating if the point is: • In the right, left of the edge or • If it doesn't matter with 'b' or NULL. • If column not present 'b' is considered.

Where:

ANY-INTEGER:
smallint, int, bigint
ANY-NUMERICAL:
smallint, int, bigint, real, float

Combinations query

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

Result Columns

Column	Type	Description
start_vid	BIGINT	Identifier of the starting vertex. When negative: is a point's pid.
end_vid	BIGINT	Identifier of the ending point. When negative: is a point's pid.
agg_cost	FLOAT	Aggregate cost from start_vid to end_vid.

Additional Examples

Example:
From point \(1\) and vertex \(2\) to point \(3\) and vertex \(7\), with **right** side driving topology

```
SELECT * FROM pgr_withPointsCost(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    ARRAY[-1,2], ARRAY[-3,7],
    driving_side := 'l');
 start_pid | end_pid | agg_cost
-----------+---------+----------
        -1 |      -3 |      3.2
        -1 |       7 |      3.6
         2 |      -3 |      2.6
         2 |       7 |        3
(4 rows)
```

Example:
From point \(1\) and vertex \(2\) to point \(3\) and vertex \(7\), with **left** side driving topology

```
SELECT * FROM pgr_withPointsCost(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    ARRAY[-1,2], ARRAY[-3,7],
    driving_side := 'r');
 start_pid | end_pid | agg_cost
-----------+---------+----------
        -1 |      -3 |        4
        -1 |       7 |      4.4
         2 |      -3 |      2.6
         2 |       7 |        3
(4 rows)
```

Example:
From point \(1\) and vertex \(2\) to point \(3\) and vertex \(7\), does not matter driving side.

```
SELECT * FROM pgr_withPointsCost(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    ARRAY[-1,2], ARRAY[-3,7],
    driving_side := 'b');
 start_pid | end_pid | agg_cost
-----------+---------+----------
        -1 |      -3 |      3.2
        -1 |       7 |      3.6
         2 |      -3 |      2.6
         2 |       7 |        3
(4 rows)
```

The queries use the **Sample Data** network.

See Also

- **withPoints - Family of functions**

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2**

pgr_withPointsKSP - Proposed

`pgr_withPointsKSP` - Find the K shortest paths using Yen's algorithm.

> **Warning**
>
> Proposed functions for next mayor release.
>
> - They are not officially in the current release.
> - They will likely officially be part of the next mayor release:
>   - The functions make use of ANY-INTEGER and ANY-NUMERICAL
>   - Name might not change. (But still can)
>   - Signature might not change. (But still can)
>   - Functionality might not change. (But still can)
>   - pgTap tests have being done. But might need more.
>   - Documentation might need refinement.

Boost Graph Inside

Availability

- Version 2.2.0
  - New **proposed** function

Description

Modifies the graph to include the points defined in the `points_sql` and using Yen algorithm, finds the \(K\) shortest paths.

Signatures

Summary

```
pgr_withPointsKSP(edges_sql, points_sql, start_pid, end_pid, K [, directed] [, heap_paths] [, driving_side] [, details])
RETURNS SET OF (seq, path_id, path_seq, node, edge, cost, agg_cost)
```

Using defaults

```
pgr_withPointsKSP(edges_sql, points_sql, start_pid, end_pid, K)
RETURNS SET OF (seq, path_id, path_seq, node, edge, cost, agg_cost)
```

Example:
From point \(1\) to point \(2\) in \(2\) cycles

- For a **directed** graph.
- The driving side is set as **b** both. So arriving/departing to/from the point(s) can be in any direction.
- No **details** are given about distance of other points of the query.
- No **heap paths** are returned.

```
SELECT * FROM pgr_withPointsKSP(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    -1, -2, 2);
 seq | path_id | path_seq | node | edge | cost | agg_cost
-----+---------+----------+------+------+------+----------
   1 |       1 |        1 |   -1 |    1 |  0.6 |        0
   2 |       1 |        2 |    2 |    4 |    1 |      0.6
   3 |       1 |        3 |    5 |    8 |    1 |      1.6
   4 |       1 |        4 |    6 |    9 |    1 |      2.6
   5 |       1 |        5 |    9 |   15 |  0.4 |      3.6
   6 |       1 |        6 |   -2 |   -1 |    0 |        4
   7 |       2 |        1 |   -1 |    1 |  0.6 |        0
   8 |       2 |        2 |    2 |    4 |    1 |      0.6
   9 |       2 |        3 |    5 |    8 |    1 |      1.6
  10 |       2 |        4 |    6 |   11 |    1 |      2.6
  11 |       2 |        5 |   11 |   13 |    1 |      3.6
  12 |       2 |        6 |   12 |   15 |  0.6 |      4.6
  13 |       2 |        7 |   -2 |   -1 |    0 |      5.2
(13 rows)
```

Complete Signature

Finds the \(K\) shortest paths depending on the optional parameters setup.

```
pgr_withPointsKSP(edges_sql, points_sql, start_pid, end_pid, K [, directed] [, heap_paths] [, driving_side] [, details])
RETURNS SET OF (seq, path_id, path_seq, node, edge, cost, agg_cost)
```

Example:
From point \(1\) to vertex \(6\) in \(2\) cycles with details.

```
SELECT * FROM pgr_withPointsKSP(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    -1, 6, 2, details := true);
 seq | path_id | path_seq | node | edge | cost | agg_cost
-----+---------+----------+------+------+------+----------
   1 |       1 |        1 |   -1 |    1 |  0.6 |        0
   2 |       1 |        2 |    2 |    4 |  0.7 |      0.6
   3 |       1 |        3 |   -6 |    4 |  0.3 |      1.3
   4 |       1 |        4 |    5 |    8 |    1 |      1.6
   5 |       1 |        5 |    6 |   -1 |    0 |      2.6
   6 |       2 |        1 |   -1 |    1 |  0.6 |        0
   7 |       2 |        2 |    2 |    4 |  0.7 |      0.6
   8 |       2 |        3 |   -6 |    4 |  0.3 |      1.3
   9 |       2 |        4 |    5 |   10 |    1 |      1.6
  10 |       2 |        5 |   10 |   12 |  0.6 |      2.6
  11 |       2 |        6 |   -3 |   12 |  0.4 |      3.2
  12 |       2 |        7 |   11 |   13 |    1 |      3.6
  13 |       2 |        8 |   12 |   15 |  0.6 |      4.6
  14 |       2 |        9 |   -2 |   15 |  0.4 |      5.2
  15 |       2 |       10 |    9 |    9 |    1 |      5.6
  16 |       2 |       11 |    6 |   -1 |    0 |      6.6
(16 rows)
```

Parameters

Parameter	Type	Description
edges_sql	TEXT	Edges SQL query as described above.
points_sql	TEXT	Points SQL query as described above.
start_pid	ANY-INTEGER	Starting point id.
end_pid	ANY-INTEGER	Ending point id.
K	INTEGER	Number of shortest paths.
directed	BOOLEAN	(optional). When `false` the graph is considered as Undirected. Default is `true` which considers the graph as Directed.
heap_paths	BOOLEAN	(optional). When `true` the paths calculated to get the shortests paths will be returned also. Default is `false` only the K shortest paths are returned.
driving_side	CHAR	(optional) Value in ['b', 'r', 'l', NULL] indicating if the driving side is: • In the right or left or • If it doesn't matter with 'b' or NULL. • If column not present 'b' is considered.
details	BOOLEAN	(optional). When `true` the results will include the driving distance to the points with in the `distance`. Default is `false` which ignores other points of the points_sql.

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Description of the Points SQL query

points_sql:
an SQL query, which should return a set of rows with the following columns:

Column	Type	Description
pid	ANY-INTEGER	(optional) Identifier of the point. • If column present, it can not be NULL. • If column not present, a sequential identifier will be given automatically.
edge_id	ANY-INTEGER	Identifier of the "closest" edge to the point.
fraction	ANY-NUMERICAL	Value in <0,1> that indicates the relative postition from the first end point of the edge.
side	CHAR	(optional) Value in ['b', 'r', 'l', NULL] indicating if the point is: • In the right, left of the edge or • If it doesn't matter with 'b' or NULL. • If column not present 'b' is considered.

Where:

ANY-INTEGER:
smallint, int, bigint
ANY-NUMERICAL:
smallint, int, bigint, real, float

Result Columns

Column	Type	Description
seq	INTEGER	Row sequence.
path_seq	INTEGER	Relative position in the path of node and edge. Has value 1 for the beginning of a path.
path_id	INTEGER	Path identifier. The ordering of the paths: For two paths i, j if i < j then agg_cost(i) <= agg_cost(j).
node	BIGINT	Identifier of the node in the path. Negative values are the identifiers of a point.
edge	BIGINT	Identifier of the edge used to go from node to the next node in the path sequence. • -1 for the last row in the path sequence.
cost	FLOAT	Cost to traverse from node using edge to the next node in the path sequence. • 0 for the last row in the path sequence.
agg_cost	FLOAT	Aggregate cost from start_pid to node. • 0 for the first row in the path sequence.

Additional Examples

Example:
Left side driving topology from point \(1\) to point \(2\) in \(2\) cycles, with details

```
SELECT * FROM pgr_withPointsKSP(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    -1, -2, 2,
    driving_side := 'l', details := true);
 seq | path_id | path_seq | node | edge | cost | agg_cost
-----+---------+----------+------+------+------+----------
   1 |       1 |        1 |   -1 |    1 |  0.6 |        0
   2 |       1 |        2 |    2 |    4 |  0.7 |      0.6
   3 |       1 |        3 |   -6 |    4 |  0.3 |      1.3
   4 |       1 |        4 |    5 |    8 |    1 |      1.6
   5 |       1 |        5 |    6 |    9 |    1 |      2.6
   6 |       1 |        6 |    9 |   15 |    1 |      3.6
   7 |       1 |        7 |   12 |   15 |  0.6 |      4.6
   8 |       1 |        8 |   -2 |   -1 |    0 |      5.2
   9 |       2 |        1 |   -1 |    1 |  0.6 |        0
  10 |       2 |        2 |    2 |    4 |  0.7 |      0.6
  11 |       2 |        3 |   -6 |    4 |  0.3 |      1.3
  12 |       2 |        4 |    5 |    8 |    1 |      1.6
  13 |       2 |        5 |    6 |   11 |    1 |      2.6
  14 |       2 |        6 |   11 |   13 |    1 |      3.6
  15 |       2 |        7 |   12 |   15 |  0.6 |      4.6
  16 |       2 |        8 |   -2 |   -1 |    0 |      5.2
(16 rows)
```

Example:
Right side driving topology from point \(1\) to point \(2\) in \(2\) cycles, with heap paths and details

```
SELECT * FROM pgr_withPointsKSP(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    -1, -2, 2,
    heap_paths := true, driving_side := 'r', details := true);
 seq | path_id | path_seq | node | edge | cost | agg_cost
-----+---------+----------+------+------+------+----------
   1 |       1 |        1 |   -1 |    1 |  0.4 |        0
   2 |       1 |        2 |    1 |    1 |    1 |      0.4
   3 |       1 |        3 |    2 |    4 |  0.7 |      1.4
   4 |       1 |        4 |   -6 |    4 |  0.3 |      2.1
   5 |       1 |        5 |    5 |    8 |    1 |      2.4
   6 |       1 |        6 |    6 |    9 |    1 |      3.4
   7 |       1 |        7 |    9 |   15 |  0.4 |      4.4
   8 |       1 |        8 |   -2 |   -1 |    0 |      4.8
   9 |       2 |        1 |   -1 |    1 |  0.4 |        0
  10 |       2 |        2 |    1 |    1 |    1 |      0.4
  11 |       2 |        3 |    2 |    4 |  0.7 |      1.4
  12 |       2 |        4 |   -6 |    4 |  0.3 |      2.1
  13 |       2 |        5 |    5 |    8 |    1 |      2.4
  14 |       2 |        6 |    6 |   11 |    1 |      3.4
  15 |       2 |        7 |   11 |   13 |    1 |      4.4
  16 |       2 |        8 |   12 |   15 |    1 |      5.4
  17 |       2 |        9 |    9 |   15 |  0.4 |      6.4
  18 |       2 |       10 |   -2 |   -1 |    0 |      6.8
  19 |       3 |        1 |   -1 |    1 |  0.4 |        0
  20 |       3 |        2 |    1 |    1 |    1 |      0.4
  21 |       3 |        3 |    2 |    4 |  0.7 |      1.4
  22 |       3 |        4 |   -6 |    4 |  0.3 |      2.1
  23 |       3 |        5 |    5 |   10 |    1 |      2.4
  24 |       3 |        6 |   10 |   12 |  0.6 |      3.4
  25 |       3 |        7 |   -3 |   12 |  0.4 |        4
  26 |       3 |        8 |   11 |   13 |    1 |      4.4
  27 |       3 |        9 |   12 |   15 |    1 |      5.4
  28 |       3 |       10 |    9 |   15 |  0.4 |      6.4
  29 |       3 |       11 |   -2 |   -1 |    0 |      6.8
(29 rows)
```

The queries use the **Sample Data** network.

See Also

- **withPoints - Family of functions**

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2**

pgr_withPointsDD - Proposed

`pgr_withPointsDD` - Returns the driving distance from a starting point.

> **Warning**
>
> Proposed functions for next mayor release.
>
> - They are not officially in the current release.
> - They will likely officially be part of the next mayor release:
>   - The functions make use of ANY-INTEGER and ANY-NUMERICAL
>   - Name might not change. (But still can)
>   - Signature might not change. (But still can)
>   - Functionality might not change. (But still can)
>   - pgTap tests have being done. But might need more.
>   - Documentation might need refinement.

Boost Graph Inside

Availability

- Version 2.2.0
  - New **proposed** function

Description

Modify the graph to include points and using Dijkstra algorithm, extracts all the nodes and points that have costs less than or equal to the value `distance` from the starting point. The edges extracted will conform the corresponding spanning tree.

Signatures

Summary

```
pgr_withPointsDD(edges_sql, points_sql, from_vids, distance [, directed] [, driving_side] [, details] [, equicost])
RETURNS SET OF (seq, node, edge, cost, agg_cost)
```

Using defaults

- For a **directed** graph.
- The driving side is set as **b** both. So arriving/departing to/from the point(s) can be in any direction.
- No **details** are given about distance of other points of the query.

```
pgr_withPointsDD(edges_sql, points_sql, start_vid, distance)
RETURNS SET OF (seq, node, edge, cost, agg_cost)
```

Example:
From point \(1\) with \(agg_cost <= 3.8\)

- For a **directed** graph.
- The driving side is set as **b** both. So arriving/departing to/from the point(s) can be in any direction.
- No **details** are given about distance of other points of the query.

```
SELECT * FROM pgr_withPointsDD(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    -1, 3.8);
 seq | node | edge | cost | agg_cost
-----+------+------+------+----------
   1 |   -1 |   -1 |    0 |        0
   2 |    1 |    1 |  0.4 |      0.4
   3 |    2 |    1 |  0.6 |      0.6
   4 |    5 |    4 |    1 |      1.6
   5 |    6 |    8 |    1 |      2.6
   6 |    8 |    7 |    1 |      2.6
   7 |   10 |   10 |    1 |      2.6
   8 |    7 |    6 |    1 |      3.6
   9 |    9 |    9 |    1 |      3.6
  10 |   11 |   11 |    1 |      3.6
  11 |   13 |   14 |    1 |      3.6
(11 rows)
```

Single vertex

Finds the driving distance depending on the optional parameters setup.

```
pgr_withPointsDD(edges_sql, points_sql, from_vid,  distance [, directed] [, driving_side] [, details])
RETURNS SET OF (seq, node, edge, cost, agg_cost)
```

Example:
Right side driving topology, from point \(1\) with \(agg_cost <= 3.8\)

```
SELECT * FROM pgr_withPointsDD(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    -1, 3.8,
    driving_side := 'r',
    details := true);
 seq | node | edge | cost | agg_cost
-----+------+------+------+----------
   1 |   -1 |   -1 |    0 |        0
   2 |    1 |    1 |  0.4 |      0.4
   3 |    2 |    1 |    1 |      1.4
   4 |   -6 |    4 |  0.7 |      2.1
   5 |    5 |    4 |  0.3 |      2.4
   6 |    6 |    8 |    1 |      3.4
   7 |    8 |    7 |    1 |      3.4
   8 |   10 |   10 |    1 |      3.4
(8 rows)
```

Multiple vertices

Finds the driving distance depending on the optional parameters setup.

```
pgr_withPointsDD(edges_sql, points_sql, from_vids, distance [, directed] [, driving_side] [, details] [, equicost])
RETURNS SET OF (seq, node, edge, cost, agg_cost)
```

Parameters

Parameter	Type	Description
edges_sql	TEXT	Edges SQL query as described above.
points_sql	TEXT	Points SQL query as described above.
start_vid	ANY-INTEGER	Starting point id
distance	ANY-NUMERICAL	Distance from the start_pid
directed	BOOLEAN	(optional). When false the graph is considered as Undirected. Default is true which considers the graph as Directed.
driving_side	CHAR	(optional). Value in ['b', 'r', 'l', NULL] indicating if the driving side is: • In the right or left or • If it doesn't matter with 'b' or NULL. • If column not present 'b' is considered.
details	BOOLEAN	(optional). When true the results will include the driving distance to the points with in the distance. Default is false which ignores other points of the points_sql.
equicost	BOOLEAN	(optional). When true the nodes will only appear in the closest start_v list. Default is false which resembles several calls using the single starting point signatures. Tie brakes are arbitrary.

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Description of the Points SQL query

points_sql:
an SQL query, which should return a set of rows with the following columns:

Column	Type	Description
pid	ANY-INTEGER	(optional) Identifier of the point. • If column present, it can not be NULL. • If column not present, a sequential identifier will be given automatically.
edge_id	ANY-INTEGER	Identifier of the “closest” edge to the point.
fraction	ANY-NUMERICAL	Value in <0,1> that indicates the relative postition from the first end point of the edge.
side	CHAR	(optional) Value in [‘b’, ‘r’, ‘l’, NULL] indicating if the point is: • In the right, left of the edge or • If it doesn’t matter with ‘b’ or NULL. • If column not present ‘b’ is considered.

Where:

ANY-INTEGER:
smallint, int, bigint
ANY-NUMERICAL:
smallint, int, bigint, real, float

Result Columns

Column	Type	Description
seq	INT	row sequence.
node	BIGINT	Identifier of the node within the Distance from start_pid. If details =: true a negative value is the identifier of a point.
edge	BIGINT	Identifier of the edge used to go from node to the next node in the path sequence. • -1 when start_vid = node.
cost	FLOAT	Cost to traverse edge. • 0 when start_vid = node.
agg_cost	FLOAT	Aggregate cost from start_vid to node. • 0 when start_vid = node.

Additional Examples

Examples for queries marked as directed with cost and reverse_cost columns.

The examples in this section use the following **Network for queries marked as directed and cost and reverse_cost columns are used**

Example:
Left side driving topology from point \(1\) with \(agg_cost <= 3.8\), with details

```
SELECT * FROM pgr_withPointsDD(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    -1, 3.8,
    driving_side := 'l',
    details := true);
 seq | node | edge | cost | agg_cost
-----+------+------+------+----------
   1 |   -1 |   -1 |    0 |        0
   2 |    2 |    1 |  0.6 |      0.6
   3 |   -6 |    4 |  0.7 |      1.3
   4 |    5 |    4 |  0.3 |      1.6
   5 |    1 |    1 |    1 |      1.6
   6 |    6 |    8 |    1 |      2.6
   7 |    8 |    7 |    1 |      2.6
   8 |   10 |   10 |    1 |      2.6
   9 |   -3 |   12 |  0.6 |      3.2
  10 |   -4 |    6 |  0.7 |      3.3
  11 |    7 |    6 |  0.3 |      3.6
  12 |    9 |    9 |    1 |      3.6
  13 |   11 |   11 |    1 |      3.6
  14 |   13 |   14 |    1 |      3.6
(14 rows)
```

Example:
From point \(1\) with \(agg_cost <= 3.8\), does not matter driving side, with details

```
SELECT * FROM pgr_withPointsDD(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    'SELECT pid, edge_id, fraction, side from pointsOfInterest',
    -1, 3.8,
    driving_side := 'b',
    details := true);
 seq | node | edge | cost | agg_cost
-----+------+------+------+----------
   1 |   -1 |   -1 |    0 |        0
   2 |    1 |    1 |  0.4 |      0.4
   3 |    2 |    1 |  0.6 |      0.6
   4 |   -6 |    4 |  0.7 |      1.3
   5 |    5 |    4 |  0.3 |      1.6
   6 |    6 |    8 |    1 |      2.6
   7 |    8 |    7 |    1 |      2.6
   8 |   10 |   10 |    1 |      2.6
   9 |   -3 |   12 |  0.6 |      3.2
  10 |   -4 |    6 |  0.7 |      3.3
  11 |    7 |    6 |  0.3 |      3.6
  12 |    9 |    9 |    1 |      3.6
  13 |   11 |   11 |    1 |      3.6
  14 |   13 |   14 |    1 |      3.6
(14 rows)
```

The queries use the **Sample Data** network.

See Also

- **pgr_drivingDistance** - Driving distance using dijkstra.
- **pgr_alphaShape** - Alpha shape computation.

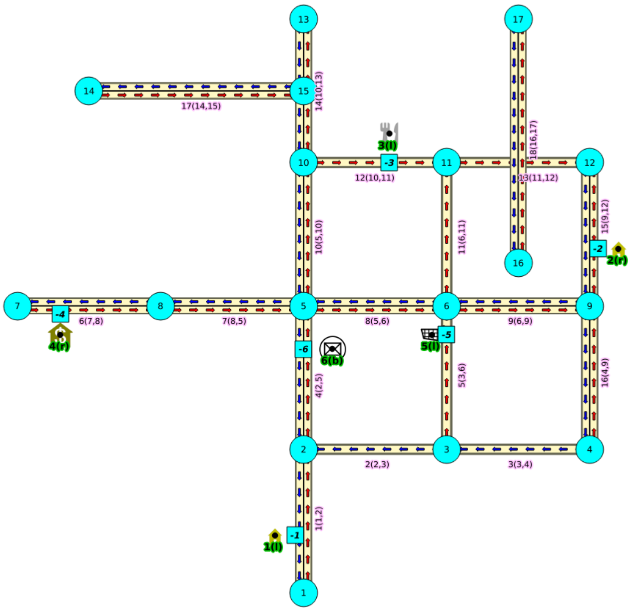
Indices and tables

- **Index**
- **Search Page**

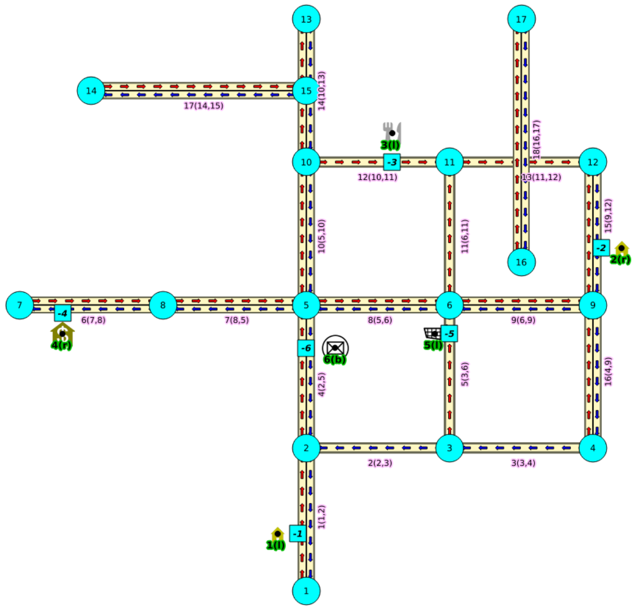
Images

The squared vertices are the temporary vertices, The temporary vertices are added according to the driving side, The following images visually show the differences on how depending on the driving side the data is interpreted.

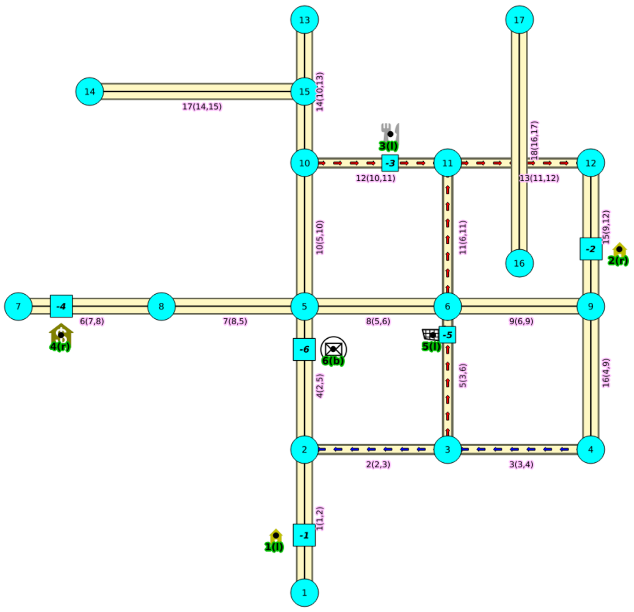
Right driving side



Left driving side



doesn’t matter the driving side



Introduction

This family of functions was thought for routing vehicles, but might as well work for some other application that we can not think of.

The with points family of function give you the ability to route between arbitrary points located outside the original graph.

When given a point identified with a *pid* that its being mapped to and edge with an identifier*edge_id*, with a *fraction* along that edge (from the source to the target of the edge) and some additional information about which *side* of the edge the point is on, then routing from arbitrary points more accurately reflect routing vehicles in road networks,

I talk about a family of functions because it includes different functionalities.

- pgr_withPoints is pgr_dijkstra based
- pgr_withPointsCost is pgr_dijkstraCost based
- pgr_withPointsKSP is pgr_ksp based
- pgr_withPointsDD is pgr_drivingDistance based

In all this functions we have to take care of as many aspects as possible:

- Must work for routing:
  - Cars (directed graph)
  - Pedestrians (undirected graph)
- Arriving at the point:
  - In either side of the street.

    - Compulsory arrival on the side of the street where the point is located.
- Countries with:
    - Right side driving
    - Left side driving
- Some points are:
    - Permanent, for example the set of points of clients stored in a table in the data base
    - Temporal, for example points given through a web application
- The numbering of the points are handled with negative sign.
    - Original point identifiers are to be positive.
    - Transformation to negative is done internally.
    - For results for involving vertices identifiers
        - positive sign is a vertex of the original graph
        - negative sign is a point of the temporary points

The reason for doing this is to avoid confusion when there is a vertex with the same number as identifier as the points identifier.

Graph & edges

- Let $G_d(V,E)$ where V is the set of vertices and E is the set of edges be the original directed graph.
    - An edge of the original *edges_sql* is $(id, source, target, cost, reverse\_cost)$ will generate internally
        - $(id, source, target, cost)$
        - $(id, target, source, reverse\_cost)$

Point Definition

- A point is defined by the quadruplet: $(pid, eid, fraction, side)$
    - **pid** is the point identifier
    - **eid** is an edge id of the *edges_sql*
    - **fraction** represents where the edge *eid* will be cut.
    - **side** Indicates the side of the edge where the point is located.

Creating Temporary Vertices in the Graph

For edge (15, 9,12 10, 20), & lets insert point (2, 12, 0.3, r)

On a right hand side driving network

From first image above:

- We can arrive to the point only via vertex 9.
- It only affects the edge (15, 9,12, 10) so that edge is removed.
- Edge (15, 12,9, 20) is kept.
- Create new edges:
    - (15, 9,-1, 3) edge from vertex 9 to point 1 has cost 3
    - (15, -1,12, 7) edge from point 1 to vertex 12 has cost 7

On a left hand side driving network

From second image above:

- We can arrive to the point only via vertex 12.
- It only affects the edge (15, 12,9 20) so that edge is removed.
- Edge (15, 9,12, 10) is kept.
- Create new edges:
    - (15, 12,-1, 14) edge from vertex 12 to point 1 has cost 14
    - (15, -1,9, 6) edge from point 1 to vertex 9 has cost 6

Remember:
that fraction is from vertex 9 to vertex 12

When driving side does not matter

From third image above:

- We can arrive to the point either via vertex 12 or via vertex 9
- Edge (15, 12,9 20) is removed.
- Edge (15, 9,12, 10) is removed.
- Create new edges:
    - (15, 12,-1, 14) edge from vertex 12 to point 1 has cost 14
    - (15, -1,9, 6) edge from point 1 to vertex 9 has cost 6

- (15, 9,-1, 3) edge from vertex 9 to point 1 has cost 3
- (15, -1,12, 7) edge from point 1 to vertex 12 has cost 7

See Also

Indices and tables

- **Index**
- **Search Page**

See Also

- **Experimental Functions**

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2**

Experimental Functions

Warning

Possible server crash

- These functions might create a server crash

Warning

Experimental functions

- They are not officially of the current release.
- They likely will not be officially be part of the next release:
  - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
  - Name might change.
  - Signature might change.
  - Functionality might change.
  - pgTap tests might be missing.
  - Might need c/c++ coding.
  - May lack documentation.
  - Documentation if any might need to be rewritten.
  - Documentation examples might need to be automatically generated.
  - Might need a lot of feedback from the comunity.
  - Might depend on a proposed function of pgRouting
  - Might depend on a deprecated function of pgRouting

Families

Flow - Family of functions

- **pgr_maxFlowMinCost - Experimental** - Details of flow and cost on edges.
- **pgr_maxFlowMinCost_Cost - Experimental** - Only the Min Cost calculation.

Chinese Postman Problem - Family of functions (Experimental)

- **pgr_chinesePostman - Experimental**
- **pgr_chinesePostmanCost - Experimental**

Coloring - Family of functions (Experimental)

- **pgr_sequentialVertexColoring - Experimental** - Vertex coloring algorithm using greedy approach.
- **pgr_bipartite -Experimental** - Bipartite graph algorithm using a DFS-based coloring approach.

Topology - Family of Functions

- **pgr_extractVertices – Experimental** - Extracts vertices information based on the source and target.

Transformation - Family of functions (Experimental)

- **pgr_lineGraph - Experimental** - Transformation algorithm for generating a Line Graph.
- **pgr_lineGraphFull - Experimental** - Transformation algorithm for generating a Line Graph out of each vertex in the input graph.

Traversal - Family of functions (Experimental)

- **pgr_depthFirstSearch - Experimental** - Depth first search traversal of the graph.

Components - Family of functions

- **pgr_makeConnected - Experimental** - Details of edges to make graph connected.

Dijkstra - Family of functions

- **pgr_dijkstraNear - Experimental** - Get the route to the nearest vertex.
- **pgr_dijkstraNearCost - Experimental** - Get the cost to the nearest vertex.

- **Supported versions: Latest** (**3.2**) **3.1 3.0**

Chinese Postman Problem - Family of functions (Experimental)

- **pgr_chinesePostman - Experimental**
- **pgr_chinesePostmanCost - Experimental**

- **Supported versions Latest** (**3.2**) **3.1 3.0**

pgr_chinesePostman - Experimental

`pgr_chinesePostman` — Calculates the shortest circuit path which contains every edge in a directed graph and starts and ends on the same vertex.

> **Warning**
>
> Possible server crash
>
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>   - Documentation if any might need to be rewritten.
>   - Documentation examples might need to be automatically generated.
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>   - Might depend on a proposed function of pgRouting
>   - Might depend on a deprecated function of pgRouting

Availability

- Version 3.0.0
  - New **experimental** function

Description

The main characteristics are:

- Process is done only on edges with **positive** costs.
- Running time: \(O(E * (E + V * logV))\)

- Graph must be connected.
- Returns EMPTY SET on a disconnected graph

Signatures

```
pgr_chinesePostman(edges_sql)
RETURNS SET OF (seq, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

```
SELECT * FROM pgr_chinesePostman(
    'SELECT id,
     source, target,
     cost, reverse_cost FROM edge_table where id < 17'
);
 seq | node | edge | cost | agg_cost
-----+------+------+------+----------
   1 |    1 |    1 |    1 |        0
   2 |    2 |    4 |    1 |        1
   3 |    5 |    4 |    1 |        2
   4 |    2 |    4 |    1 |        3
   5 |    5 |    7 |    1 |        4
   6 |    8 |    6 |    1 |        5
   7 |    7 |    6 |    1 |        6
   8 |    8 |    7 |    1 |        7
   9 |    5 |    8 |    1 |        8
  10 |    6 |    8 |    1 |        9
  11 |    5 |   10 |    1 |       10
  12 |   10 |   10 |    1 |       11
  13 |    5 |   10 |    1 |       12
  14 |   10 |   14 |    1 |       13
  15 |   13 |   14 |    1 |       14
  16 |   10 |   12 |    1 |       15
  17 |   11 |   13 |    1 |       16
  18 |   12 |   15 |    1 |       17
  19 |    9 |    9 |    1 |       18
  20 |    6 |    9 |    1 |       19
  21 |    9 |   15 |    1 |       20
  22 |   12 |   15 |    1 |       21
  23 |    9 |   16 |    1 |       22
  24 |    4 |    3 |    1 |       23
  25 |    3 |    5 |    1 |       24
  26 |    6 |   11 |    1 |       25
  27 |   11 |   13 |    1 |       26
  28 |   12 |   15 |    1 |       27
  29 |    9 |   16 |    1 |       28
  30 |    4 |   16 |    1 |       29
  31 |    9 |   16 |    1 |       30
  32 |    4 |    3 |    1 |       31
  33 |    3 |    2 |    1 |       32
  34 |    2 |    1 |    1 |       33
  35 |    1 |   -1 |    0 |       34
(35 rows)
```

Parameters

Column	Type	Default	Description
edges_sql	TEXT		The edges SQL query as described in **Inner query**.

Inner query

An Edges SQL that represents a **directed** graph with the following columns

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it’s not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it’s not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns set of `(seq, node, edge, cost, agg_cost)`

Column	Type	Description
seq	`INT`	Sequential value starting from **1**.
node	`BIGINT`	Identifier of the node in the path from `start_vid` to `end_vid`.
edge	`BIGINT`	Identifier of the edge used to go from `node` to the next node in the path sequence. `-1` for the last node of the path.
cost	`FLOAT`	Cost to traverse from `node` using `edge` to the next node in the path sequence.
agg_cost	`FLOAT`	Aggregate cost from `start_v` to `node`.

See Also

- **Chinese Postman Problem - Family of functions (Experimental)**

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.1 3.0**

pgr_chinesePostmanCost - Experimental

`pgr_chinesePostmanCost` — Calculates the minimum costs of a circuit path which contains every edge in a directed graph and starts and ends on the same vertex.

> **Warning**
>
> Possible server crash
>
> - These functions might create a server crash

> **Warning**
>
> Experimental functions
>
> - They are not officially of the current release.
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>   - Functionality might change.
>   - pgTap tests might be missing.
>   - Might need c/c++ coding.
>   - May lack documentation.
>   - Documentation if any might need to be rewritten.
>   - Documentation examples might need to be automatically generated.
>   - Might need a lot of feedback from the comunity.
>   - Might depend on a proposed function of pgRouting
>   - Might depend on a deprecated function of pgRouting

Availability

- Version 3.0.0
  - New **experimental** function

Description

The main characteristics are:

- Process is done only on edges with **positive** costs.
- Running time: \(O(E * (E + V * logV))\)
- Graph must be connected.
- [TBD] Return value when the graph if disconnected

Signatures

```
pgr_chinesePostmanCost(edges_sql)
RETURNS FLOAT
```

Example:

```
SELECT * FROM pgr_chinesePostmanCost(
   'SELECT id,
    source, target,
    cost, reverse_cost FROM edge_table where id < 17'
);
 pgr_chinesepostmancost
------------------------
                     34
(1 row)
```

Parameters

Column	Type	Default	Description
edges_sql	TEXT		The edges SQL query as described in **Inner query**.

Inner query

An Edges SQL that represents a **directed** graph with the following columns

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* - When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, - When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Type	Description
FLOAT	Minimum costs of a circuit path.

See Also

- **Chinese Postman Problem - Family of functions (Experimental)**

Indices and tables

- **Index**
- **Search Page**

Warning

Possible server crash

- These functions might create a server crash

Warning

Experimental functions

- They are not officially of the current release.
- They likely will not be officially be part of the next release:
  - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
  - Name might change.
  - Signature might change.
  - Functionality might change.
  - pgTap tests might be missing.
  - Might need c/c++ coding.
  - May lack documentation.
  - Documentation if any might need to be rewritten.
  - Documentation examples might need to be automatically generated.
  - Might need a lot of feedback from the comunity.
  - Might depend on a proposed function of pgRouting
  - Might depend on a deprecated function of pgRouting

Description

The main characteristics are:

- Process is done only on edges with **positive** costs.
- Running time: \(O(E * (E + V * logV))\)
- Graph must be connected.

Parameters

Column	Type	Default	Description
edges_sql	TEXT		The edges SQL query as described in **Inner query**.

Inner query

An Edges SQL that represents a **directed** graph with the following columns

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

See Also

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest** (**3.2**)

Coloring - Family of functions (Experimental)

Warning

Possible server crash

- These functions might create a server crash

Warning

Experimental functions

- They are not officially of the current release.
- They likely will not be officially be part of the next release:
  - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
  - Name might change.
  - Signature might change.
  - Functionality might change.
  - pgTap tests might be missing.
  - Might need c/c++ coding.
  - May lack documentation.
  - Documentation if any might need to be rewritten.
  - Documentation examples might need to be automatically generated.
  - Might need a lot of feedback from the comunity.
  - Might depend on a proposed function of pgRouting
  - Might depend on a deprecated function of pgRouting

- **pgr_sequentialVertexColoring - Experimental** - Vertex coloring algorithm using greedy approach.
- **pgr_bipartite -Experimental** - Bipartite graph algorithm using a DFS-based coloring approach.

- **Supported versions: Latest (3.2)**

pgr_sequentialVertexColoring - Experimental

`pgr_sequentialVertexColoring` — Returns the vertex coloring of an undirected graph, using greedy approach.

Boost Graph Inside

Warning

Possible server crash

- These functions might create a server crash

Warning

Experimental functions

- They are not officially of the current release.
- They likely will not be officially be part of the next release:
  - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
  - Name might change.
  - Signature might change.
  - Functionality might change.
  - pgTap tests might be missing.
  - Might need c/c++ coding.
  - May lack documentation.
  - Documentation if any might need to be rewritten.
  - Documentation examples might need to be automatically generated.
  - Might need a lot of feedback from the comunity.
  - Might depend on a proposed function of pgRouting
  - Might depend on a deprecated function of pgRouting

Availability

- Version 3.2.0
  - New **experimental** function

Description

Sequential Vertex Coloring algorithm is a graph coloring algorithm in which color identifiers are assigned to the vertices of a graph in a sequential manner, such that no edge connects two identically colored vertices.

The main Characteristics are:

- The implementation is applicable only for **undirected** graphs.
- Provides the color to be assigned to all the vertices present in the graph.
- Color identifiers values are in the Range \([1, |V|]\)
- The algorithm tries to assign the least possible color to every vertex.
- Efficient graph coloring is an NP-Hard problem, and therefore, this algorithm does not always produce optimal coloring. It follows a greedy strategy by iterating through all the vertices sequentially, and assigning the smallest possible color that is not used by its neighbors, to each vertex.
- The returned rows are ordered in ascending order of the vertex value.
- Sequential Vertex Coloring Running Time: \(O(|V|*(d + k))\)
  - where \(|V|\) is the number of vertices,
  - \(d\) is the maximum degree of the vertices in the graph,
  - \(k\) is the number of colors used.

Signatures

```
pgr_sequentialVertexColoring(Edges SQL) -- Experimental on v3.2

RETURNS SET OF (vertex_id, color_id)
OR EMPTY SET
```

Example:
Graph coloring of pgRouting **Sample Data**

```
SELECT * FROM pgr_sequentialVertexColoring(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table
    ORDER BY id'
);
 vertex_id | color_id
-----------+----------
         1 |        1
         2 |        2
         3 |        1
         4 |        2
         5 |        1
         6 |        2
         7 |        1
         8 |        2
         9 |        1
        10 |        2
        11 |        1
        12 |        2
        13 |        1
        14 |        1
        15 |        2
        16 |        1
        17 |        2
(17 rows)
```

Parameters

Parameter	Type	Description
Edges SQL	TEXT	Inner query as described below.

Inner query

Edges SQL:
an SQL query of an **undirected** graph, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Column	Type	Default	Description
cost	ANY-NUMERICAL		• When positive: edge *(source, target)* exist on the graph. • When negative: edge *(source, target)* does not exist on the graph.
reverse_cost	ANY-NUMERICAL	-1	• When positive: edge *(target, source)* exist on the graph. • When negative: edge *(target, source)* does not exist on the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns SET OF (vertex_id, color_id)

Column	Type	Description
vertex_id	BIGINT	Identifier of the vertex.
color_id	BIGINT	Identifier of the color of the vertex. • The minimum value of color is 1.

See Also

- The queries use the **Sample Data** network.
- **Boost: Sequential Vertex Coloring algorithm documentation**
- **Wikipedia: Graph coloring**

Indices and tables

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- **Supported versions: Latest (3.2)**

pgr_bipartite -Experimental

pgr_bipartite — If graph is bipartite then function returns the vertex id along with color (0 and 1) else it will return an empty set. In particular, the is_bipartite() algorithm implemented by Boost.Graph.

Boost Graph Inside

> **Warning**
>
> Possible server crash
>
> - These functions might create a server crash

> **Warning**
>
> Experimental functions
>
> - They are not officially of the current release.
> - They likely will not be officially be part of the next release:
>   - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
>   - Name might change.
>   - Signature might change.
>   - Functionality might change.
>   - pgTap tests might be missing.
>   - Might need c/c++ coding.

- May lack documentation.
- Documentation if any might need to be rewritten.
- Documentation examples might need to be automatically generated.
- Might need a lot of feedback from the comunity.
- Might depend on a proposed function of pgRouting
- Might depend on a deprecated function of pgRouting

Availability

- Version 3.2.0
  - New **experimental** function

Description

A bipartite graph is a graph with two sets of vertices which are connected to each other, but not within themselves. A bipartite graph is possible if the graph coloring is possible using two colors such that vertices in a set are colored with the same color.

The main Characteristics are:

- The algorithm works in undirected graph only.
- The returned values are not ordered.
- The algorithm checks graph is bipartite or not. If it is bipartite then it returns the node along with two colors *0* and *1* which represents two different sets.
- If graph is not bipartite then algorithm returns empty set.
- Running time: \(O(V + E)\)

Signatures

```
pgr_bipartite(Edges SQL) -- Experimental on v3.2

RETURNS SET OF (vertex_id, color_id)
OR EMPTY SET
```

Example:
The pgr_bipartite algorithm with and edge_sql as a parameter when graph is bipartite:

```
SELECT * FROM pgr_bipartite(
   $$SELECT id,source,target,cost,reverse_cost FROM edge_table$$
);
 vertex_id | color_id
-----------+----------
         1 |        0
         2 |        1
         3 |        0
         4 |        1
         5 |        0
         6 |        1
         7 |        0
         8 |        1
         9 |        0
        10 |        1
        11 |        0
        12 |        1
        13 |        0
        14 |        0
        15 |        1
        16 |        0
        17 |        1
(17 rows)
```

Parameters

Parameter	Type	Description
Edges SQL	TEXT	Inner query as described below.

Inner query

Edges SQL:
an SQL query of an **undirected** graph, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.

Column	Type	Default	Description
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		• When positive: edge *(source, target)* exist on the graph. • When negative: edge *(source, target)* does not exist on the graph.
reverse_cost	ANY-NUMERICAL	-1	• When positive: edge *(target, source)* exist on the graph. • When negative: edge *(target, source)* does not exist on the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns SET OF (vertex_id, color_id)

Column	Type	Description
vertex_id	BIGINT	Identifier of the vertex.
color_id	BIGINT	Identifier of the color of the vertex. • The minimum value of color is 1.

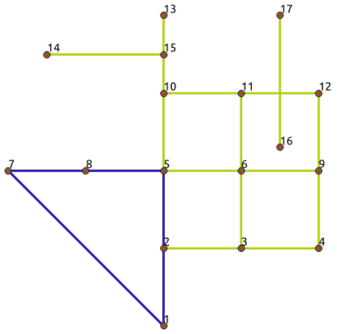
Additional Example

Example:
The odd length cyclic graph can not be bipartite.

The following edge will make subgraph with vertices {1, 2, 5, 7, 8} an odd length cyclic graph.

```
INSERT INTO edge_table (source, target, cost, reverse_cost) VALUES
(1, 7, 1, 1);
INSERT 0 1
```

The new graph is not bipartite because it has a odd length cycle of 5 vertices. Edges in blue represent odd length cycle.




```
SELECT * FROM pgr_bipartite(
    $$SELECT id,source,target,cost,reverse_cost FROM edge_table$$
);
 vertex_id | color_id
-----------+----------
(0 rows)
```

See Also

- **Boost: is_bipartite algorithm documentation**
- **Wikipedia: bipartite graph**
- **Sample Data** network.

Indices and tables

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Parameters

Parameter	Type	Description
Edges SQL	TEXT	Inner query as described below.

Inner query

Edges SQL:
an SQL query of an **undirected** graph, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		• When positive: edge *(source, target)* exist on the graph. • When negative: edge *(source, target)* does not exist on the graph.
reverse_cost	ANY-NUMERICAL	-1	• When positive: edge *(target, source)* exist on the graph. • When negative: edge *(target, source)* does not exist on the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns SET OF (vertex_id, color_id)

Column	Type	Description
vertex_id	BIGINT	Identifier of the vertex.
color_id	BIGINT	Identifier of the color of the vertex. • The minimum value of color is 1.

See Also

- **Boost: Sequential Vertex Coloring algorithm documentation**
- **Wikipedia: Graph coloring**

- **Boost: is_bipartite algorithm documentation**
- **Wikipedia: bipartite graph**

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- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.1) 3.0**
- **Unsupported versions: 2.6**

Transformation - Family of functions (Experimental)

> **Warning**
>
> Possible server crash
>
> - These functions might create a server crash

> **Warning**
>
> Experimental functions
>
> - They are not officially of the current release.

- They likely will not be officially be part of the next release:
  - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
  - Name might change.
  - Signature might change.
  - Functionality might change.
  - pgTap tests might be missing.
  - Might need c/c++ coding.
  - May lack documentation.
  - Documentation if any might need to be rewritten.
  - Documentation examples might need to be automatically generated.
  - Might need a lot of feedback from the comunity.
  - Might depend on a proposed function of pgRouting
  - Might depend on a deprecated function of pgRouting

- **pgr_lineGraph - Experimental** - Transformation algorithm for generating a Line Graph.
- **pgr_lineGraphFull - Experimental** - Transformation algorithm for generating a Line Graph out of each vertex in the input graph.

- **Supported versions: Latest** (**3.2**) **3.1**) **3.0**
- **Unsupported versions: 2.6 2.5**

pgr_lineGraph - Experimental

`pgr_lineGraph` — Transforms a given graph into its corresponding edge-based graph.

Boost Graph Inside

Warning

Possible server crash

- These functions might create a server crash

Warning

Experimental functions

- They are not officially of the current release.
- They likely will not be officially be part of the next release:
  - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
  - Name might change.
  - Signature might change.
  - Functionality might change.
  - pgTap tests might be missing.
  - Might need c/c++ coding.
  - May lack documentation.
  - Documentation if any might need to be rewritten.
  - Documentation examples might need to be automatically generated.
  - Might need a lot of feedback from the comunity.
  - Might depend on a proposed function of pgRouting
  - Might depend on a deprecated function of pgRouting

Availability

- Version 2.5.0
  - New **Experimental** function

Description

Given a graph G, its line graph L(G) is a graph such that:

- Each vertex of L(G) represents an edge of G

- Two vertices of L(G) are adjacent if and only if their corresponding edges share a common endpoint in G.

Signatures

Summary

```
pgr_lineGraph(edges_sql, directed)
RETURNS SET OF (seq, source, target, cost, reverse_cost)
OR EMPTY SET
```

Using defaults

```
pgr_lineGraph(edges_sql)
RETURNS SET OF (seq, source, target, cost, reverse_cost) OR EMPTY SET
```

Example:
For a **directed** graph

```
SELECT * FROM pgr_lineGraph(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table'
);
 seq | source | target | cost | reverse_cost
-----+--------+--------+------+-------------
   1 |    -18 |     18 |    1 |            1
   2 |    -17 |     17 |    1 |            1
   3 |    -16 |     -3 |    1 |           -1
   4 |    -16 |     16 |    1 |            1
   5 |    -15 |     -9 |    1 |            1
   6 |    -15 |     15 |    1 |            1
   7 |    -14 |    -10 |    1 |            1
   8 |    -14 |     12 |    1 |           -1
   9 |    -14 |     14 |    1 |            1
  10 |    -10 |     -7 |    1 |            1
  11 |    -10 |     -4 |    1 |            1
  12 |    -10 |      8 |    1 |            1
  13 |    -10 |     10 |    1 |            1
  14 |     -9 |     -8 |    1 |            1
  15 |     -9 |      9 |    1 |            1
  16 |     -9 |     11 |    1 |           -1
  17 |     -8 |     -7 |    1 |            1
  18 |     -8 |     -4 |    1 |            1
  19 |     -8 |      8 |    1 |            1
  20 |     -7 |     -6 |    1 |            1
  21 |     -6 |      6 |    1 |            1
  22 |     -4 |     -1 |    1 |            1
  23 |     -4 |      4 |    1 |            1
  24 |     -3 |     -2 |    1 |           -1
  25 |     -3 |      5 |    1 |           -1
  26 |     -2 |     -1 |    1 |           -1
  27 |     -2 |      4 |    1 |           -1
  28 |     -1 |      1 |    1 |            1
  29 |      5 |     -8 |    1 |           -1
  30 |      5 |      9 |    1 |           -1
  31 |      5 |     11 |    1 |           -1
  32 |      7 |     -7 |    1 |            1
  33 |      7 |     -4 |    1 |            1
  34 |      8 |     11 |    1 |           -1
  35 |     10 |     12 |    1 |           -1
  36 |     11 |     13 |    1 |           -1
  37 |     12 |     13 |    1 |           -1
  38 |     13 |    -15 |    1 |           -1
  39 |     16 |     -9 |    1 |            1
  40 |     16 |     15 |    1 |            1
(40 rows)
```

Complete Signature

```
pgr_lineGraph(edges_sql, directed);
RETURNS SET OF (seq, source, target, cost, reverse_cost) OR EMPTY SET
```

Example:
For an **undirected** graph

```
SELECT * FROM pgr_lineGraph(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    FALSE
);
 seq | source | target | cost | reverse_cost
-----+--------+--------+------+-------------
   1 |     -3 |     -2 |    1 |           -1
   2 |     -3 |      5 |    1 |           -1
   3 |     -2 |      4 |    1 |           -1
   4 |      1 |      4 |    1 |           -1
   5 |      4 |      8 |    1 |           -1
   6 |      4 |     10 |    1 |           -1
   7 |      5 |      9 |    1 |           -1
   8 |      5 |     11 |    1 |           -1
   9 |      6 |      7 |    1 |           -1
  10 |      7 |      8 |    1 |           -1
  11 |      7 |     10 |    1 |           -1
  12 |      8 |      9 |    1 |           -1
  13 |      8 |     11 |    1 |           -1
  14 |      9 |     15 |    1 |           -1
  15 |     10 |     12 |    1 |           -1
  16 |     10 |     14 |    1 |           -1
  17 |     11 |     13 |    1 |           -1
  18 |     12 |     13 |    1 |           -1
  19 |     16 |     15 |    1 |           -1
(19 rows)
```

Parameters

Column	Type	Description
edges_sql	TEXT	SQL query as described above.
directed	BOOLEAN	• When true the graph is considered as *Directed*. • When false the graph is considered as *Undirected*.

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

RETURNS SETOF (seq, source, target, cost, reverse_cost)

Column	Type	Description
seq	INTEGER	Sequential value starting from **1**.
source	BIGINT	Identifier of the source vertex of the current edge*id*. • When *negative*: the source is the reverse edge in the original graph.
target	BIGINT	Identifier of the target vertex of the current edge*id*. • When *negative*: the target is the reverse edge in the original graph.
cost	FLOAT	Weight of the edge (*source*, *target*). • When *negative*: edge (*source*, *target*) does not exist, therefore it's not part of the graph.

Column	Type	Description
reverse_cost	FLOAT	Weight of the edge (*target*, *source*). • When *negative*: edge (*target*, *source*) does not exist, therefore it's not part of the graph.

See Also

- **https://en.wikipedia.org/wiki/Line_graph**
- The queries use the **Sample Data** network.

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- **Supported versions: Latest** (**3.2**) **3.1**) **3.0**
- **Unsupported versions: 2.6**

pgr_lineGraphFull - Experimental

pgr_lineGraphFull — Transforms a given graph into a new graph where all of the vertices from the original graph are converted to line graphs.

Warning

Possible server crash

- These functions might create a server crash

Warning

Experimental functions

- They are not officially of the current release.
- They likely will not be officially be part of the next release:
  - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
  - Name might change.
  - Signature might change.
  - Functionality might change.
  - pgTap tests might be missing.
  - Might need c/c++ coding.
  - May lack documentation.
  - Documentation if any might need to be rewritten.
  - Documentation examples might need to be automatically generated.
  - Might need a lot of feedback from the comunity.
  - Might depend on a proposed function of pgRouting
  - Might depend on a deprecated function of pgRouting

Availability

- Version 2.6.0
  - New **Experimental** function

Description

pgr_lineGraphFull, converts original directed graph to a directed line graph by converting each vertex to a complete graph and keeping all the original edges. The new connecting edges have a cost 0 and go between the adjacent original edges, respecting the directionality.

A possible application of the resulting graph is **"routing with two edge restrictions"**:

- Setting a cost of using the vertex when routing between edges on the connecting edge
- Forbid the routing between two edges by removing the connecting edge

This is possible because each of the intersections (vertices) in the original graph are now complete graphs that have a new edge for each possible turn across that intersection.

The main characteristics are:

- This function is for **directed** graphs.
- Results are undefined when a negative vertex id is used in the input graph.
- Results are undefined when a duplicated edge id is used in the input graph.
- Running time: TBD

Signatures

Summary

```
pgr_lineGraphFull(edges_sql)
RETURNS SET OF (seq, source, target, cost, edge)
   OR EMPTY SET
```

Using defaults

```
pgr_lineGraphFull(TEXT edges_sql)
RETURNS SET OF (seq, source, target, cost, edge) OR EMPTY SET
```

Example:
Full line graph of subgraph of edges\(\{4, 7, 8, 10\}\)

```
SELECT * FROM pgr_lineGraphFull(
   'SELECT id, source, target, cost, reverse_cost
      FROM edge_table
      WHERE id IN (4,7,8,10)'
);
 seq | source | target | cost | edge
-----+--------+--------+------+------
   1 |     -1 |      5 |    1 |    4
   2 |      2 |     -1 |    0 |    0
   3 |     -2 |      2 |    1 |   -4
   4 |     -3 |      8 |    1 |   -7
   5 |     -4 |      6 |    1 |    8
   6 |     -5 |     10 |    1 |   10
   7 |      5 |     -2 |    0 |    0
   8 |      5 |     -3 |    0 |    0
   9 |      5 |     -4 |    0 |    0
  10 |      5 |     -5 |    0 |    0
  11 |     -6 |     -2 |    0 |    0
  12 |     -6 |     -3 |    0 |    0
  13 |     -6 |     -4 |    0 |    0
  14 |     -6 |     -5 |    0 |    0
  15 |     -7 |     -2 |    0 |    0
  16 |     -7 |     -3 |    0 |    0
  17 |     -7 |     -4 |    0 |    0
  18 |     -7 |     -5 |    0 |    0
  19 |     -8 |     -2 |    0 |    0
  20 |     -8 |     -3 |    0 |    0
  21 |     -8 |     -4 |    0 |    0
  22 |     -8 |     -5 |    0 |    0
  23 |     -9 |     -6 |    1 |    7
  24 |      8 |     -9 |    0 |    0
  25 |    -10 |     -7 |    1 |   -8
  26 |      6 |    -10 |    0 |    0
  27 |    -11 |     -8 |    1 |  -10
  28 |     10 |    -11 |    0 |    0
(28 rows)
```

Parameters

Column	Type	Default	Description
sql	TEXT		SQL query as described above.

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.

Column	Type	Default	Description
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Additional Examples

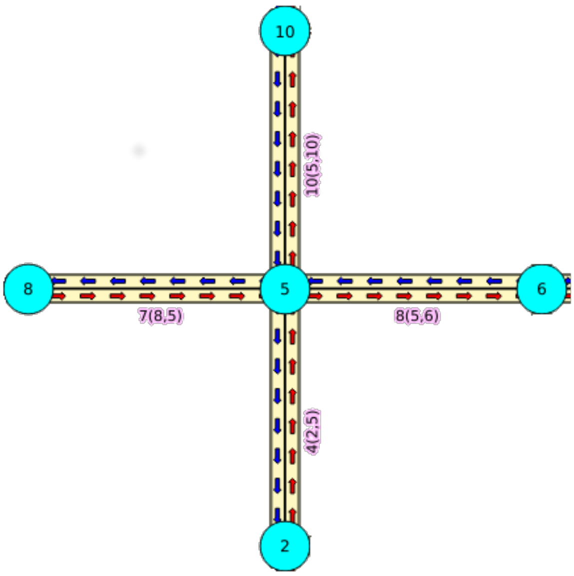
The examples of this section are based on the **Sample Data** network.

The examples include the subgraph including edges 4, 7, 8, and 10 with reverse_cost.

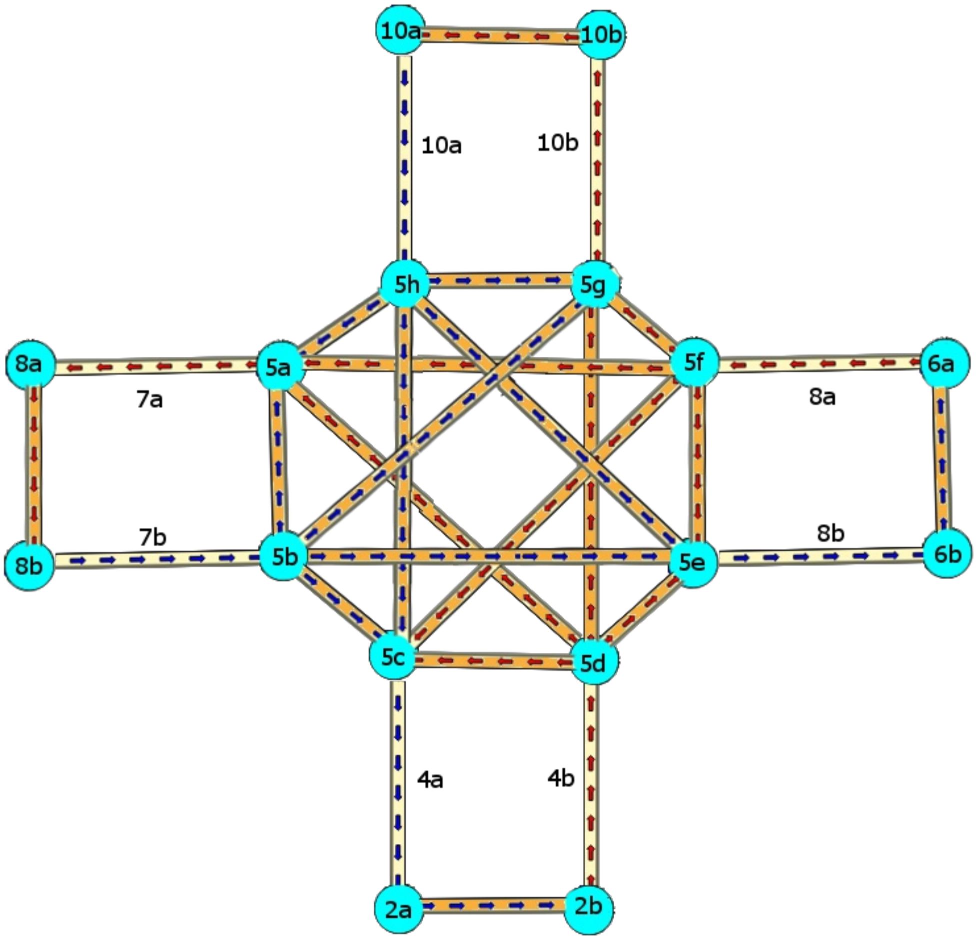
Example:
For generating the LineGraphFull

This example displays how this graph transformation works to create additional edges for each possible turn in a graph.

```
SELECT id, source, target, cost, reverse_cost
  FROM edge_table
  WHERE id IN (4,7,8,10);
```




```
SELECT * FROM pgr_lineGraphFull('SELECT id,
                                    source,
                                    target,
                                    cost,
                                    reverse_cost
                                FROM edge_table
                                  WHERE id IN (4,7,8,10)');
```



In the transformed graph, all of the edges from the original graph are still present (yellow), but we now have additional edges for every turn that could be made across vertex 6 (orange).

Example:
For creating table that identifies transformed vertices

The vertices in the transformed graph are each created by splitting up the vertices in the original graph. Unless a vertex in the original graph is a leaf vertex, it will generate more than one vertex in the transformed graph. One of the newly created vertices in the transformed graph will be given the same vertex-id as the vertex that it was created from in the original graph, but the rest of the newly created vertices will have negative vertex ids. Following is an example of how to generate a table that maps the ids of the newly created vertices with the original vertex that they were created from

The first step is to store your results graph into a table and then create the vertex mapping table with one row for each distinct vertex id in the results graph.

```
CREATE TABLE lineGraph_edges AS SELECT * FROM pgr_lineGraphFull(
    $$SELECT id, source, target, cost, reverse_cost
    FROM edge_table WHERE id IN (4,7,8,10)$$
);
SELECT 28
CREATE TABLE lineGraph_vertices AS
SELECT *, NULL::BIGINT AS original_id
FROM (SELECT source AS id FROM lineGraph_edges
    UNION
    SELECT target FROM lineGraph_edges) as foo
ORDER BY id;
SELECT 16
```

Next, we set the original_id of all of the vertices in the results graph that were given the same vertex id as the vertex that it was created from in the original graph.

```
UPDATE lineGraph_vertices AS r
  SET original_id = v.id
  FROM edge_table_vertices_pgr AS v
  WHERE v.id = r.id;
UPDATE 5
```

Then, we cross reference all of the other newly created vertices that do not have the same original_id and set their original_id values.

```
WITH
unassignedVertices
  AS (SELECT e.id, e.original_id
      FROM lineGraph_vertices AS e
      WHERE original_id IS NOT NULL),
edgesWithUnassignedSource
  AS (SELECT *
       FROM lineGraph_edges
       WHERE cost = 0 and source IN (SELECT id FROM unassignedVertices)),
edgesWithUnassignedSourcePlusVertices
  AS (SELECT *
       FROM edgesWithUnassignedSource
       JOIN lineGraph_vertices
       ON(source = id)),
verticesFromEdgesWithUnassignedSource
  AS (SELECT DISTINCT edgesWithUnassignedSourcePlusVertices.target,
                   edgesWithUnassignedSourcePlusVertices.original_id
       FROM edgesWithUnassignedSourcePlusVertices
       JOIN lineGraph_vertices AS r
       ON(target = r.id AND r.original_id IS NULL))
UPDATE lineGraph_vertices
  SET original_id = verticesFromEdgesWithUnassignedSource.original_id
  FROM verticesFromEdgesWithUnassignedSource
  WHERE verticesFromEdgesWithUnassignedSource.target = id;
UPDATE 8
WITH
unassignedVertices
  AS (SELECT e.id, e.original_id
       FROM lineGraph_vertices AS e
       WHERE original_id IS NOT NULL),
edgesWithUnassignedTarget
  AS (SELECT *
       FROM lineGraph_edges
       WHERE cost = 0 and target IN (SELECT id FROM unassignedVertices)),
edgesWithUnassignedTargetPlusVertices
  AS (SELECT *
       FROM edgesWithUnassignedTarget
       JOIN lineGraph_vertices
       ON(target = id)),
verticesFromEdgesWithUnassignedTarget
  AS (SELECT DISTINCT edgesWithUnassignedTargetPlusVertices.source,
                  edgesWithUnassignedTargetPlusVertices.original_id
       FROM edgesWithUnassignedTargetPlusVertices
       JOIN lineGraph_vertices AS r
       ON(source = r.id AND r.original_id IS NULL))
UPDATE lineGraph_vertices
  SET original_id = verticesFromEdgesWithUnassignedTarget.original_id
  FROM verticesFromEdgesWithUnassignedTarget
  WHERE verticesFromEdgesWithUnassignedTarget.source = id;
UPDATE 3
```

The only vertices left that have not been mapped are a few of the leaf vertices from the original graph. The following sql completes the mapping for these leaf vertices (in the case of this example graph there are no leaf vertices but this is necessary for larger graphs).

```
WITH
unassignedVertexIds
  AS (SELECT id
       FROM lineGraph_vertices
       WHERE original_id IS NULL),
edgesWithUnassignedSource
  AS (SELECT source,edge
       FROM lineGraph_edges
       WHERE source IN (SELECT id FROM unassignedVertexIds)),
originalEdgesWithUnassignedSource
  AS (SELECT id,source
       FROM edge_table
       WHERE id IN (SELECT edge FROM edgesWithUnassignedSource))
UPDATE lineGraph_vertices AS d
  SET original_id = (SELECT source
                     FROM originalEdgesWithUnassignedSource
                     WHERE originalEdgesWithUnassignedSource.id =
                       (SELECT edge
                          FROM edgesWithUnassignedSource
                          WHERE edgesWithUnassignedSource.source = d.id))
  WHERE id IN (SELECT id FROM unassignedVertexIds);
UPDATE 0
WITH
unassignedVertexIds
  AS (SELECT id
       FROM lineGraph_vertices
       WHERE original_id IS NULL),
edgesWithUnassignedTarget
  AS (SELECT target,edge
       FROM lineGraph_edges
       WHERE target IN (SELECT id FROM unassignedVertexIds)),
originalEdgesWithUnassignedTarget
  AS (SELECT id,target
       FROM edge_table
       WHERE id IN (SELECT edge FROM edgesWithUnassignedTarget))
UPDATE lineGraph_vertices AS d
  SET original_id = (SELECT target
                     FROM originalEdgesWithUnassignedTarget
                     WHERE originalEdgesWithUnassignedTarget.id =
                       (SELECT edge
                          FROM edgesWithUnassignedTarget
                          WHERE edgesWithUnassignedTarget.target = d.id))
  WHERE id IN (SELECT id FROM unassignedVertexIds);
UPDATE 0
```

Now our vertex mapping table is complete:

```
SELECT * FROM lineGraph_vertices;
 id  | original_id
-----+-------------
   2 |           2
   5 |           5
   6 |           6
   8 |           8
  10 |          10
 -11 |          10
 -10 |           6
  -9 |           8
  -5 |           5
  -4 |           5
  -3 |           5
  -2 |           5
  -1 |           2
  -8 |           5
  -7 |           5
  -6 |           5
(16 rows)
```

Example:
For running a dijkstra’s shortest path with turn penalties

One use case for this graph transformation is to be able to run a shortest path search that takes into account the cost or limitation of turning. Below is an example of running a dijkstra’s shortest path from vertex 2 to vertex 8 in the original graph, while adding a turn penalty cost of 100 to the turn from edge 4 to edge -7.

First we must increase set the cost of making the turn to 100:

```
UPDATE lineGraph_edges
  SET cost = 100
  WHERE source IN (SELECT target
                   FROM lineGraph_edges
                   WHERE edge = 4) AND target IN (SELECT source
                                                  FROM lineGraph_edges
                                                  WHERE edge = -7);
UPDATE 1
```

Then we must run a dijkstra’s shortest path search using all of the vertices in the new graph that were created from vertex 2 as the starting point, and all of the vertices in the new graph that were created from vertex 8 as the ending point.

```
SELECT * FROM
  (SELECT * FROM
    (SELECT * FROM pgr_dijkstra($$SELECT seq AS id, * FROM lineGraph_edges$$,
      (SELECT array_agg(id) FROM lineGraph_vertices where original_id = 2),
      (SELECT array_agg(id) FROM lineGraph_vertices where original_id = 8)
    )) as shortestPaths
  WHERE start_vid = 2 AND end_vid = 8 AND (cost != 0 OR edge = -1)) as b;
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
  29 |        2 |         2 |       8 |   -1 |    1 |    1 |        0
  31 |        4 |         2 |       8 |   -4 |    5 |    1 |        1
  33 |        6 |         2 |       8 |  -10 |   25 |    1 |        2
  35 |        8 |         2 |       8 |   -3 |    4 |    1 |        3
  36 |        9 |         2 |       8 |    8 |   -1 |    0 |        4
(5 rows)
```

Normally the shortest path from vertex 2 to vertex 8 would have an aggregate cost of 2, but since there is a large penalty for making the turn needed to get this cost, the route goes through vertex 6 to avoid this turn.

If you cross reference the node column in the dijkstra results with the vertex id mapping table, this will show you that the path goes from v2 -> v5 -> v6 -> v5 -> v8 in the original graph.

See Also

- **https://en.wikipedia.org/wiki/Line_graph**
- **https://en.wikipedia.org/wiki/Complete_graph**

Indices and tables

- **Index**
- **Search Page**

Introduction

This family of functions is used for transforming a given input graph\(G(V,E)\) into a new graph \(G'(V',E')\).

See Also

Indices and tables

- **Index**
- **Search Page**

- **Supported versions:** **Latest** current(**3.2**)

Traversal - Family of functions (Experimental)

> **Warning**
>
> Possible server crash
>
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- Might depend on a proposed function of pgRouting
- Might depend on a deprecated function of pgRouting

- **pgr_depthFirstSearch - Experimental** - Depth first search traversal of the graph.

- **Supported versions: Latest** (**3.2**)

pgr_depthFirstSearch - Experimental

`pgr_depthFirstSearch` — Returns a depth first search traversal of the graph. The graph can be directed or undirected.

Boost Graph Inside

Warning

Possible server crash

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Warning

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  - Might depend on a proposed function of pgRouting
  - Might depend on a deprecated function of pgRouting

Availability

- Version 3.2.0
  - New **experimental** function

Description

Depth First Search algorithm is a traversal algorithm which starts from a root vertex, goes as deep as possible, and backtracks once a vertex is reached with no adjacent vertices or with all visited adjacent vertices. The traversal continues until all the vertices reachable from the root vertex are visited.

The main Characteristics are:

- The implementation works for both **directed** and **undirected** graphs.
- Provides the Depth First Search traversal order from a root vertex or from a set of root vertices.
- An optional non-negative maximum depth parameter to limit the results up to a particular depth.
- For optimization purposes, any duplicated values in the *Root vids* are ignored.
- It does not produce the shortest path from a root vertex to a target vertex.
- The aggregate cost of traversal is not guaranteed to be minimal.
- The returned values are ordered in ascending order of *start_vid*.
- Depth First Search Running time: \(O(E + V)\)

Signatures

Summary

```
pgr_depthFirstSearch(Edges SQL, Root vid [, directed] [, max_depth]) -- Experimental on v3.2
pgr_depthFirstSearch(Edges SQL, Root vids [, directed] [, max_depth]) -- Experimental on v3.2

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Using defaults

Example:
From root vertex \(2\) on a **directed** graph

```
SELECT * FROM pgr_depthFirstSearch(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table
    ORDER BY id',
    2
);
 seq | depth | start_vid | node | edge | cost | agg_cost
-----+-------+-----------+------+------+------+----------
   1 |     0 |         2 |    2 |   -1 |    0 |        0
   2 |     1 |         2 |    1 |    1 |    1 |        1
   3 |     1 |         2 |    5 |    4 |    1 |        1
   4 |     2 |         2 |    8 |    7 |    1 |        2
   5 |     3 |         2 |    7 |    6 |    1 |        3
   6 |     2 |         2 |    6 |    8 |    1 |        2
   7 |     3 |         2 |    9 |    9 |    1 |        3
   8 |     4 |         2 |   12 |   15 |    1 |        4
   9 |     4 |         2 |    4 |   16 |    1 |        4
  10 |     5 |         2 |    3 |    3 |    1 |        5
  11 |     3 |         2 |   11 |   11 |    1 |        3
  12 |     2 |         2 |   10 |   10 |    1 |        2
  13 |     3 |         2 |   13 |   14 |    1 |        3
(13 rows)
```

Single vertex

```
pgr_depthFirstSearch(Edges SQL, Root vid [, directed] [, max_depth])

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Example:
From root vertex \(2\) on an **undirected** graph, with \(depth <= 2\)

```
SELECT * FROM pgr_depthFirstSearch(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table
    ORDER BY id',
    2, directed => false, max_depth => 2
);
 seq | depth | start_vid | node | edge | cost | agg_cost
-----+-------+-----------+------+------+------+----------
   1 |     0 |         2 |    2 |   -1 |    0 |        0
   2 |     1 |         2 |    1 |    1 |    1 |        1
   3 |     1 |         2 |    3 |    2 |    1 |        1
   4 |     2 |         2 |    4 |    3 |    1 |        2
   5 |     2 |         2 |    6 |    5 |    1 |        2
   6 |     1 |         2 |    5 |    4 |    1 |        1
   7 |     2 |         2 |    8 |    7 |    1 |        2
   8 |     2 |         2 |   10 |   10 |    1 |        2
(8 rows)
```

Multiple vertices

```
pgr_depthFirstSearch(Edges SQL, Root vids [, directed] [, max_depth])

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Example:
From root vertices \(\{11, 2\}\) on an **undirected** graph with \(depth <= 2\)

```
SELECT * FROM pgr_depthFirstSearch(
   'SELECT id, source, target, cost, reverse_cost FROM edge_table
   ORDER BY id',
   ARRAY[11, 2], directed => false, max_depth => 2
);
 seq | depth | start_vid | node | edge | cost | agg_cost
-----+-------+-----------+------+------+------+----------
   1 |     0 |         2 |    2 |   -1 |    0 |        0
   2 |     1 |         2 |    1 |    1 |    1 |        1
   3 |     1 |         2 |    3 |    2 |    1 |        1
   4 |     2 |         2 |    4 |    3 |    1 |        2
   5 |     2 |         2 |    6 |    5 |    1 |        2
   6 |     1 |         2 |    5 |    4 |    1 |        1
   7 |     2 |         2 |    8 |    7 |    1 |        2
   8 |     2 |         2 |   10 |   10 |    1 |        2
   9 |     0 |        11 |   11 |   -1 |    0 |        0
  10 |     1 |        11 |    6 |   11 |    1 |        1
  11 |     2 |        11 |    3 |    5 |    1 |        2
  12 |     2 |        11 |    5 |    8 |    1 |        2
  13 |     2 |        11 |    9 |    9 |    1 |        2
  14 |     1 |        11 |   10 |   12 |    1 |        1
  15 |     2 |        11 |   13 |   14 |    1 |        2
  16 |     1 |        11 |   12 |   13 |    1 |        1
(16 rows)
```

Parameters

Parameter	Type	Description
Edges SQL	`TEXT`	SQL query described in **Inner query**.
Root vid	`BIGINT`	Identifier of the root vertex of the tree. • Used on **Single Vertex**.
Root vids	`ARRAY[ANY-INTEGER]`	Array of identifiers of the root vertices. • Used on **Multiple Vertices**. • For optimization purposes, any duplicated value is ignored.

Optional Parameters

Parameter	Type	Default	Description
directed	`BOOLEAN`	`true`	• When `true` Graph is *Directed* • When `false` the graph is *Undirected*.
max_depth	`BIGINT`	9223372036854775807	Upper limit for the depth of traversal • When value is `Negative` then **throws error**

Inner query

Edges SQL

Column	Type	Default	Description
id	`ANY-INTEGER`		Identifier of the edge.
source	`ANY-INTEGER`		Identifier of the first end point vertex of the edge.
target	`ANY-INTEGER`		Identifier of the second end point vertex of the edge.
cost	`ANY-NUMERICAL`		• When positive: edge *(source, target)* exist on the graph. • When negative: edge *(source, target)* does not exist on the graph.
reverse_cost	`ANY-NUMERICAL`	-1	• When positive: edge *(target, source)* exist on the graph. • When negative: edge *(target, source)* does not exist on the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns SET OF `(seq, depth, start_vid, node, edge, cost, agg_cost)`

Column	Type	Description
seq	BIGINT	Sequential value starting from \(1\).
depth	BIGINT	Depth of the node. - \(0\) when node = start_vid.
start_vid	BIGINT	Identifier of the root vertex. - I n **Multiple Vertices** results are in ascending order.
node	BIGINT	Identifier of node reached using edge.
edge	BIGINT	Identifier of the edge used to arrive to node. - \(-1\) when node = start_vid.
cost	FLOAT	Cost to traverse edge.
agg_cost	FLOAT	Aggregate cost from start_vid to node.

Additional Examples

The examples of this section are based on the **Sample Data** network.

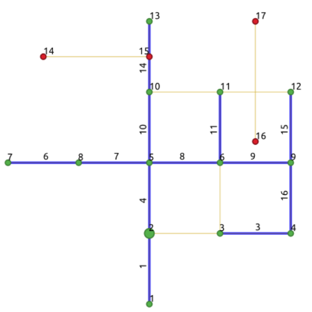
Example: No internal ordering on traversal

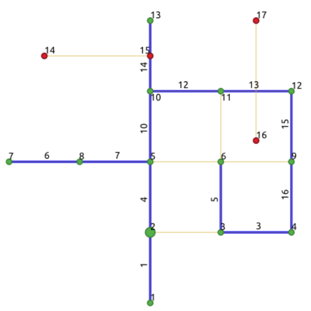
In the following query, the inner query of the example: “Using defaults” is modified so that the data is entered into the algorithm is given in the reverse ordering of the id.

```
SELECT * FROM pgr_depthFirstSearch(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table
    ORDER BY id DESC',
    2
);
 seq | depth | start_vid | node | edge | cost | agg_cost
-----+-------+-----------+------+------+------+----------
   1 |     0 |         2 |    2 |   -1 |    0 |        0
   2 |     1 |         2 |    5 |    4 |    1 |        1
   3 |     2 |         2 |   10 |   10 |    1 |        2
   4 |     3 |         2 |   13 |   14 |    1 |        3
   5 |     3 |         2 |   11 |   12 |    1 |        3
   6 |     4 |         2 |   12 |   13 |    1 |        4
   7 |     5 |         2 |    9 |   15 |    1 |        5
   8 |     6 |         2 |    4 |   16 |    1 |        6
   9 |     7 |         2 |    3 |    3 |    1 |        7
  10 |     8 |         2 |    6 |    5 |    1 |        8
  11 |     2 |         2 |    8 |    7 |    1 |        2
  12 |     3 |         2 |    7 |    6 |    1 |        3
  13 |     1 |         2 |    1 |    1 |    1 |        1
(13 rows)
```

The resulting traversal is different.

The left image shows the result with ascending order of ids and the right image shows with descending order of ids:





See Also

- The queries use the **Sample Data** network.
- **Boost: Depth First Search algorithm documentation**
- **Boost: Undirected DFS algorithm documentation**
- **Wikipedia: Depth First Search algorithm**

Indices and tables

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Inner query

Edges SQL

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		• When positive: edge *(source, target)* exist on the graph. • When negative: edge *(source, target)* does not exist on the graph.
reverse_cost	ANY-NUMERICAL	-1	• When positive: edge *(target, source)* exist on the graph. • When negative: edge *(target, source)* does not exist on the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

See Also

- **Boost: Depth First Search algorithm documentation**
- **Boost: Undirected DFS algorithm documentation**
- **Wikipedia: Depth First Search algorithm**

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categories

Vehicle Routing Functions - Category (Experimental)

- Pickup and delivery problem
  - **pgr_pickDeliver - Experimental** - Pickup & Delivery using a Cost Matrix
  - **pgr_pickDeliverEuclidean - Experimental** - Pickup & Delivery with Euclidean distances
- Distribution problem
  - **pgr_vrpOneDepot - Experimental** - From a single depot, distributes orders

- **Supported versions: Latest** (**3.2 3.1**) **3.0**

Vehicle Routing Functions - Category (Experimental)

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Contents

- **Supported versions: Latest** (**3.2**) **3.1**) **3.0**

pgr_pickDeliver - Experimental

pgr_pickDeliver - Pickup and delivery Vehicle Routing Problem

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  - Might depend on a deprecated function of pgRouting

Availability

- Version 3.0.0
  - New **experimental** function

Synopsis

Problem: Distribute and optimize the pickup-delivery pairs into a fleet of vehicles.

- Optimization problem is NP-hard.
- pickup and Delivery with time windows.
- All vehicles are equal.
  - Same Starting location.
  - Same Ending location which is the same as Starting location.
  - All vehicles travel at the same speed.
- A customer is for doing a pickup or doing a deliver.
  - has an open time.
  - has a closing time.
  - has a service time.
  - has an (x, y) location.
- There is a customer where to deliver a pickup.
  - travel time between customers is distance / speed
  - pickup and delivery pair is done with the same vehicle.
  - A pickup is done before the delivery.

Characteristics

- All trucks depart at time 0.
- No multiple time windows for a location.
- Less vehicle used is considered better.
- Less total duration is better.
- Less wait time is better.
- the algorithm will raise an exception when
  - If there is a pickup-deliver pair than violates time window
  - The speed, max_cycles, ma_capacity have illegal values
- Six different initial will be optimized - the best solution found will be result

Signature

```
pgr_pickDeliver(orders_sql, vehicles_sql, matrix_sql [, factor, max_cycles, initial_sol])
RETURNS SET OF (seq, vehicle_number, vehicle_id, stop, order_id, stop_type, cargo,
        travel_time, arrival_time, wait_time, service_time, departure_time)
```

Parameters

The parameters are:

```
orders_sql, vehicles_sql, matrix_sql [, factor, max_cycles, initial_sol]
```

Column	Type	Default	Description
orders_sql	TEXT		**Pick & Deliver Orders SQL** query contianing the orders to be processed.
vehicles_sql	TEXT		**Pick & Deliver Vehicles SQL** query containing the vehicles to be used.
matrix_sql	TEXT		**Pick & Deliver Matrix SQL** query containing the distance or travel times.
factor	NUMERIC	1	Travel time multiplier. See **Factor Handling**
max_cycles	INTEGER	10	Maximum number of cycles to perform on the optimization.
initial_sol	INTEGER	4	Initial solution to be used. - 1 One order per truck - 2 Push front order. - 3 Push back order. - 4 Optimize insert. - 5 Push back order that allows more orders to be inserted at the back - 6 Push front order that allows more orders to be inserted at the front

Pick & Deliver Orders SQL

A *SELECT* statement that returns the following columns:

```
id, demand
p_node_id, p_open, p_close, [p_service, ]
d_node_id, d_open, d_close, [d_service, ]
```

where:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the pick-delivery order pair.
demand	ANY-NUMERICAL		Number of units in the order
p_open	ANY-NUMERICAL		The time, relative to 0, when the pickup location opens.
p_close	ANY-NUMERICAL		The time, relative to 0, when the pickup location closes.
d_service	ANY-NUMERICAL	0	The duration of the loading at the pickup location.
d_open	ANY-NUMERICAL		The time, relative to 0, when the delivery location opens.
d_close	ANY-NUMERICAL		The time, relative to 0, when the delivery location closes.
d_service	ANY-NUMERICAL	0	The duration of the loading at the delivery location.

For the non euclidean implementation, the starting and ending identifiers are needed:

Column	Type	Description
p_node_id	ANY-INTEGER	The node identifier of the pickup, must match a node identifier in the matrix table.
d_node_id	ANY-INTEGER	The node identifier of the delivery, must match a node identifier in the matrix table.

Pick & Deliver Vehicles SQL

A *SELECT* statement that returns the following columns:

```
id, capacity
start_node_id, start_open, start_close [, start_service, ]
[ end_node_id, end_open, end_close, end_service ]
```

where:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the pick-delivery order pair.
capacity	ANY-NUMERICAL		Number of units in the order
speed	ANY-NUMERICAL	*1*	Average speed of the vehicle.
start_open	ANY-NUMERICAL		The time, relative to 0, when the starting location opens.
start_close	ANY-NUMERICAL		The time, relative to 0, when the starting location closes.
start_service	ANY-NUMERICAL	*0*	The duration of the loading at the starting location.
end_open	ANY-NUMERICAL	*start_open*	The time, relative to 0, when the ending location opens.
end_close	ANY-NUMERICAL	*start_close*	The time, relative to 0, when the ending location closes.
end_service	ANY-NUMERICAL	*start_service*	The duration of the loading at the ending location.

For the non euclidean implementation, the starting and ending identifiers are needed:

Column	Type	Default	Description
start_node_id	ANY-INTEGER		The node identifier of the starting location, must match a node identifier in the matrix table.
end_node_id	ANY-INTEGER	*start_node_id*	The node identifier of the ending location, must match a node identifier in the matrix table.

Pick & Deliver Matrix SQL

A *SELECT* statement that returns the following columns:

> **Warning**
>
> TODO

Where:

ANY-INTEGER:

SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Example

This example use the following data: TODO put link

```
SELECT * FROM pgr_pickDeliver(
    $$ SELECT * FROM orders ORDER BY id $$,
    $$ SELECT * FROM vehicles ORDER BY id$$,
    $$ SELECT * from pgr_dijkstraCostMatrix(
        'SELECT * FROM edge_table ',
        (SELECT array_agg(id) FROM (SELECT p_node_id AS id FROM orders
        UNION
        SELECT d_node_id FROM orders
        UNION
        SELECT start_node_id FROM vehicles) a))
    $$
);
 seq | vehicle_seq | vehicle_id | stop_seq | stop_type | stop_id | order_id | cargo | travel_time | arrival_time | wait_time | service_time | departure_time
-----+-------------+------------+----------+-----------+---------+----------+-------+-------------+--------------+-----------+--------------+---------------
   1 |           1 |          1 |        1 |         1 |       6 |       -1 |     0 |           0 |            0 |         0 |            0 |              0
   2 |           1 |          1 |        2 |         2 |       5 |        3 |    30 |           1 |            1 |         1 |            3 |              5
   3 |           1 |          1 |        3 |         3 |      11 |        3 |     0 |           2 |            7 |         0 |            3 |             10
   4 |           1 |          1 |        4 |         2 |       9 |        2 |    20 |           2 |           12 |         0 |            2 |             14
   5 |           1 |          1 |        5 |         3 |       4 |        2 |     0 |           1 |           15 |         0 |            3 |             18
   6 |           1 |          1 |        6 |         6 |       6 |       -1 |     0 |           2 |           20 |         0 |            0 |             20
   7 |           2 |          1 |        1 |         1 |       6 |       -1 |     0 |           0 |            0 |         0 |            0 |              0
   8 |           2 |          1 |        2 |         2 |       3 |        1 |    10 |           3 |            3 |         0 |            3 |              6
   9 |           2 |          1 |        3 |         3 |       8 |        1 |     0 |           3 |            9 |         0 |            3 |             12
  10 |           2 |          1 |        4 |         6 |       6 |       -1 |     0 |           2 |           14 |         0 |            0 |             14
  11 |          -2 |          0 |        0 |        -1 |      -1 |       -1 |    -1 |          16 |           -1 |         1 |           17 |             34
(11 rows)
```

See Also

- **Vehicle Routing Functions - Category (Experimental)**
- The queries use the **Sample Data** network.

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- **Supported versions: Latest** (**3.2**) current(**3.1**) **3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2 2.1**

pgr_pickDeliverEuclidean - Experimental

`pgr_pickDeliverEuclidean` - Pickup and delivery Vehicle Routing Problem

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>   - Functionality might change.
>   - pgTap tests might be missing.
>   - Might need c/c++ coding.
>   - May lack documentation.
>   - Documentation if any might need to be rewritten.
>   - Documentation examples might need to be automatically generated.
>   - Might need a lot of feedback from the comunity.

- Might depend on a proposed function of pgRouting
- Might depend on a deprecated function of pgRouting

Availability

- Version 3.0.0
  - Replaces `pgr_gsoc_vrppdtw`
  - New **experimental** function

Synopsis

Problem: Distribute and optimize the pickup-delivery pairs into a fleet of vehicles.

- Optimization problem is NP-hard.
- Pickup and Delivery:
  - capacitated
  - with time windows.
- The vehicles
  - have (x, y) start and ending locations.
  - have a start and ending service times.
  - have opening and closing times for the start and ending locations.
- An order is for doing a pickup and a a deliver.
  - has (x, y) pickup and delivery locations.
  - has opening and closing times for the pickup and delivery locations.
  - has a pickup and deliver service times.
- There is a customer where to deliver a pickup.
  - travel time between customers is distance / speed
  - pickup and delivery pair is done with the same vehicle.
  - A pickup is done before the delivery.

Characteristics

- No multiple time windows for a location.
- Less vehicle used is considered better.
- Less total duration is better.
- Less wait time is better.
- Six different optional different initial solutions
  - the best solution found will be result

Signature

```
pgr_pickDeliverEuclidean(orders_sql, vehicles_sql [,factor, max_cycles, initial_sol])
RETURNS SET OF (seq, vehicle_seq, vehicle_id, stop_seq, stop_type, order_id,
    cargo, travel_time, arrival_time, wait_time, service_time, departure_time)
```

Parameters

The parameters are:

```
orders_sql, vehicles_sql [,factor, max_cycles, initial_sol]
```

Where:

Column	Type	Default	Description
orders_sql	`TEXT`		**Pick & Deliver Orders SQL** query containing the orders to be processed.
vehicles_sql	`TEXT`		**Pick & Deliver Vehicles SQL** query containing the vehicles to be used.
factor	`NUMERIC`	1	(Optional) Travel time multiplier. See **Factor Handling**
max_cycles	`INTEGER`	10	(Optional) Maximum number of cycles to perform on the optimization.
initial_sol	`INTEGER`	4	(Optional) Initial solution to be used. - `1` One order per truck - `2` Push front order. - `3` Push back order. - `4` Optimize insert. - `5` Push back order that allows more orders to be inserted at the back - `6` Push front order that allows more orders to be inserted at the front

Pick & Deliver Orders SQL

A *SELECT* statement that returns the following columns:

```
id, demand
p_x, p_y, p_open, p_close, [p_service, ]
d_x, d_y, d_open, d_close, [d_service, ]
```

Where:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the pick-delivery order pair.
demand	ANY-NUMERICAL		Number of units in the order
p_open	ANY-NUMERICAL		The time, relative to 0, when the pickup location opens.
p_close	ANY-NUMERICAL		The time, relative to 0, when the pickup location closes.
d_service	ANY-NUMERICAL	0	The duration of the loading at the pickup location.
d_open	ANY-NUMERICAL		The time, relative to 0, when the delivery location opens.
d_close	ANY-NUMERICAL		The time, relative to 0, when the delivery location closes.
d_service	ANY-NUMERICAL	0	The duration of the loading at the delivery location.

For the euclidean implementation, pick up and delivery \((x,y)\) locations are needed:

Column	Type	Description
p_x	ANY-NUMERICAL	\(x\) value of the pick up location
p_y	ANY-NUMERICAL	\(y\) value of the pick up location
d_x	ANY-NUMERICAL	\(x\) value of the delivery location
d_y	ANY-NUMERICAL	\(y\) value of the delivery location

Pick & Deliver Vehicles SQL

A *SELECT* statement that returns the following columns:

```
id, capacity
start_x, start_y, start_open, start_close [, start_service, ]
[ end_x, end_y, end_open, end_close, end_service ]
```

where:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the pick-delivery order pair.
capacity	ANY-NUMERICAL		Number of units in the order
speed	ANY-NUMERICAL	*1*	Average speed of the vehicle.
start_open	ANY-NUMERICAL		The time, relative to 0, when the starting location opens.
start_close	ANY-NUMERICAL		The time, relative to 0, when the starting location closes.
start_service	ANY-NUMERICAL	*0*	The duration of the loading at the starting location.
end_open	ANY-NUMERICAL	*start_open*	The time, relative to 0, when the ending location opens.
end_close	ANY-NUMERICAL	*start_close*	The time, relative to 0, when the ending location closes.
end_service	ANY-NUMERICAL	*start_service*	The duration of the loading at the ending location.

For the euclidean implementation, starting and ending\((x,y)\) locations are needed:

Column	Type	Default	Description
start_x	ANY-NUMERICAL		\(x\) value of the coordinate of the starting location.
start_y	ANY-NUMERICAL		\(y\) value of the coordinate of the starting location.
end_x	ANY-NUMERICAL	*start_x*	\(x\) value of the coordinate of the ending location.
end_y	ANY-NUMERICAL	*start_y*	\(y\) value of the coordinate of the ending location.

Description of the result (TODO Disussion: Euclidean & Matrix)

```
RETURNS SET OF
    (seq, vehicle_seq, vehicle_id, stop_seq, stop_type,
        travel_time, arrival_time, wait_time, service_time,  departure_time)
    UNION
    (summary row)
```

Column	Type	Description
seq	INTEGER	Sequential value starting from **1**.
vehicle_seq	INTEGER	Sequential value starting from **1** for current vehicles. The n_{th} vehicle in the solution.
vehicle_id	BIGINT	Current vehicle identifier.
stop_seq	INTEGER	Sequential value starting from **1** for the stops made by the current vehicle. The m_{th} stop of the current vehicle.
stop_type	INTEGER	Kind of stop location the vehicle is at: • `1`: Starting location • `2`: Pickup location • `3`: Delivery location • `6`: Ending location
order_id	BIGINT	Pickup-Delivery order pair identifier. • `-1`: When no order is involved on the current stop location.
cargo	FLOAT	Cargo units of the vehicle when leaving the stop.
travel_time	FLOAT	Travel time from previous `stop_seq` to current `stop_seq`. • `0` When `stop_type = 1`
arrival_time	FLOAT	Previous `departure_time` plus current `travel_time`.
wait_time	FLOAT	Time spent waiting for current *location* to open.
service_time	FLOAT	Service time at current *location*.
departure_time	FLOAT	$arrival\_time + wait\_time + service\_time$. • When `stop_type = 6` has the *total_time* used for the current vehicle.

Summary Row

> **Warning**
>
> TODO: Review the summary

Column	Type	Description
seq	INTEGER	Continues the Sequential value
vehicle_seq	INTEGER	`-2` to indicate is a summary row
vehicle_id	BIGINT	*Total Capacity Violations* in the solution.
stop_seq	INTEGER	*Total Time Window Violations* in the solution.
stop_type	INTEGER	`-1`
order_id	BIGINT	`-1`
cargo	FLOAT	`-1`
travel_time	FLOAT	*total_travel_time* The sum of all the *travel_time*
arrival_time	FLOAT	`-1`
wait_time	FLOAT	*total_waiting_time* The sum of all the *wait_time*
service_time	FLOAT	*total_service_time* The sum of all the *service_time*
departure_time	FLOAT	*total_solution_time* = $total\_travel\_time + total\_wait\_time + total\_service\_time$.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Example

This example use the following data: TODO put link

```
SELECT * FROM pgr_pickDeliverEuclidean(
    'SELECT * FROM orders ORDER BY id',
    'SELECT * from vehicles'
);
 seq | vehicle_seq | vehicle_id | stop_seq | stop_type | order_id | cargo |  travel_time  | arrival_time  | wait_time | service_time | departure_time
-----+-------------+------------+----------+-----------+----------+-------+---------------+---------------+-----------+--------------+----------------
   1 |           1 |          1 |        1 |         1 |       -1 |     0 |             0 |             0 |         0 |            0 |              0
   2 |           1 |          1 |        2 |         2 |        3 |    30 |             1 |             1 |         1 |            3 |              5
   3 |           1 |          1 |        3 |         3 |        3 |     0 | 1.41421356237 | 6.41421356237 |         0 |            3 |  9.41421356237
   4 |           1 |          1 |        4 |         2 |        2 |    20 | 1.41421356237 | 10.8284271247 |         0 |            2 |  12.8284271247
   5 |           1 |          1 |        5 |         3 |        2 |     0 |             1 | 13.8284271247 |         0 |            3 |  16.8284271247
   6 |           1 |          1 |        6 |         6 |       -1 |     0 | 1.41421356237 | 18.2426406871 |         0 |            0 |  18.2426406871
   7 |           2 |          1 |        1 |         1 |       -1 |     0 |             0 |             0 |         0 |            0 |              0
   8 |           2 |          1 |        2 |         2 |        1 |    10 |             1 |             1 |         1 |            3 |              5
   9 |           2 |          1 |        3 |         3 |        1 |     0 |  2.2360679775 |  7.2360679775 |         0 |            3 |  10.2360679775
  10 |           2 |          1 |        4 |         6 |       -1 |     0 |             2 | 12.2360679775 |         0 |            0 |  12.2360679775
  11 |          -2 |          0 |        0 |        -1 |       -1 |    -1 | 11.4787086646 |            -1 |         2 |           17 |  30.4787086646
(11 rows)
```

See Also

- **Vehicle Routing Functions - Category (Experimental)**
- The queries use the **Sample Data** network.

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2 2.1**

pgr_vrpOneDepot - Experimental

> **Warning**
>
> Possible server crash
>
> - These functions might create a server crash

> **Warning**
>
> Experimental functions
>
> - They are not officially of the current release.
> - They likely will not be officially be part of the next release:
>   - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
>   - Name might change.
>   - Signature might change.
>   - Functionality might change.
>   - pgTap tests might be missing.
>   - Might need c/c++ coding.
>   - May lack documentation.
>   - Documentation if any might need to be rewritten.
>   - Documentation examples might need to be automatically generated.
>   - Might need a lot of feedback from the comunity.
>   - Might depend on a proposed function of pgRouting
>   - Might depend on a deprecated function of pgRouting

No documentation available

Availability

- Version 2.1.0
  - New **experimental** function
- **TBD**

Description

- TBD

Signatures

- TBD

Parameters

- TBD

Inner query

- TBD

Result Columns

- TBD

Additional Example:

```
BEGIN;
BEGIN
SET client_min_messages TO NOTICE;
SET
SELECT * FROM pgr_vrpOneDepot(
    'SELECT * FROM solomon_100_RC_101',
    'SELECT * FROM vrp_vehicles',
    'SELECT * FROM vrp_distance',
    1);
 oid | opos | vid | tarrival | tdepart
-----+------+-----+----------+---------
  -1 |    1 |   1 |        0 |       0
   7 |    2 |   1 |        0 |       0
   9 |    3 |   1 |        0 |       0
   8 |    4 |   1 |        0 |       0
   6 |    5 |   1 |        0 |       0
   5 |    6 |   1 |        0 |       0
   4 |    7 |   1 |        0 |       0
   2 |    8 |   1 |        0 |       0
   6 |    9 |   1 |       40 |      51
   8 |   10 |   1 |       62 |      89
   9 |   11 |   1 |       94 |     104
   7 |   12 |   1 |      110 |     120
   4 |   13 |   1 |      131 |     141
   2 |   14 |   1 |      144 |     155
   5 |   15 |   1 |      162 |     172
  -1 |   16 |   1 |      208 |     208
  -1 |    1 |   2 |        0 |       0
  10 |    2 |   2 |        0 |       0
  11 |    3 |   2 |        0 |       0
  10 |    4 |   2 |       34 |     101
  11 |    5 |   2 |      106 |     129
  -1 |    6 |   2 |      161 |     161
  -1 |    1 |   3 |        0 |       0
   3 |    2 |   3 |        0 |       0
   3 |    3 |   3 |       31 |      60
  -1 |    4 |   3 |       91 |      91
  -1 |    0 |   0 |       -1 |     460
(27 rows)

ROLLBACK;
ROLLBACK
```

Data

```
DROP TABLE IF EXISTS solomon_100_RC_101 cascade;
CREATE TABLE solomon_100_RC_101 (
    id integer NOT NULL PRIMARY KEY,
    order_unit integer,
    open_time integer,
    close_time integer,
    service_time integer,
    x float8,
    y float8
);

COPY solomon_100_RC_101
(id, x, y, order_unit, open_time, close_time, service_time) FROM stdin;
1 40.000000 50.000000 0 0 240 0
2 25.000000 85.000000 20 145 175 10
3 22.000000 75.000000 30 50 80 10
4 22.000000 85.000000 10 109 139 10
5 20.000000 80.000000 40 141 171 10
6 20.000000 85.000000 20 41 71 10
7 18.000000 75.000000 20 95 125 10
8 15.000000 75.000000 20 79 109 10
9 15.000000 80.000000 10 91 121 10
10 10.000000 35.000000 20 91 121 10
11 10.000000 40.000000 30 119 149 10
\.

DROP TABLE IF EXISTS vrp_vehicles cascade;
CREATE TABLE vrp_vehicles (
    vehicle_id integer not null primary key,
    capacity integer,
    case_no integer
);

copy vrp_vehicles (vehicle_id, capacity, case_no) from stdin;
1 200 5
2 200 5
3 200 5
\.

DROP TABLE IF EXISTS vrp_distance cascade;
WITH
the_matrix_info AS (
    SELECT A.id AS src_id, B.id AS dest_id, sqrt( (a.x - b.x) * (a.x - b.x) + (a.y - b.y) * (a.y - b.y)) AS cost
    FROM solomon_100_rc_101 AS A, solomon_100_rc_101 AS B WHERE A.id != B.id
)
SELECT src_id, dest_id, cost, cost AS distance, cost AS traveltime
INTO vrp_distance
FROM the_matrix_info;
```

See Also

- **https://en.wikipedia.org/wiki/Vehicle_routing_problem**

Indices and tables

- **Index**
- **Search Page**

Introduction

Vehicle Routing Problems *VRP* are **NP-hard** optimization problem, it generalises the travelling salesman problem (TSP).

- The objective of the VRP is to minimize the total route cost.
- There are several variants of the VRP problem,

pgRouting does not try to implement all variants.

Characteristics

- Capacitated Vehicle Routing Problem *CVRP* where The vehicles have limited carrying capacity of the goods.
- Vehicle Routing Problem with Time Windows *VRPTW* where the locations have time windows within which the vehicle's visits must be made.
- Vehicle Routing Problem with Pickup and Delivery *VRPPD* where a number of goods need to be moved from certain pickup locations to other delivery locations.

Limitations

- No multiple time windows for a location.
- Less vehicle used is considered better.
- Less total duration is better.
- Less wait time is better.

Pick & Delivery

Problem: *CVRPPDTW* Capacitated Pick and Delivery Vehicle Routing problem with Time Windows

- Times are relative to *0*
- The vehicles
  - have start and ending service duration times.
  - have opening and closing times for the start and ending locations.
  - have a capacity.
- The orders
  - Have pick up and delivery locations.
  - Have opening and closing times for the pickup and delivery locations.
  - Have pickup and delivery duration service times.
  - have a demand request for moving goods from the pickup location to the delivery location.
- Time based calculations:
  - Travel time between customers is \(distance / speed\)
  - Pickup and delivery order pair is done by the same vehicle.
  - A pickup is done before the delivery.

Parameters

Pick & deliver

Both implementations use the following same parameters:

Column	Type	Default	Description
orders_sql	TEXT		**Pick & Deliver Orders SQL** query containing the orders to be processed.
vehicles_sql	TEXT		**Pick & Deliver Vehicles SQL** query containing the vehicles to be used.
factor	NUMERIC	1	(Optional) Travel time multiplier. See **Factor Handling**
max_cycles	INTEGER	10	(Optional) Maximum number of cycles to perform on the optimization.
initial_sol	INTEGER	4	(Optional) Initial solution to be used. • 1 One order per truck • 2 Push front order. • 3 Push back order. • 4 Optimize insert. • 5 Push back order that allows more orders to be inserted at the back • 6 Push front order that allows more orders to be inserted at the front

The non euclidean implementation, additionally has:

Column	Type	Description
matrix_sql	TEXT	**Pick & Deliver Matrix SQL** query containing the distance or travel times.

Inner Queries

- **Pick & Deliver Orders SQL**
- **Pick & Deliver Vehicles SQL**
- **Pick & Deliver Matrix SQL**

return columns

- **Description of return columns**
- **Description of the return columns for Euclidean version**

Pick & Deliver Orders SQL

In general, the columns for the orders SQL is the same in both implementation of pick and delivery:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the pick-delivery order pair.
demand	ANY-NUMERICAL		Number of units in the order
p_open	ANY-NUMERICAL		The time, relative to 0, when the pickup location opens.
p_close	ANY-NUMERICAL		The time, relative to 0, when the pickup location closes.
d_service	ANY-NUMERICAL	0	The duration of the loading at the pickup location.
d_open	ANY-NUMERICAL		The time, relative to 0, when the delivery location opens.

Column	Type	Default	Description
d_close	ANY-NUMERICAL		The time, relative to 0, when the delivery location closes.
d_service	ANY-NUMERICAL	0	The duration of the loading at the delivery location.

For the non euclidean implementation, the starting and ending identifiers are needed:

Column	Type	Description
p_node_id	ANY-INTEGER	The node identifier of the pickup, must match a node identifier in the matrix table.
d_node_id	ANY-INTEGER	The node identifier of the delivery, must match a node identifier in the matrix table.

For the euclidean implementation, pick up and delivery (x,y) locations are needed:

Column	Type	Description
p_x	ANY-NUMERICAL	x value of the pick up location
p_y	ANY-NUMERICAL	y value of the pick up location
d_x	ANY-NUMERICAL	x value of the delivery location
d_y	ANY-NUMERICAL	y value of the delivery location

Pick & Deliver Vehicles SQL

In general, the columns for the vehicles_sql is the same in both implementation of pick and delivery:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the pick-delivery order pair.
capacity	ANY-NUMERICAL		Number of units in the order
speed	ANY-NUMERICAL	*1*	Average speed of the vehicle.
start_open	ANY-NUMERICAL		The time, relative to 0, when the starting location opens.
start_close	ANY-NUMERICAL		The time, relative to 0, when the starting location closes.
start_service	ANY-NUMERICAL	*0*	The duration of the loading at the starting location.
end_open	ANY-NUMERICAL	*start_open*	The time, relative to 0, when the ending location opens.
end_close	ANY-NUMERICAL	*start_close*	The time, relative to 0, when the ending location closes.
end_service	ANY-NUMERICAL	*start_service*	The duration of the loading at the ending location.

For the non euclidean implementation, the starting and ending identifiers are needed:

Column	Type	Default	Description
start_node_id	ANY-INTEGER		The node identifier of the starting location, must match a node identifier in the matrix table.
end_node_id	ANY-INTEGER	*start_node_id*	The node identifier of the ending location, must match a node identifier in the matrix table.

For the euclidean implementation, starting and ending(x,y) locations are needed:

Column	Type	Default	Description
start_x	ANY-NUMERICAL		x value of the coordinate of the starting location.
start_y	ANY-NUMERICAL		y value of the coordinate of the starting location.
end_x	ANY-NUMERICAL	*start_x*	x value of the coordinate of the ending location.
end_y	ANY-NUMERICAL	*start_y*	y value of the coordinate of the ending location.

Pick & Deliver Matrix SQL

Warning

TODO

Results

Description of the result (TODO Disussion: Euclidean & Matrix)

```
RETURNS SET OF
    (seq, vehicle_seq, vehicle_id, stop_seq, stop_type,
        travel_time, arrival_time, wait_time, service_time,  departure_time)
    UNION
    (summary row)
```

Column	Type	Description
seq	INTEGER	Sequential value starting from **1**.
vehicle_seq	INTEGER	Sequential value starting from **1** for current vehicles. The \(n_{th}\) vehicle in the solution.
vehicle_id	BIGINT	Current vehicle identifier.
stop_seq	INTEGER	Sequential value starting from **1** for the stops made by the current vehicle. The\(m_{th}\) stop of the current vehicle.
stop_type	INTEGER	Kind of stop location the vehicle is at: • `1`: Starting location • `2`: Pickup location • `3`: Delivery location • `6`: Ending location
order_id	BIGINT	Pickup-Delivery order pair identifier. • `-1`: When no order is involved on the current stop location.
cargo	FLOAT	Cargo units of the vehicle when leaving the stop.
travel_time	FLOAT	Travel time from previous `stop_seq` to current `stop_seq`. • `0` When `stop_type = 1`
arrival_time	FLOAT	Previous `departure_time` plus current `travel_time`.
wait_time	FLOAT	Time spent waiting for current *location* to open.
service_time	FLOAT	Service time at current *location*.
departure_time	FLOAT	\(arrival_time + wait_time + service_time\). • When `stop_type = 6` has the *total_time* used for the current vehicle.

Summary Row

> **Warning**
>
> TODO: Review the summary

Column	Type	Description
seq	INTEGER	Continues the Sequential value
vehicle_seq	INTEGER	`-2` to indicate is a summary row
vehicle_id	BIGINT	*Total Capacity Violations* in the solution.
stop_seq	INTEGER	*Total Time Window Violations* in the solution.
stop_type	INTEGER	`-1`
order_id	BIGINT	`-1`
cargo	FLOAT	`-1`
travel_time	FLOAT	*total_travel_time* The sum of all the *travel_time*
arrival_time	FLOAT	`-1`
wait_time	FLOAT	*total_waiting_time* The sum of all the *wait_time*
service_time	FLOAT	*total_service_time* The sum of all the *service_time*
departure_time	FLOAT	*total_solution_time* = \(total_travel_time + total_wait_time + total_service_time\).

Description of the result (TODO Disussion: Euclidean & Matrix)

```
RETURNS SET OF
    (seq, vehicle_seq, vehicle_id, stop_seq, stop_type,
        travel_time, arrival_time, wait_time, service_time,  departure_time)
    UNION
    (summary row)
```

Column	Type	Description
seq	INTEGER	Sequential value starting from **1**.
vehicle_seq	INTEGER	Sequential value starting from **1** for current vehicles. The \(n_{th}\) vehicle in the solution.
vehicle_id	BIGINT	Current vehicle identifier.

Column	Type	Description
stop_seq	INTEGER	Sequential value starting from **1** for the stops made by the current vehicle. The m_{th} stop of the current vehicle.
stop_type	INTEGER	Kind of stop location the vehicle is at: • `1`: Starting location • `2`: Pickup location • `3`: Delivery location • `6`: Ending location
order_id	BIGINT	Pickup-Delivery order pair identifier. • `-1`: When no order is involved on the current stop location.
cargo	FLOAT	Cargo units of the vehicle when leaving the stop.
travel_time	FLOAT	Travel time from previous `stop_seq` to current `stop_seq`. • `0` When `stop_type = 1`
arrival_time	FLOAT	Previous `departure_time` plus current `travel_time`.
wait_time	FLOAT	Time spent waiting for current *location* to open.
service_time	FLOAT	Service time at current *location*.
departure_time	FLOAT	$arrival\_time + wait\_time + service\_time$. • When `stop_type = 6` has the *total_time* used for the current vehicle.

Summary Row

> **Warning**
>
> TODO: Review the summary

Column	Type	Description
seq	INTEGER	Continues the Sequential value
vehicle_seq	INTEGER	`-2` to indicate is a summary row
vehicle_id	BIGINT	*Total Capacity Violations* in the solution.
stop_seq	INTEGER	*Total Time Window Violations* in the solution.
stop_type	INTEGER	`-1`
order_id	BIGINT	`-1`
cargo	FLOAT	`-1`
travel_time	FLOAT	*total_travel_time* The sum of all the *travel_time*
arrival_time	FLOAT	`-1`
wait_time	FLOAT	*total_waiting_time* The sum of all the *wait_time*
service_time	FLOAT	*total_service_time* The sum of all the *service_time*
departure_time	FLOAT	*total_solution_time* = $total\_travel\_time + total\_wait\_time + total\_service\_time$.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Handling Parameters

To define a problem, several considerations have to be done, to get consistent results. This section gives an insight of how parameters are to be considered.

- **Capacity and Demand Units Handling**
- **Locations**
- **Time Handling**
- **Factor Handling**

Capacity and Demand Units Handling

The *capacity* of a vehicle, can be measured in:

- Volume units like m^3.
- Area units like m^2 (when no stacking is allowed).
- Weight units like kg.
- Number of boxes that fit in the vehicle.
- Number of seats in the vehicle

The *demand* request of the pickup-deliver orders must use the same units as the units used in the vehicle's *capacity*.

To handle problems like: 10 (equal dimension) boxes of apples and 5 kg of feathers that are to be transported (not packed in boxes).

If the vehicle's *capacity* is measured by *boxes*, a conversion of *kg of feathers* to *equivalent number of boxes* is needed. If the vehicle's *capacity* is measured by *kg*, a conversion of *box of apples* to *equivalent number of kg* is needed.

Showing how the 2 possible conversions can be done

Let: - f_boxes: number of boxes that would be used for *1* kg of feathers. - a_weight: weight of *1* box of apples.

Capacity Units	apples	feathers
boxes	10	$5 * f\_boxes$
kg	$10 * a\_weight$	5

Locations

- When using the Euclidean signatures:
  - The vehicles have (x, y) pairs for start and ending locations.
  - The orders Have (x, y) pairs for pickup and delivery locations.
- When using a matrix:
  - The vehicles have identifiers for the start and ending locations.
  - The orders have identifiers for the pickup and delivery locations.
  - All the identifiers are indices to the given matrix.

Time Handling

The times are relative to 0

Suppose that a vehicle's driver starts the shift at 9:00 am and ends the shift at 4:30 pm and the service time duration is 10 minutes with 30 seconds.

All time units have to be converted

Meaning of 0	time units	9:00 am	4:30 pm	10 min 30 secs
0:00 am	hours	9	16.5	$10.5 / 60 = 0.175$
9:00 am	hours	0	7.5	$10.5 / 60 = 0.175$
0:00 am	minutes	$9*60 = 54$	$16.5*60 = 990$	10.5
9:00 am	minutes	0	$7.5*60 = 540$	10.5

Factor Handling

> **Warning**
>
> TODO

See Also

- **https://en.wikipedia.org/wiki/Vehicle_routing_problem**
- The queries use the **Sample Data** network.

Indices and tables

- **Index**
- **Search Page**

Not classified

- **pgr_bellmanFord - Experimental**
- **pgr_binaryBreadthFirstSearch - Experimental**

- pgr_breadthFirstSearch - Experimental
- pgr_dagShortestPath - Experimental
- pgr_edwardMoore - Experimental
- pgr_isPlanar - Experimental
- pgr_stoerWagner - Experimental
- pgr_topologicalSort - Experimental
- pgr_transitiveClosure - Experimental
- pgr_turnRestrictedPath - Experimental
- pgr_lengauerTarjanDominatorTree -Experimental

- **Supported versions: Latest (3.2) 3.1 3.0**

pgr_bellmanFord - Experimental

`pgr_bellmanFord` — Returns the shortest path(s) using Bellman-Ford algorithm. In particular, the Bellman-Ford algorithm implemented by Boost.Graph.

Boost Graph Inside

> **Warning**
>
> Possible server crash
>
> - These functions might create a server crash

> **Warning**
>
> Experimental functions
>
> - They are not officially of the current release.
> - They likely will not be officially be part of the next release:
>   - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
>   - Name might change.
>   - Signature might change.
>   - Functionality might change.
>   - pgTap tests might be missing.
>   - Might need c/c++ coding.
>   - May lack documentation.
>   - Documentation if any might need to be rewritten.
>   - Documentation examples might need to be automatically generated.
>   - Might need a lot of feedback from the comunity.
>   - Might depend on a proposed function of pgRouting
>   - Might depend on a deprecated function of pgRouting

Availability

- Version 3.2.0
  - New **experimental** function:
    - pgr_bellmanFord(Combinations)
- Version 3.0.0
  - New **experimental** function

Description

Bellman-Ford's algorithm, is named after Richard Bellman and Lester Ford, who first published it in 1958 and 1956, respectively. It is a graph search algorithm that computes shortest paths from a starting vertex (`start_vid`) to an ending vertex (`end_vid`) in a graph where some of the edge weights may be negative number. Though it is more versatile, it is slower than Dijkstra's algorithm/ This implementation can be used with a directed graph and an undirected graph.

The main characteristics are:

- Process is valid for edges with both positive and negative edge weights.
- Values are returned when there is a path.

- When the start vertex and the end vertex are the same, there is no path. The agg_cost would be 0.
- When the start vertex and the end vertex are different, and there exists a path between them without having a *negative cycle*. The agg_cost would be some finite value denoting the shortest distance between them.
- When the start vertex and the end vertex are different, and there exists a path between them, but it contains a *negative cycle*. In such case, agg_cost for those vertices keep on decreasing furthermore, Hence agg_cost can't be defined for them.
- When the start vertex and the end vertex are different, and there is no path. The agg_cost is \(\infty\).

- For optimization purposes, any duplicated value in the *start_vids* or *end_vids* are ignored.
- The returned values are ordered:
  - *start_vid* ascending
  - *end_vid* ascending
- Running time: \(O(| start_vids | * (V * E))\)

Signatures

Summary

```
pgr_bellmanFord(Edges SQL, from_vid,  to_vid  [, directed])
pgr_bellmanFord(Edges SQL, from_vid,  to_vids [, directed])
pgr_bellmanFord(Edges SQL, from_vids, to_vid  [, directed])
pgr_bellmanFord(Edges SQL, from_vids, to_vids [, directed])
pgr_bellmanFord(Edges SQL, Combinations SQL [, directed]) -- Experimental on v3.2

RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost)
OR EMPTY SET
```

Using defaults

```
pgr_bellmanFord(Edges SQL, start_vid, end_vid)
RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertex \(2\) to vertex \(3\) on a **directed** graph

```
SELECT * FROM pgr_bellmanFord(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, 3
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    4 |    1 |        0
   2 |        2 |    5 |    8 |    1 |        1
   3 |        3 |    6 |    9 |    1 |        2
   4 |        4 |    9 |   16 |    1 |        3
   5 |        5 |    4 |    3 |    1 |        4
   6 |        6 |    3 |   -1 |    0 |        5
(6 rows)
```

One to One

```
pgr_bellmanFord(Edges SQL, from_vid,  to_vid  [, directed])
RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertex \(2\) to vertex \(3\) on an **undirected** graph

```
SELECT * FROM pgr_bellmanFord(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, 3,
    FALSE
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    2 |    1 |        0
   2 |        2 |    3 |   -1 |    0 |        1
(2 rows)
```

One to many

```
pgr_bellmanFord(Edges SQL, from_vid,  to_vids [, directed])
RETURNS SET OF (seq, path_seq, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertex \(2\) to vertices \(\{ 3, 5\}\) on an **undirected** graph

```
SELECT * FROM pgr_bellmanFord(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, ARRAY[3,5],
    FALSE
);
 seq | path_seq | end_vid | node | edge | cost | agg_cost
-----+----------+---------+------+------+------+----------
   1 |        1 |       3 |    2 |    2 |    1 |        0
   2 |        2 |       3 |    3 |   -1 |    0 |        1
   3 |        1 |       5 |    2 |    4 |    1 |        0
   4 |        2 |       5 |    5 |   -1 |    0 |        1
(4 rows)
```

Many to One

```
pgr_bellmanFord(Edges SQL, from_vids, to_vid  [, directed])
RETURNS SET OF (seq, path_seq, start_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertices \(\{2, 11\}\) to vertex \(5\) on a **directed** graph

```
SELECT * FROM pgr_bellmanFord(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[2,11], 5
);
 seq | path_seq | start_vid | node | edge | cost | agg_cost
-----+----------+-----------+------+------+------+----------
   1 |        1 |         2 |    2 |    4 |    1 |        0
   2 |        2 |         2 |    5 |   -1 |    0 |        1
   3 |        1 |        11 |   11 |   13 |    1 |        0
   4 |        2 |        11 |   12 |   15 |    1 |        1
   5 |        3 |        11 |    9 |    9 |    1 |        2
   6 |        4 |        11 |    6 |    8 |    1 |        3
   7 |        5 |        11 |    5 |   -1 |    0 |        4
(7 rows)
```

Many to Many

```
pgr_bellmanFord(Edges SQL, from_vids, to_vids [, directed])
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertices \(\{2, 11\}\) to vertices \(\{3, 5\}\) on an **undirected** graph

```
SELECT * FROM pgr_bellmanFord(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[2,11], ARRAY[3,5]
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    4 |    1 |        0
   2 |        2 |         2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |         2 |       3 |    6 |    9 |    1 |        2
   4 |        4 |         2 |       3 |    9 |   16 |    1 |        3
   5 |        5 |         2 |       3 |    4 |    3 |    1 |        4
   6 |        6 |         2 |       3 |    3 |   -1 |    0 |        5
   7 |        1 |         2 |       5 |    2 |    4 |    1 |        0
   8 |        2 |         2 |       5 |    5 |   -1 |    0 |        1
   9 |        1 |        11 |       3 |   11 |   13 |    1 |        0
  10 |        2 |        11 |       3 |   12 |   15 |    1 |        1
  11 |        3 |        11 |       3 |    9 |   16 |    1 |        2
  12 |        4 |        11 |       3 |    4 |    3 |    1 |        3
  13 |        5 |        11 |       3 |    3 |   -1 |    0 |        4
  14 |        1 |        11 |       5 |   11 |   13 |    1 |        0
  15 |        2 |        11 |       5 |   12 |   15 |    1 |        1
  16 |        3 |        11 |       5 |    9 |    9 |    1 |        2
  17 |        4 |        11 |       5 |    6 |    8 |    1 |        3
  18 |        5 |        11 |       5 |    5 |   -1 |    0 |        4
(18 rows)
```

Combinations

```
pgr_bellmanFord(Edges SQL, Combinations SQL [, directed])
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
Using a combinations table on an **undirected** graph.

```
SELECT * FROM pgr_bellmanFord(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    'SELECT * FROM ( VALUES (2, 3), (11, 5) ) AS t(source, target)'
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    4 |    1 |        0
   2 |        2 |         2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |         2 |       3 |    6 |    9 |    1 |        2
   4 |        4 |         2 |       3 |    9 |   16 |    1 |        3
   5 |        5 |         2 |       3 |    4 |    3 |    1 |        4
   6 |        6 |         2 |       3 |    3 |   -1 |    0 |        5
   7 |        1 |        11 |       5 |   11 |   13 |    1 |        0
   8 |        2 |        11 |       5 |   12 |   15 |    1 |        1
   9 |        3 |        11 |       5 |    9 |    9 |    1 |        2
  10 |        4 |        11 |       5 |    6 |    8 |    1 |        3
  11 |        5 |        11 |       5 |    5 |   -1 |    0 |        4
(11 rows)
```

Parameters

Description of the parameters of the signatures

Parameter	Type	Default	Description
Edges SQL	TEXT		Edges query as described below.
Combinations SQL	TEXT		Combinations query as described below.
start_vid	BIGINT		Identifier of the starting vertex of the path.
start_vids	ARRAY[BIGINT]		Array of identifiers of starting vertices.
end_vid	BIGINT		Identifier of the ending vertex of the path.
end_vids	ARRAY[BIGINT]		Array of identifiers of ending vertices.
directed	BOOLEAN	true	• When true Graph is considered *Directed* • When false the graph is considered as *Undirected*.

Inner Queries

Edges query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Combinations query

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.

Column	Type	Default	Description
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

Results Columns

Returns set of (seq, path_seq [, start_vid] [, end_vid], node, edge, cost, agg_cost)

Column	Type	Description
seq	INT	Sequential value starting from **1**.
path_seq	INT	Relative position in the path. Has value **1** for the beginning of a path.
start_vid	BIGINT	Identifier of the starting vertex. Returned when multiple starting vetrices are in the query. • **Many to One** • **Many to Many**
end_vid	BIGINT	Identifier of the ending vertex. Returned when multiple ending vertices are in the query. • **One to Many** • **Many to Many**
node	BIGINT	Identifier of the node in the path from start_vid to end_vid.
edge	BIGINT	Identifier of the edge used to go from node to the next node in the path sequence. -1 for the last node of the path.
cost	FLOAT	Cost to traverse from node using edge to the next node in the path sequence.
agg_cost	FLOAT	Aggregate cost from start_v to node.

See Also

- **https://en.wikipedia.org/wiki/Bellman%E2%80%93Ford_algorithm**
- The queries use the **Sample Data** network.

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2)**

pgr_binaryBreadthFirstSearch - Experimental

pgr_binaryBreadthFirstSearch — Returns the shortest path(s) in a binary graph. Any graph whose edge-weights belongs to the set {0,X}, where ‘X’ is any non-negative real integer, is termed as a ‘binary graph’.

Boost Graph Inside

> **Warning**
>
> Possible server crash
>
> - These functions might create a server crash

> **Warning**
>
> Experimental functions
>
> - They are not officially of the current release.
> - They likely will not be officially be part of the next release:
>   - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL

- Name might change.
- Signature might change.
- Functionality might change.
- pgTap tests might be missing.
- Might need c/c++ coding.
- May lack documentation.
- Documentation if any might need to be rewritten.
- Documentation examples might need to be automatically generated.
- Might need a lot of feedback from the comunity.
- Might depend on a proposed function of pgRouting
- Might depend on a deprecated function of pgRouting

Availability

- Version 3.2.0
  - New **experimental** function:
    - pgr_binaryBreadthFirstSearch(Combinations)
- Version 3.0.0
  - New **experimental** function

Description

It is well-known that the shortest paths between a single source and all other vertices can be found using Breadth First Search in \(O(|E|)\) in an unweighted graph, i.e. the distance is the minimal number of edges that you need to traverse from the source to another vertex. We can interpret such a graph also as a weighted graph, where every edge has the weight 1. If not all edges in graph have the same weight, that we need a more general algorithm, like Dijkstra's Algorithm which runs in \(O(|E|log|V|)\) time.

However if the weights are more constrained, we can use a faster algorithm. This algorithm, termed as 'Binary Breadth First Search' as well as '0-1 BFS', is a variation of the standard Breadth First Search problem to solve the SSSP (single-source shortest path) problem in \(O(|E|)\), if the weights of each edge belongs to the set {0,X}, where 'X' is any non-negative real integer.

The main Characteristics are:

- Process is done only on 'binary graphs'. ('Binary Graph': Any graph whose edge-weights belongs to the set {0,X}, where 'X' is any non-negative real integer.)
- For optimization purposes, any duplicated value in the *start_vids* or *end_vids* are ignored.
- The returned values are ordered:
  - *start_vid* ascending
  - *end_vid* ascending
- Running time: \(O(| start_vids | * |E|)\)

Signatures

```
pgr_binaryBreadthFirstSearch(Edges SQL, start_vid,  end_vid  [, directed])
pgr_binaryBreadthFirstSearch(Edges SQL, start_vid,  end_vids [, directed])
pgr_binaryBreadthFirstSearch(Edges SQL, start_vids, end_vid  [, directed])
pgr_binaryBreadthFirstSearch(Edges SQL, start_vids, end_vids [, directed])
pgr_binaryBreadthFirstSearch(Edges SQL, Combinations SQL [, directed]) -- Proposed on v3.2
RETURNS SET OF (seq, path_seq [, start_vid] [, end_vid], node, edge, cost, agg_cost)
OR EMPTY SET
```

```
pgr_binaryBreadthFirstSearch(Edges SQL, start_vid, end_vid)
RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost) or EMPTY SET
```

Example:
From vertex \(2\) to vertex \(3\) on a **directed** binary graph

```
SELECT * FROM pgr_binaryBreadthFirstSearch(
    'SELECT id, source, target, road_work as cost, reverse_road_work as reverse_cost FROM roadworks',
    2, 3
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    4 |    0 |        0
   2 |        2 |    5 |    8 |    1 |        0
   3 |        3 |    6 |    9 |    1 |        1
   4 |        4 |    9 |   16 |    0 |        2
   5 |        5 |    4 |    3 |    0 |        2
   6 |        6 |    3 |   -1 |    0 |        2
(6 rows)
```

One to One

```
pgr_binaryBreadthFirstSearch(Edges SQL, start_vid, end_vid [, directed]);
RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertex \(2\) to vertex \(3\) on an **undirected** binary graph

```
SELECT * FROM pgr_binaryBreadthFirstSearch(
    'SELECT id, source, target, road_work as cost, reverse_road_work as reverse_cost FROM roadworks',
    2, 3,
    FALSE
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    2 |    1 |        0
   2 |        2 |    3 |   -1 |    0 |        1
(2 rows)
```

One to many

```
pgr_binaryBreadthFirstSearch(Edges SQL, start_vid, end_vids [, directed]);
RETURNS SET OF (seq, path_seq, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertex \(2\) to vertices \(\{3, 5\}\) on an **undirected** binary graph

```
SELECT * FROM pgr_binaryBreadthFirstSearch(
    'SELECT id, source, target, road_work as cost FROM roadworks',
    2, ARRAY[3,5],
    FALSE
);
 seq | path_seq | end_vid | node | edge | cost | agg_cost
-----+----------+---------+------+------+------+----------
   1 |        1 |       3 |    2 |    4 |    0 |        0
   2 |        2 |       3 |    5 |    8 |    1 |        0
   3 |        3 |       3 |    6 |    5 |    1 |        1
   4 |        4 |       3 |    3 |   -1 |    0 |        2
   5 |        1 |       5 |    2 |    4 |    0 |        0
   6 |        2 |       5 |    5 |   -1 |    0 |        0
(6 rows)
```

Many to One

```
pgr_binaryBreadthFirstSearch(Edges SQL, start_vids, end_vid [, directed]);
RETURNS SET OF (seq, path_seq, start_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertices \(\{2, 11\}\) to vertex \(5\) on a **directed** binary graph

```
SELECT * FROM pgr_binaryBreadthFirstSearch(
    'SELECT id, source, target, road_work as cost, reverse_road_work as reverse_cost FROM roadworks',
    ARRAY[2,11], 5
);
 seq | path_seq | start_vid | node | edge | cost | agg_cost
-----+----------+-----------+------+------+------+----------
   1 |        1 |         2 |    2 |    4 |    0 |        0
   2 |        2 |         2 |    5 |   -1 |    0 |        0
   3 |        1 |        11 |   11 |   13 |    1 |        0
   4 |        2 |        11 |   12 |   15 |    0 |        1
   5 |        3 |        11 |    9 |   16 |    0 |        1
   6 |        4 |        11 |    4 |    3 |    0 |        1
   7 |        5 |        11 |    3 |    2 |    1 |        1
   8 |        6 |        11 |    2 |    4 |    0 |        2
   9 |        7 |        11 |    5 |   -1 |    0 |        2
(9 rows)
```

Many to Many

```
pgr_binaryBreadthFirstSearch(Edges SQL, start_vids, end_vids [, directed]);
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertices \(\{2, 11\}\) to vertices \(\{3, 5\}\) on an **undirected** binary graph

```
SELECT * FROM pgr_binaryBreadthFirstSearch(
    'SELECT id, source, target, road_work as cost, reverse_road_work as reverse_cost FROM roadworks',
    ARRAY[2,11], ARRAY[3,5],
    FALSE
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    2 |    1 |        0
   2 |        2 |         2 |       3 |    3 |   -1 |    0 |        1
   3 |        1 |         2 |       5 |    2 |    4 |    0 |        0
   4 |        2 |         2 |       5 |    5 |   -1 |    0 |        0
   5 |        1 |        11 |       3 |   11 |   13 |    1 |        0
   6 |        2 |        11 |       3 |   12 |   15 |    0 |        1
   7 |        3 |        11 |       3 |    9 |   16 |    0 |        1
   8 |        4 |        11 |       3 |    4 |    3 |    0 |        1
   9 |        5 |        11 |       3 |    3 |   -1 |    0 |        1
  10 |        1 |        11 |       5 |   11 |   12 |    0 |        0
  11 |        2 |        11 |       5 |   10 |   10 |    1 |        0
  12 |        3 |        11 |       5 |    5 |   -1 |    0 |        1
(12 rows)
```

Combinations

```
pgr_binaryBreadthFirstSearch(Edges SQL, Combinations SQL [, directed]);
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

Using a combinations table on an **undirected** binary graph.

```
SELECT * FROM pgr_binaryBreadthFirstSearch(
    'SELECT id, source, target, road_work as cost, reverse_road_work as reverse_cost FROM roadworks',
    'SELECT * FROM ( VALUES (2, 3), (11, 5) ) AS t(source, target)',
    FALSE
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    2 |    1 |        0
   2 |        2 |         2 |       3 |    3 |   -1 |    0 |        1
   3 |        1 |        11 |       5 |   11 |   12 |    0 |        0
   4 |        2 |        11 |       5 |   10 |   10 |    1 |        0
   5 |        3 |        11 |       5 |    5 |   -1 |    0 |        1
(5 rows)
```

Parameters

Parameter	Type	Default	Description
Edges SQL	TEXT		Edges query as described below.
Combinations SQL	TEXT		Combinations query as described below.
start_vid	BIGINT		Identifier of the starting vertex of the path.
start_vids	ARRAY[BIGINT]		Array of identifiers of starting vertices.
end_vid	BIGINT		Identifier of the ending vertex of the path.
end_vids	ARRAY[BIGINT]		Array of identifiers of ending vertices.
directed	BOOLEAN	true	• When true Graph is considered *Directed* • When false the graph is considered as *Undirected*.

Inner queries

Edges query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.

Column	Type	Default	Description
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Combinations query

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

Return Columns

Returns set of (seq, path_id, path_seq [, start_vid] [, end_vid], node, edge, cost, agg_cost)

Column	Type	Description
seq	INT	Sequential value starting from **1**.
path_id	INT	Path identifier. Has value **1** for the first of a path. Used when there are multiple paths for the same start_vid to end_vid combination.
path_seq	INT	Relative position in the path. Has value **1** for the beginning of a path.
start_vid	BIGINT	Identifier of the starting vertex. Returned when multiple starting vetrices are in the query. • **Many to One** • **Many to Many**
end_vid	BIGINT	Identifier of the ending vertex. Returned when multiple ending vertices are in the query. • **One to Many** • **Many to Many**
node	BIGINT	Identifier of the node in the path from start_vid to end_vid.
edge	BIGINT	Identifier of the edge used to go from node to the next node in the path sequence. -1 for the last node of the path.
cost	FLOAT	Cost to traverse from node using edge to the next node in the path sequence.
agg_cost	FLOAT	Aggregate cost from start_v to node.

Example Data

This type of data is used on the examples of this page.

Edwards-Moore Algorithm is best applied when trying to answer queries such as the following: **"Find the path with the minimum number from Source to Destination"** Here: * *Source* = Source Vertex, *Destination* = Any arbitrary destination vertex * *X* is an event/property * Each edge in the graph is either "*X*" or "*Not X*" .

Example: "Find the path with the minimum number of road works from Source to Destination"

Here, a road under work(aka **road works**) means that part of the road is occupied for construction work/maintenance.

Here: * Edge (*u* , *v*) has weight = 0 if no road work is ongoing on the road from *u* to *v*. * Edge (*u*, *v*) has weight = 1 if road work is ongoing on the road from *u* to *v*.

Then, upon running the algorithm, we obtain the path with the minimum number of road works from the given source and destination.

Thus, the queries used in the previous section can be interpreted in this manner.

Table Data

The queries in the previous sections use the table 'roadworks'. The data of the table:

```
DROP TABLE IF EXISTS roadworks CASCADE;
NOTICE:  table "roadworks" does not exist, skipping
DROP TABLE
CREATE table roadworks (
    id BIGINT not null primary key,
    source BIGINT,
    target BIGINT,
    road_work FLOAT,
    reverse_road_work FLOAT
);
CREATE TABLE
INSERT INTO roadworks(
  id, source, target, road_work, reverse_road_work) VALUES
  (1,  1,  2,  0,  0),
  (2,  2,  3,  -1,  1),
  (3,  3,  4,  -1,  0),
  (4,  2,  5,  0,  0),
  (5,  3,  6,  1,  -1),
  (6,  7,  8,  1,  1),
  (7,  8,  5,  0,  0),
  (8,  5,  6,  1,  1),
  (9,  6,  9,  1,  1),
  (10,  5,  10,  1,  1),
  (11,  6,  11,  1,  -1),
  (12,  10,  11,  0,  -1),
  (13,  11,  12,  1,  -1),
  (14,  10,  13,  1,  1),
  (15,  9,  12,  0,  0),
  (16,  4,  9,  0,  0),
  (17,  14,  15,  0,  0),
  (18,  16,  17,  0,  0);
INSERT 0 18
```

See Also

- **https://cp-algorithms.com/graph/01_bfs.html**
- **https://en.wikipedia.org/wiki/Dijkstra%27s_algorithm#Specialized_variants**

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2)**

pgr_breadthFirstSearch - Experimental

`pgr_breadthFirstSearch` — Returns the traversal order(s) using Breadth First Search algorithm.

Boost Graph Inside

> **Warning**
>
> Possible server crash
>
> - These functions might create a server crash

> **Warning**
>
> Experimental functions
>
> - They are not officially of the current release.
> - They likely will not be officially be part of the next release:
>   - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
>   - Name might change.
>   - Signature might change.
>   - Functionality might change.
>   - pgTap tests might be missing.
>   - Might need c/c++ coding.

- May lack documentation.
- Documentation if any might need to be rewritten.
- Documentation examples might need to be automatically generated.
- Might need a lot of feedback from the comunity.
- Might depend on a proposed function of pgRouting
- Might depend on a deprecated function of pgRouting

Availability

Description

Provides the Breadth First Search traversal order from a root vertex to a particular depth.

The main Characteristics are:

- The implementation will work on any type of graph.
- Provides the Breadth First Search traversal order from a source node to a target depth level
- Breath First Search Running time: $O(E + V)$

Signatures

```
pgr_breadthFirstSearch(Edges SQL, Root vid [, max_depth] [, directed])
pgr_breadthFirstSearch(Edges SQL, Root vids [, max_depth] [, directed])

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Single Vertex

```
pgr_breadthFirstSearch(Edges SQL, Root vid [, max_depth] [, directed])

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Example:
The Breadth First Search traversal with root vertex 2

```
SELECT * FROM pgr_breadthFirstSearch(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    2
);
 seq | depth | start_vid | node | edge | cost | agg_cost
-----+-------+-----------+------+------+------+----------
   1 |     0 |         2 |    2 |   -1 |    0 |        0
   2 |     1 |         2 |    1 |    1 |    1 |        1
   3 |     1 |         2 |    5 |    4 |    1 |        1
   4 |     2 |         2 |    8 |    7 |    1 |        2
   5 |     2 |         2 |    6 |    8 |    1 |        2
   6 |     2 |         2 |   10 |   10 |    1 |        2
   7 |     3 |         2 |    7 |    6 |    1 |        3
   8 |     3 |         2 |    9 |    9 |    1 |        3
   9 |     3 |         2 |   11 |   11 |    1 |        3
  10 |     3 |         2 |   13 |   14 |    1 |        3
  11 |     4 |         2 |   12 |   15 |    1 |        4
  12 |     4 |         2 |    4 |   16 |    1 |        4
  13 |     5 |         2 |    3 |    3 |    1 |        5
(13 rows)
```

Multiple Vertices

```
pgr_breadthFirstSearch(Edges SQL, Root vids [, max_depth] [, directed])

RETURNS SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)
```

Example:
The Breadth First Search traverls starting on vertices $\{11, 12\}$ with $depth <= 2$

```
SELECT * FROM pgr_breadthFirstSearch(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    ARRAY[11,12], max_depth := 2
);
 seq | depth | start_vid | node | edge | cost | agg_cost
-----+-------+-----------+------+------+------+----------
   1 |     0 |        11 |   11 |   -1 |    0 |        0
   2 |     1 |        11 |   12 |   13 |    1 |        1
   3 |     2 |        11 |    9 |   15 |    1 |        2
   4 |     0 |        12 |   12 |   -1 |    0 |        0
   5 |     1 |        12 |    9 |   15 |    1 |        1
   6 |     2 |        12 |    6 |    9 |    1 |        2
   7 |     2 |        12 |    4 |   16 |    1 |        2
(7 rows)
```

Parameters

Parameter	Type	Description
Edges SQL	TEXT	SQL query described in **Inner query**.
Root vid	BIGINT	Identifier of the root vertex of the tree. • Used on **Single Vertex**.
Root vids	ARRAY[ANY-INTEGER]	Array of identifiers of the root vertices. • Used on **Multiple Vertices**. • For optimization purposes, any duplicated value is ignored.

Optional Parameters

Parameter	Type	Default	Description
max_depth	BIGINT	9223372036854775807	Upper limit for depth of node in the tree • When value is Negative then **throws error**
directed	BOOLEAN	true	• When true Graph is considered *Directed* • When false the graph is considered as *Undirected*.

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns SET OF (seq, depth, start_vid, node, edge, cost, agg_cost)

Column	Type	Description
seq	BIGINT	Sequential value starting from 1.
depth	BIGINT	Depth of the node. • 0 when node = start_vid.

Column	Type	Description
start_vid	BIGINT	Identifier of the root vertex. • I n *Multiple Vertices* results are in ascending order.
node	BIGINT	Identifier of node reached using edge.
edge	BIGINT	Identifier of the edge used to arrive to node. • \(-1\) when node = start_vid.
cost	FLOAT	Cost to traverse edge.
agg_cost	FLOAT	Aggregate cost from start_vid to node.

Additional Examples

Undirected Graph

Example:
The Breadth First Search traverls starting on vertices\(\{11, 12\}\) with \(depth <= 2\) as well as considering the graph to be undirected.

```
SELECT * FROM pgr_breadthFirstSearch(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    ARRAY[11,12], max_depth := 2, directed := false
);
 seq | depth | start_vid | node | edge | cost | agg_cost
-----+-------+-----------+------+------+------+----------
   1 |     0 |        11 |   11 |   -1 |    0 |        0
   2 |     1 |        11 |    6 |   11 |    1 |        1
   3 |     1 |        11 |   10 |   12 |    1 |        1
   4 |     1 |        11 |   12 |   13 |    1 |        1
   5 |     2 |        11 |    3 |    5 |    1 |        2
   6 |     2 |        11 |    5 |    8 |    1 |        2
   7 |     2 |        11 |    9 |    9 |    1 |        2
   8 |     2 |        11 |   13 |   14 |    1 |        2
   9 |     0 |        12 |   12 |   -1 |    0 |        0
  10 |     1 |        12 |   11 |   13 |    1 |        1
  11 |     1 |        12 |    9 |   15 |    1 |        1
  12 |     2 |        12 |    6 |   11 |    1 |        2
  13 |     2 |        12 |   10 |   12 |    1 |        2
  14 |     2 |        12 |    4 |   16 |    1 |        2
(14 rows)
```

Vertex Out Of Graph

Example:
The output of the function when a vertex not present in the graph is passed as a parameter.

```
SELECT * FROM pgr_breadthFirstSearch(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table ORDER BY id',
    -10
);
 seq | depth | start_vid | node | edge | cost | agg_cost
-----+-------+-----------+------+------+------+----------
(0 rows)
```

See Also

- The queries use the **Sample Data** network.
- **Boost: Breadth First Search algorithm documentation**
- **Wikipedia: Breadth First Search algorithm**

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.1 3.0**

pgr_dagShortestPath - Experimental

pgr_dagShortestPath — Returns the shortest path(s) for weighted directed acyclic graphs(DAG). In particular, the DAG shortest paths algorithm implemented by Boost.Graph.

Boost Graph Inside

Warning

Possible server crash

- These functions might create a server crash

Warning

Experimental functions

- They are not officially of the current release.
- They likely will not be officially be part of the next release:
  - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
  - Name might change.
  - Signature might change.
  - Functionality might change.
  - pgTap tests might be missing.
  - Might need c/c++ coding.
  - May lack documentation.
  - Documentation if any might need to be rewritten.
  - Documentation examples might need to be automatically generated.
  - Might need a lot of feedback from the comunity.
  - Might depend on a proposed function of pgRouting
  - Might depend on a deprecated function of pgRouting

Availability

- Version 3.2.0
  - New **experimental** function:
    - pgr_dagShortestPath(Combinations)
- Version 3.0.0
  - New **experimental** function

Description

Shortest Path for Directed Acyclic Graph(DAG) is a graph search algorithm that solves the shortest path problem for weighted directed acyclic graph, producing a shortest path from a starting vertex (`start_vid`) to an ending vertex (`end_vid`).

This implementation can only be used with a **directed** graph with no cycles i.e. directed acyclic graph.

The algorithm relies on topological sorting the dag to impose a linear ordering on the vertices, and thus is more efficient for DAG's than either the Dijkstra or Bellman-Ford algorithm.

The main characteristics are:

- Process is valid for weighted directed acyclic graphs only. otherwise it will throw warnings.
- Values are returned when there is a path.
  - When the starting vertex and ending vertex are the same, there is no path.
    - The *agg_cost* the non included values *(v, v)* is *0*
  - When the starting vertex and ending vertex are the different and there is no path:
    - The *agg_cost* the non included values *(u, v)* is \(\infty\)
- For optimization purposes, any duplicated value in the *start_vids* or *end_vids* are ignored.
- The returned values are ordered:
  - *start_vid* ascending
  - *end_vid* ascending
- Running time: \(O(| start_vids | * (V + E))\)

Signatures

Summary

```
pgr_dagShortestPath(Edges SQL, from_vid,  to_vid)
pgr_dagShortestPath(Edges SQL, from_vid,  to_vids)
pgr_dagShortestPath(Edges SQL, from_vids, to_vid)
pgr_dagShortestPath(Edges SQL, from_vids, to_vids)
pgr_dagShortestPath(Edges SQL, Combinations) -- Experimental on v3.2

RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost)
OR EMPTY SET
```

One to One

```
pgr_dagShortestPath(Edges SQL, from_vid,  to_vid)
RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertex \(1\) to vertex \(6\)

```
SELECT * FROM pgr_dagShortestPath(
    'SELECT id, source, target, cost FROM edge_table',
    1, 6
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    1 |    1 |    1 |        0
   2 |        2 |    2 |    4 |    1 |        1
   3 |        3 |    5 |    8 |    1 |        2
   4 |        4 |    6 |   -1 |    0 |        3
(4 rows)
```

One to Many

```
pgr_dagShortestPath(Edges SQL, from_vid,  to_vids)
RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertex \(1\) to vertices \(\{ 5, 6\}\)

```
SELECT * FROM pgr_dagShortestPath(
    'SELECT id, source, target, cost FROM edge_table',
    1, ARRAY[5,6]
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    1 |    1 |    1 |        0
   2 |        2 |    2 |    4 |    1 |        1
   3 |        3 |    5 |   -1 |    0 |        2
   4 |        1 |    1 |    1 |    1 |        0
   5 |        2 |    2 |    4 |    1 |        1
   6 |        3 |    5 |    8 |    1 |        2
   7 |        4 |    6 |   -1 |    0 |        3
(7 rows)
```

Many to One

```
pgr_dagShortestPath(Edges SQL, from_vids, to_vid)
RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:

From vertices \(\{1, 3\}\) to vertex \(6\)

```
SELECT * FROM pgr_dagShortestPath(
    'SELECT id, source, target, cost FROM edge_table',
    ARRAY[1,3], 6
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    1 |    1 |    1 |        0
   2 |        2 |    2 |    4 |    1 |        1
   3 |        3 |    5 |    8 |    1 |        2
   4 |        4 |    6 |   -1 |    0 |        3
   5 |        1 |    3 |    5 |    1 |        0
   6 |        2 |    6 |   -1 |    0 |        1
(6 rows)
```

Many to Many

```
pgr_dagShortestPath(Edges SQL, from_vids, to_vids)
RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertices \(\{1, 4\}\) to vertices \(\{12, 6\}\)

```
SELECT * FROM pgr_dagShortestPath(
    'SELECT id, source, target, cost FROM edge_table',
    ARRAY[1, 4],ARRAY[12,6]
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    1 |    1 |    1 |        0
   2 |        2 |    2 |    4 |    1 |        1
   3 |        3 |    5 |    8 |    1 |        2
   4 |        4 |    6 |   -1 |    0 |        3
   5 |        1 |    1 |    1 |    1 |        0
   6 |        2 |    2 |    4 |    1 |        1
   7 |        3 |    5 |   10 |    1 |        2
   8 |        4 |   10 |   12 |    1 |        3
   9 |        5 |   11 |   13 |    1 |        4
  10 |        6 |   12 |   -1 |    0 |        5
  11 |        1 |    4 |   16 |    1 |        0
  12 |        2 |    9 |   15 |    1 |        1
  13 |        3 |   12 |   -1 |    0 |        2
(13 rows)
```

Combinations

```
pgr_dagShortestPath(Edges SQL, Combinations)
RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
Using a combinations table on a Directed Acyclic Graph.

```
SELECT * FROM pgr_dagShortestPath(
    'SELECT id, source, target, cost FROM edge_table',
    'SELECT * FROM ( VALUES (1, 6), (4, 12) ) AS t(source, target)'
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    1 |    1 |    1 |        0
   2 |        2 |    2 |    4 |    1 |        1
   3 |        3 |    5 |    8 |    1 |        2
   4 |        4 |    6 |   -1 |    0 |        3
   5 |        1 |    4 |   16 |    1 |        0
   6 |        2 |    9 |   15 |    1 |        1
   7 |        3 |   12 |   -1 |    0 |        2
(7 rows)
```

Parameters

Description of the parameters of the signatures

Parameter	Type	Default	Description
Edges SQL	TEXT		Edges query as described below.
Combinations SQL	TEXT		Combinations query as described above.
start_vid	BIGINT		Identifier of the starting vertex of the path.
start_vids	ARRAY[BIGINT]		Array of identifiers of starting vertices.
end_vid	BIGINT		Identifier of the ending vertex of the path.
end_vids	ARRAY[BIGINT]		Array of identifiers of ending vertices.

Inner Queries

Edges query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.

Column	Type	Default	Description
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Combinations query

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

Results Columns

Returns set of (seq, path_seq [, start_vid] [, end_vid], node, edge, cost, agg_cost)

Column	Type	Description
seq	INT	Sequential value starting from **1**.
path_seq	INT	Relative position in the path. Has value **1** for the beginning of a path.
start_vid	BIGINT	Identifier of the starting vertex. Returned when multiple starting vetrices are in the query. • **Many to One** • **Many to Many**
end_vid	BIGINT	Identifier of the ending vertex. Returned when multiple ending vertices are in the query. • **One to Many** • **Many to Many**
node	BIGINT	Identifier of the node in the path from start_vid to end_vid.
edge	BIGINT	Identifier of the edge used to go from node to the next node in the path sequence. -1 for the last node of the path.
cost	FLOAT	Cost to traverse from node using edge to the next node in the path sequence.
agg_cost	FLOAT	Aggregate cost from start_v to node.

See Also

- **https://en.wikipedia.org/wiki/Topological_sorting**
- The queries use the **Sample Data** network.

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2)**

pgr_edwardMoore - Experimental

pgr_edwardMoore — Returns the shortest path(s) using Edward-Moore algorithm. Edward Moore's Algorithm is an improvement of the Bellman-Ford Algorithm.

Warning

Possible server crash

- These functions might create a server crash

Warning

Experimental functions

- They are not officially of the current release.
- They likely will not be officially be part of the next release:
  - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
  - Name might change.
  - Signature might change.
  - Functionality might change.
  - pgTap tests might be missing.
  - Might need c/c++ coding.
  - May lack documentation.
  - Documentation if any might need to be rewritten.
  - Documentation examples might need to be automatically generated.
  - Might need a lot of feedback from the comunity.
  - Might depend on a proposed function of pgRouting
  - Might depend on a deprecated function of pgRouting

Availability

- Version 3.2.0
  - New **experimental** function:
    - pgr_edwardMoore(Combinations)
- Version 3.0.0
  - New **experimental** function

Description

Edward Moore's Algorithm is an improvement of the Bellman-Ford Algorithm. It can compute the shortest paths from a single source vertex to all other vertices in a weighted directed graph. The main difference between Edward Moore's Algorithm and Bellman Ford's Algorithm lies in the run time.

The worst-case running time of the algorithm is\(O(| V | * | E |)\) similar to the time complexity of Bellman-Ford algorithm. However, experiments suggest that this algorithm has an average running time complexity of \(O(| E |)\) for random graphs. This is significantly faster in terms of computation speed.

Thus, the algorithm is at-best, significantly faster than Bellman-Ford algorithm and is at-worst, as good as Bellman-Ford algorithm

The main characteristics are:

- Values are returned when there is a path.
  - When the starting vertex and ending vertex are the same, there is no path.
    - The *agg_cost* the non included values *(v, v)* is *0*
  - When the starting vertex and ending vertex are the different and there is no path:
    - The *agg_cost* the non included values *(u, v)* is \(\infty\)
- For optimization purposes, any duplicated value in the *start_vids* or *end_vids* are ignored.
- The returned values are ordered:
  - *start_vid* ascending
  - *end_vid* ascending
- Running time: - Worst case: \(O(| V | * | E |)\) - Average case: \(O(| E |)\)

Signatures

```
pgr_edwardMoore(Edges SQL, start_vid,  end_vid  [, directed])
pgr_edwardMoore(Edges SQL, start_vid,  end_vids [, directed])
pgr_edwardMoore(Edges SQL, start_vids, end_vid  [, directed])
pgr_edwardMoore(Edges SQL, start_vids, end_vids [, directed])
pgr_edwardMoore(Edges SQL, Combinations SQL [, directed])
RETURNS SET OF (seq, path_seq [, start_vid] [, end_vid], node, edge, cost, agg_cost)
OR EMPTY SET
```

```
pgr_edwardMoore(Edges SQL, start_vid, end_vid)
RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost) or EMPTY SET
```

Example:
From vertex \(2\) to vertex \(3\) on a **directed** graph

```
SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, 3
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    4 |    1 |        0
   2 |        2 |    5 |    8 |    1 |        1
   3 |        3 |    6 |    9 |    1 |        2
   4 |        4 |    9 |   16 |    1 |        3
   5 |        5 |    4 |    3 |    1 |        4
   6 |        6 |    3 |   -1 |    0 |        5
(6 rows)
```

One to One

```
pgr_edwardMoore(Edges SQL, start_vid, end_vid [, directed]);
RETURNS SET OF (seq, path_seq, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertex \(2\) to vertex \(3\) on an **undirected** graph

```
SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, 3,
    FALSE
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    2 |    1 |        0
   2 |        2 |    3 |   -1 |    0 |        1
(2 rows)
```

One to many

```
pgr_edwardMoore(Edges SQL, start_vid, end_vids [, directed]);
RETURNS SET OF (seq, path_seq, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertex \(2\) to vertices \(\{3, 5\}\) on an **undirected** graph

```
SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost FROM edge_table',
    2, ARRAY[3,5],
    FALSE
);
 seq | path_seq | end_vid | node | edge | cost | agg_cost
-----+----------+---------+------+------+------+----------
   1 |        1 |       3 |    2 |    4 |    1 |        0
   2 |        2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |       3 |    6 |    5 |    1 |        2
   4 |        4 |       3 |    3 |   -1 |    0 |        3
   5 |        1 |       5 |    2 |    4 |    1 |        0
   6 |        2 |       5 |    5 |   -1 |    0 |        1
(6 rows)
```

Many to One

```
pgr_edwardMoore(Edges SQL, start_vids, end_vid [, directed]);
RETURNS SET OF (seq, path_seq, start_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertices \(\{2, 11\}\) to vertex \(5\) on a **directed** graph

```
SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[2,11], 5
);
 seq | path_seq | start_vid | node | edge | cost | agg_cost
-----+----------+-----------+------+------+------+----------
   1 |        1 |         2 |    2 |    4 |    1 |        0
   2 |        2 |         2 |    5 |   -1 |    0 |        1
   3 |        1 |        11 |   11 |   13 |    1 |        0
   4 |        2 |        11 |   12 |   15 |    1 |        1
   5 |        3 |        11 |    9 |    9 |    1 |        2
   6 |        4 |        11 |    6 |    8 |    1 |        3
   7 |        5 |        11 |    5 |   -1 |    0 |        4
(7 rows)
```

Many to Many

```
pgr_edwardMoore(Edges SQL, start_vids, end_vids [, directed]);
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
From vertices \(\{2, 11\}\) to vertices \(\{3, 5\}\) on an **undirected** graph

```
SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[2,11], ARRAY[3,5],
    FALSE
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    2 |    1 |        0
   2 |        2 |         2 |       3 |    3 |   -1 |    0 |        1
   3 |        1 |         2 |       5 |    2 |    4 |    1 |        0
   4 |        2 |         2 |       5 |    5 |   -1 |    0 |        1
   5 |        1 |        11 |       3 |   11 |   11 |    1 |        0
   6 |        2 |        11 |       3 |    6 |    5 |    1 |        1
   7 |        3 |        11 |       3 |    3 |   -1 |    0 |        2
   8 |        1 |        11 |       5 |   11 |   11 |    1 |        0
   9 |        2 |        11 |       5 |    6 |    8 |    1 |        1
  10 |        3 |        11 |       5 |    5 |   -1 |    0 |        2
(10 rows)
```

Combinations

```
pgr_edwardMoore(Edges SQL, Combinations SQL [, directed]);
RETURNS SET OF (seq, path_seq, start_vid, end_vid, node, edge, cost, agg_cost)
OR EMPTY SET
```

Example:
Using a combinations table on an **undirected** graph.

```
SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    'SELECT * FROM ( VALUES (2, 3), (11, 5) ) AS t(source, target)',
    FALSE
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    2 |    1 |        0
   2 |        2 |         2 |       3 |    3 |   -1 |    0 |        1
   3 |        1 |        11 |       5 |   11 |   11 |    1 |        0
   4 |        2 |        11 |       5 |    6 |    8 |    1 |        1
   5 |        3 |        11 |       5 |    5 |   -1 |    0 |        2
(5 rows)
```

Parameters

Parameter	Type	Default	Description
Edges SQL	TEXT		Edges query as described below.
Combinations SQL	TEXT		Combinations query as described below.
start_vid	BIGINT		Identifier of the starting vertex of the path.
start_vids	ARRAY[BIGINT]		Array of identifiers of starting vertices.
end_vid	BIGINT		Identifier of the ending vertex of the path.
end_vids	ARRAY[BIGINT]		Array of identifiers of ending vertices.

Parameter	Type	Default	Description
directed	BOOLEAN	true	- When true Graph is considered *Directed* - When false the graph is considered as *Undirected*.

Inner queries

Edges query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Combinations query

Column	Type	Default	Description
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT

Return Columns

Returns set of (seq, path_id, path_seq [, start_vid] [, end_vid], node, edge, cost, agg_cost)

Column	Type	Description
seq	INT	Sequential value starting from **1**.
path_id	INT	Path identifier. Has value **1** for the first of a path. Used when there are multiple paths for the same start_vid to end_vid combination.
path_seq	INT	Relative position in the path. Has value **1** for the beginning of a path.
start_vid	BIGINT	Identifier of the starting vertex. Returned when multiple starting vetrices are in the query. **Many to One** **Many to Many**
end_vid	BIGINT	Identifier of the ending vertex. Returned when multiple ending vertices are in the query. **One to Many** **Many to Many**
node	BIGINT	Identifier of the node in the path from start_vid to end_vid.
edge	BIGINT	Identifier of the edge used to go from node to the next node in the path sequence. -1 for the last node of the path.
cost	FLOAT	Cost to traverse from node using edge to the next node in the path sequence.
agg_cost	FLOAT	Aggregate cost from start_v to node.

Example Application

The examples of this section are based on the **Sample Data** network.

The examples include combinations from starting vertices 2 and 11 to ending vertices 3 and 5 in a directed and undirected graph with and with out reverse_cost.

Examples:
For queries marked as `directed` with `cost` and `reverse_cost` columns

The examples in this section use the following **Network for queries marked as directed and cost and reverse_cost columns are used**

```
SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, 3
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    4 |    1 |        0
   2 |        2 |    5 |    8 |    1 |        1
   3 |        3 |    6 |    9 |    1 |        2
   4 |        4 |    9 |   16 |    1 |        3
   5 |        5 |    4 |    3 |    1 |        4
   6 |        6 |    3 |   -1 |    0 |        5
(6 rows)

SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, 5
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    4 |    1 |        0
   2 |        2 |    5 |   -1 |    0 |        1
(2 rows)

SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, ARRAY[3,5]
);
 seq | path_seq | end_vid | node | edge | cost | agg_cost
-----+----------+---------+------+------+------+----------
   1 |        1 |       3 |    2 |    4 |    1 |        0
   2 |        2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |       3 |    6 |    9 |    1 |        2
   4 |        4 |       3 |    9 |   16 |    1 |        3
   5 |        5 |       3 |    4 |    3 |    1 |        4
   6 |        6 |       3 |    3 |   -1 |    0 |        5
   7 |        1 |       5 |    2 |    4 |    1 |        0
   8 |        2 |       5 |    5 |   -1 |    0 |        1
(8 rows)

SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    11, 3
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |   11 |   13 |    1 |        0
   2 |        2 |   12 |   15 |    1 |        1
   3 |        3 |    9 |   16 |    1 |        2
   4 |        4 |    4 |    3 |    1 |        3
   5 |        5 |    3 |   -1 |    0 |        4
(5 rows)

SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    11, 5
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |   11 |   13 |    1 |        0
   2 |        2 |   12 |   15 |    1 |        1
   3 |        3 |    9 |    9 |    1 |        2
   4 |        4 |    6 |    8 |    1 |        3
   5 |        5 |    5 |   -1 |    0 |        4
(5 rows)

SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[2,11], 5
);
 seq | path_seq | start_vid | node | edge | cost | agg_cost
-----+----------+-----------+------+------+------+----------
   1 |        1 |         2 |    2 |    4 |    1 |        0
   2 |        2 |         2 |    5 |   -1 |    0 |        1
   3 |        1 |        11 |   11 |   13 |    1 |        0
   4 |        2 |        11 |   12 |   15 |    1 |        1
   5 |        3 |        11 |    9 |    9 |    1 |        2
   6 |        4 |        11 |    6 |    8 |    1 |        3
   7 |        5 |        11 |    5 |   -1 |    0 |        4
(7 rows)

SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[2, 11], ARRAY[3,5]
);
```

```
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    4 |    1 |        0
   2 |        2 |         2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |         2 |       3 |    6 |    9 |    1 |        2
   4 |        4 |         2 |       3 |    9 |   16 |    1 |        3
   5 |        5 |         2 |       3 |    4 |    3 |    1 |        4
   6 |        6 |         2 |       3 |    3 |   -1 |    0 |        5
   7 |        1 |         2 |       5 |    2 |    4 |    1 |        0
   8 |        2 |         2 |       5 |    5 |   -1 |    0 |        1
   9 |        1 |        11 |       3 |   11 |   13 |    1 |        0
  10 |        2 |        11 |       3 |   12 |   15 |    1 |        1
  11 |        3 |        11 |       3 |    9 |   16 |    1 |        2
  12 |        4 |        11 |       3 |    4 |    3 |    1 |        3
  13 |        5 |        11 |       3 |    3 |   -1 |    0 |        4
  14 |        1 |        11 |       5 |   11 |   13 |    1 |        0
  15 |        2 |        11 |       5 |   12 |   15 |    1 |        1
  16 |        3 |        11 |       5 |    9 |    9 |    1 |        2
  17 |        4 |        11 |       5 |    6 |    8 |    1 |        3
  18 |        5 |        11 |       5 |    5 |   -1 |    0 |        4
(18 rows)
```

Examples:

For queries marked as `undirected` with `cost` and `reverse_cost` columns

The examples in this section use the following **Network for queries marked as undirected and cost and reverse_cost columns are used**

```
SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, 3,
    FALSE
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    2 |    1 |        0
   2 |        2 |    3 |   -1 |    0 |        1
(2 rows)

SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, 5,
    FALSE
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    4 |    1 |        0
   2 |        2 |    5 |   -1 |    0 |        1
(2 rows)

SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    11, 3,
    FALSE
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |   11 |   11 |    1 |        0
   2 |        2 |    6 |    5 |    1 |        1
   3 |        3 |    3 |   -1 |    0 |        2
(3 rows)

SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    11, 5,
    FALSE
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |   11 |   11 |    1 |        0
   2 |        2 |    6 |    8 |    1 |        1
   3 |        3 |    5 |   -1 |    0 |        2
(3 rows)

SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[2,11], 5,
    FALSE
);
 seq | path_seq | start_vid | node | edge | cost | agg_cost
-----+----------+-----------+------+------+------+----------
   1 |        1 |         2 |    2 |    4 |    1 |        0
   2 |        2 |         2 |    5 |   -1 |    0 |        1
   3 |        1 |        11 |   11 |   11 |    1 |        0
   4 |        2 |        11 |    6 |    8 |    1 |        1
   5 |        3 |        11 |    5 |   -1 |    0 |        2
(5 rows)

SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    2, ARRAY[3,5],
    FALSE
);
 seq | path_seq | end_vid | node | edge | cost | agg_cost
-----+----------+---------+------+------+------+----------
   1 |        1 |       3 |    2 |    2 |    1 |        0
   2 |        2 |       3 |    3 |   -1 |    0 |        1
   3 |        1 |       5 |    2 |    4 |    1 |        0
   4 |        2 |       5 |    5 |   -1 |    0 |        1
(4 rows)

SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost, reverse_cost FROM edge_table',
    ARRAY[2, 11], ARRAY[3,5],
    FALSE
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    2 |    1 |        0
   2 |        2 |         2 |       3 |    3 |   -1 |    0 |        1
   3 |        1 |         2 |       5 |    2 |    4 |    1 |        0
   4 |        2 |         2 |       5 |    5 |   -1 |    0 |        1
   5 |        1 |        11 |       3 |   11 |   11 |    1 |        0
   6 |        2 |        11 |       3 |    6 |    5 |    1 |        1
   7 |        3 |        11 |       3 |    3 |   -1 |    0 |        2
   8 |        1 |        11 |       5 |   11 |   11 |    1 |        0
   9 |        2 |        11 |       5 |    6 |    8 |    1 |        1
  10 |        3 |        11 |       5 |    5 |   -1 |    0 |        2
(10 rows)
```

Examples:

For queries marked as `directed` with `cost` column

The examples in this section use the following **Network for queries marked as directed and only cost column is used**

```
SELECT * FROM pgr_edwardMoore(
   'SELECT id, source, target, cost FROM edge_table',
   2, 3
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
(0 rows)

SELECT * FROM pgr_edwardMoore(
   'SELECT id, source, target, cost FROM edge_table',
   2, 5
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    4 |    1 |        0
   2 |        2 |    5 |   -1 |    0 |        1
(2 rows)

SELECT * FROM pgr_edwardMoore(
   'SELECT id, source, target, cost FROM edge_table',
   11, 3
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
(0 rows)

SELECT * FROM pgr_edwardMoore(
   'SELECT id, source, target, cost FROM edge_table',
   11, 5
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
(0 rows)

SELECT * FROM pgr_edwardMoore(
   'SELECT id, source, target, cost FROM edge_table',
   ARRAY[2,11], 5
);
 seq | path_seq | start_vid | node | edge | cost | agg_cost
-----+----------+-----------+------+------+------+----------
   1 |        1 |         2 |    2 |    4 |    1 |        0
   2 |        2 |         2 |    5 |   -1 |    0 |        1
(2 rows)

SELECT * FROM pgr_edwardMoore(
   'SELECT id, source, target, cost FROM edge_table',
   2, ARRAY[3,5]
);
 seq | path_seq | end_vid | node | edge | cost | agg_cost
-----+----------+---------+------+------+------+----------
   1 |        1 |       5 |    2 |    4 |    1 |        0
   2 |        2 |       5 |    5 |   -1 |    0 |        1
(2 rows)

SELECT * FROM pgr_edwardMoore(
   'SELECT id, source, target, cost FROM edge_table',
   ARRAY[2, 11], ARRAY[3,5]
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       5 |    2 |    4 |    1 |        0
   2 |        2 |         2 |       5 |    5 |   -1 |    0 |        1
(2 rows)
```

Examples:

For queries marked as `undirected` with `cost` column

The examples in this section use the following **Network for queries marked as undirected and only cost column is used**

```
SELECT * FROM pgr_edwardMoore(
   'SELECT id, source, target, cost FROM edge_table',
   2, 3,
   FALSE
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    4 |    1 |        0
   2 |        2 |    5 |    8 |    1 |        1
   3 |        3 |    6 |    5 |    1 |        2
   4 |        4 |    3 |   -1 |    0 |        3
(4 rows)

SELECT * FROM pgr_edwardMoore(
   'SELECT id, source, target, cost FROM edge_table',
   2, 5,
```

```
    FALSE
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |    2 |    4 |    1 |        0
   2 |        2 |    5 |   -1 |    0 |        1
(2 rows)

SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost FROM edge_table',
    11, 3,
    FALSE
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |   11 |   11 |    1 |        0
   2 |        2 |    6 |    5 |    1 |        1
   3 |        3 |    3 |   -1 |    0 |        2
(3 rows)

SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost FROM edge_table',
    11, 5,
    FALSE
);
 seq | path_seq | node | edge | cost | agg_cost
-----+----------+------+------+------+----------
   1 |        1 |   11 |   11 |    1 |        0
   2 |        2 |    6 |    8 |    1 |        1
   3 |        3 |    5 |   -1 |    0 |        2
(3 rows)

SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost FROM edge_table',
    ARRAY[2,11], 5,
    FALSE
);
 seq | path_seq | start_vid | node | edge | cost | agg_cost
-----+----------+-----------+------+------+------+----------
   1 |        1 |         2 |    2 |    4 |    1 |        0
   2 |        2 |         2 |    5 |   -1 |    0 |        1
   3 |        1 |        11 |   11 |   11 |    1 |        0
   4 |        2 |        11 |    6 |    8 |    1 |        1
   5 |        3 |        11 |    5 |   -1 |    0 |        2
(5 rows)

SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost FROM edge_table',
    2, ARRAY[3,5],
    FALSE
);
 seq | path_seq | end_vid | node | edge | cost | agg_cost
-----+----------+---------+------+------+------+----------
   1 |        1 |       3 |    2 |    4 |    1 |        0
   2 |        2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |       3 |    6 |    5 |    1 |        2
   4 |        4 |       3 |    3 |   -1 |    0 |        3
   5 |        1 |       5 |    2 |    4 |    1 |        0
   6 |        2 |       5 |    5 |   -1 |    0 |        1
(6 rows)

SELECT * FROM pgr_edwardMoore(
    'SELECT id, source, target, cost FROM edge_table',
    ARRAY[2, 11], ARRAY[3,5],
    FALSE
);
 seq | path_seq | start_vid | end_vid | node | edge | cost | agg_cost
-----+----------+-----------+---------+------+------+------+----------
   1 |        1 |         2 |       3 |    2 |    4 |    1 |        0
   2 |        2 |         2 |       3 |    5 |    8 |    1 |        1
   3 |        3 |         2 |       3 |    6 |    5 |    1 |        2
   4 |        4 |         2 |       3 |    3 |   -1 |    0 |        3
   5 |        1 |         2 |       5 |    2 |    4 |    1 |        0
   6 |        2 |         2 |       5 |    5 |   -1 |    0 |        1
   7 |        1 |        11 |       3 |   11 |   11 |    1 |        0
   8 |        2 |        11 |       3 |    6 |    5 |    1 |        1
   9 |        3 |        11 |       3 |    3 |   -1 |    0 |        2
  10 |        1 |        11 |       5 |   11 |   11 |    1 |        0
  11 |        2 |        11 |       5 |    6 |    8 |    1 |        1
  12 |        3 |        11 |       5 |    5 |   -1 |    0 |        2
(12 rows)
```

See Also

- https://en.wikipedia.org/wiki/Shortest_Path_Faster_Algorithm

Indices and tables

- Index
- Search Page

- **Supported versions: Latest (3.2)**

pgr_isPlanar - Experimental

`pgr_isPlanar` — Returns a boolean depending upon the planarity of the graph.

Boost Graph Inside

> **Warning**
>
> Possible server crash
>
> - These functions might create a server crash

> **Warning**
>
> Experimental functions
>
> - They are not officially of the current release.
> - They likely will not be officially be part of the next release:
>   - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
>   - Name might change.
>   - Signature might change.
>   - Functionality might change.
>   - pgTap tests might be missing.
>   - Might need c/c++ coding.
>   - May lack documentation.
>   - Documentation if any might need to be rewritten.
>   - Documentation examples might need to be automatically generated.
>   - Might need a lot of feedback from the comunity.
>   - Might depend on a proposed function of pgRouting
>   - Might depend on a deprecated function of pgRouting

Availability

- Version 3.2.0
  - New **experimental** function

Description

A graph is planar if it can be drawn in two-dimensional space with no two of its edges crossing. Such a drawing of a planar graph is called a plane drawing. Every planar graph also admits a straight-line drawing, which is a plane drawing where each edge is represented by a line segment. When a graph has K_5 or $K_{3,3}$ as subgraph then the graph is not planar.

The main characteristics are:

- This implementation use the Boyer-Myrvold Planarity Testing.
- It will return a boolean value depending upon the planarity of the graph.
- Applicable only for **undirected** graphs.
- The algorithm does not considers traversal costs in the calculations.
- Running time: $O(|V|)$

Signatures

Summary

```
pgr_isPlanar(Edges SQL) -- Experimental on v3.2

RETURNS BOOLEAN
```

```
SELECT * FROM pgr_isPlanar(
    'SELECT id, source, target, cost, reverse_cost
     FROM edge_table'
);
 pgr_isplanar
--------------
 t
(1 row)
```

Parameters

Parameter	Type	Default	Description
Edges SQL	`TEXT`		SQL query as described below.

Inner query

Edges SQL:
an SQL query, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	`ANY-INTEGER`		Identifier of the edge.
source	`ANY-INTEGER`		Identifier of the first end point vertex of the edge.
target	`ANY-INTEGER`		Identifier of the second end point vertex of the edge.
cost	`ANY-NUMERICAL`		• When positive: edge *(target, source)* is part of the graph. • When negative: edge *(target, source)* is not part of the graph.
reverse_cost	`ANY-NUMERICAL`	-1	• When positive: edge *(target, source)* is part of the graph. • When negative: edge *(target, source)* is not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns a boolean `(pgr_isplanar)`

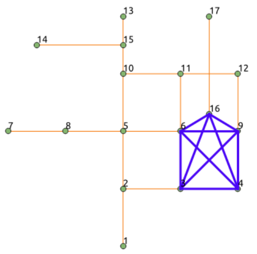
Column	Type	Description
pgr_isplanar	`BOOLEAN`	• *true* when the graph is planar. • *false* when the graph is not planar.

Additional Example:

The following edges will make the subgraph with vertices {3, 4, 6, 9, 16} a\(K_5\) graph.

```
INSERT INTO edge_table (source, target, cost, reverse_cost) VALUES
(3, 9, 1, 1), (3, 16, 1, 1),
(4, 6, 1, 1), (4, 16, 1, 1),
(6, 16, 1, 1),
(9, 16, 1, 1);
INSERT 0 6
```

The new graph is not planar because it has a\(K_5\) subgraph. Edges in blue represent\(K_5\) subgraph.



```
SELECT * FROM pgr_isPlanar(
    'SELECT id, source, target, cost, reverse_cost
     FROM edge_table'
);
 pgr_isplanar
--------------
 f
(1 row)
```

See Also

- **https://www.boost.org/libs/graph/doc/boyer_myrvold.html**
- The queries use the **Sample Data** network.

Indices and tables

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- **Search Page**

- **Supported versions: Latest (3.2) 3.1) 3.0**

pgr_stoerWagner - Experimental

`pgr_stoerWagner` — Returns the weight of the min-cut of graph using stoerWagner algorithm. Function determines a min-cut and the min-cut weight of a connected, undirected graph implemented by Boost.Graph.

Boost Graph Inside

> **Warning**
>
> Possible server crash
>
> - These functions might create a server crash

> **Warning**
>
> Experimental functions
>
> - They are not officially of the current release.
> - They likely will not be officially be part of the next release:
>   - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
>   - Name might change.
>   - Signature might change.
>   - Functionality might change.
>   - pgTap tests might be missing.
>   - Might need c/c++ coding.
>   - May lack documentation.
>   - Documentation if any might need to be rewritten.
>   - Documentation examples might need to be automatically generated.
>   - Might need a lot of feedback from the comunity.
>   - Might depend on a proposed function of pgRouting
>   - Might depend on a deprecated function of pgRouting

Availability

- Version 2.3.0
    - New **Experimental** function

Description

In graph theory, the Stoer–Wagner algorithm is a recursive algorithm to solve the minimum cut problem in undirected weighted graphs with non-negative weights. The essential idea of this algorithm is to shrink the graph by merging the most intensive vertices, until the graph only contains two combined vertex sets. At each phase, the algorithm finds the minimum s-t cut for two vertices s and t chosen as its will. Then the algorithm shrinks the edge between s and t to search for non s-t cuts. The minimum cut found in all phases will be the minimum weighted cut of the graph.

A cut is a partition of the vertices of a graph into two disjoint subsets. A minimum cut is a cut for which the size or weight of the cut is not larger than the size of any other cut. For an unweighted graph, the minimum cut would simply be the cut with the least edges. For a weighted graph, the sum of all edges' weight on the cut determines whether it is a minimum cut.

The main characteristics are:

- Process is done only on edges with positive costs.
- It's implementation is only on **undirected** graph.
- Sum of the weights of all edges between the two sets is mincut.
  - A **mincut** is a cut having the least weight.
- Values are returned when graph is connected.
  - When there is no edge in graph then EMPTY SET is return.
  - When the graph is unconnected then EMPTY SET is return.
- Sometimes a graph has multiple min-cuts, but all have the same weight. The this function determines exactly one of the min-cuts as well as its weight.
- Running time: \(O(V*E + V^2*log V)\).

Signatures

```
pgr_stoerWagner(edges_sql)

RETURNS SET OF (seq, edge, cost, mincut)
OR EMPTY SET
```

Example:

- **TBD**

```
pgr_stoerWagner(TEXT edges_sql);
RETURNS SET OF (seq, edge, cost, mincut)
OR EMPTY SET
```

```
SELECT * FROM pgr_stoerWagner(
   'SELECT id, source, target, cost, reverse_cost
      FROM edge_table
    WHERE id < 17'
);
 seq | edge | cost | mincut
-----+------+------+--------
   1 |    1 |    1 |      1
(1 row)
```

Parameters

Parameter	Type	Default	Description
edges_sql	TEXT		SQL query as described above.

Inner query

edges_sql:
an SQL query, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:

SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns set of (seq, edge, cost, mincut)

Column	Type	Description
seq	INT	Sequential value starting from **1**.
edge	BIGINT	Edges which divides the set of vertices into two.
cost	FLOAT	Cost to traverse of edge.
mincut	FLOAT	Min-cut weight of a undirected graph.

Additional Example:

```
SELECT * FROM pgr_stoerWagner(
    'SELECT id, source, target, cost, reverse_cost
        FROM edge_table
      WHERE id = 18'
);
 seq | edge | cost | mincut
-----+------+------+--------
   1 |   18 |    1 |      1
(1 row)
```

Use pgr_connectedComponents( ) function in query:

```
SELECT * FROM pgr_stoerWagner(
$$
 SELECT id, source, target, cost, reverse_cost FROM edge_table
    where source = any (ARRAY(SELECT node FROM pgr_connectedComponents(
                        'SELECT id, source, target, cost, reverse_cost FROM edge_table ')
                      WHERE component = 14)
                     )
                OR
          target = any (ARRAY(SELECT node FROM pgr_connectedComponents(
                        'SELECT id, source, target, cost, reverse_cost FROM edge_table ')
                      WHERE component = 14)
                     )
$$
 );
 seq | edge | cost | mincut
-----+------+------+--------
   1 |   17 |    1 |      1
(1 row)
```

See Also

- **https://en.wikipedia.org/wiki/Stoer%E2%80%93Wagner_algorithm**
- The queries use the **Sample Data** network.

Indices and tables

- **Index**
- **Search Page**

- **Supported versions: Latest (3.2) 3.1 3.0**

pgr_topologicalSort - Experimental

pgr_topologicalSort — Returns the linear ordering of the vertices(s) for weighted directed acyclic graphs(DAG). In particular, the topological sort algorithm implemented by Boost.Graph.

Boost Graph Inside

Warning

Possible server crash

- These functions might create a server crash

Warning

Experimental functions

- They are not officially of the current release.
- They likely will not be officially be part of the next release:
  - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
  - Name might change.
  - Signature might change.
  - Functionality might change.
  - pgTap tests might be missing.
  - Might need c/c++ coding.
  - May lack documentation.
  - Documentation if any might need to be rewritten.
  - Documentation examples might need to be automatically generated.
  - Might need a lot of feedback from the comunity.
  - Might depend on a proposed function of pgRouting
  - Might depend on a deprecated function of pgRouting

Availability

- Version 3.0.0
  - New **experimental** function
- **TBD**

Description

The topological sort algorithm creates a linear ordering of the vertices such that if edge (u,v) appears in the graph, then v comes before u in the ordering.

This implementation can only be used with a **directed** graph with no cycles i.e. directed acyclic graph.

The main characteristics are:

- Process is valid for directed acyclic graphs only. otherwise it will throw warnings.
- For optimization purposes, if there are more than one answer, the function will return one of them.
- The returned values are ordered in topological order:
- Running time: \(O((V + E))\)

Signatures

Summary

```
pgr_topologicalSort(edges_sql)

RETURNS SET OF (seq, sorted_v)
OR EMPTY SET
```

Example:
For a **directed** graph

```
SELECT * FROM pgr_topologicalsort(
  'SELECT id,source,target,cost,reverse_cost FROM edge_table1'
);
 seq | sorted_v
-----+----------
   1 |        0
   2 |        1
   3 |        3
   4 |        2
(4 rows)
```

Parameters

Parameter	Type	Default	Description
edges_sql	TEXT		SQL query as described above.

Inner query

edges_sql:
an SQL query, which should return a set of rows with the following columns:

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns set of `(seq, sorted_v)`

Column	Type	Description
seq	INT	Sequential value starting from **1**.
sorted_v	BIGINT	Linear ordering of the vertices(ordered in topological order)

See Also

- **https://en.wikipedia.org/wiki/Topological_sorting**
- The queries use the **Sample Data** network.

Indices and tables

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- **Supported versions: Latest** (**3.2**) **3.1 3.0**

pgr_transitiveClosure - Experimental

`pgr_transitiveClosure` — Returns the transitive closure graph of the input graph. In particular, the transitive closure algorithm implemented by Boost.Graph.

Boost Graph Inside

> **Warning**
>
> Possible server crash
>
> - These functions might create a server crash

> **Warning**
>
> Experimental functions

- They are not officially of the current release.
- They likely will not be officially be part of the next release:
  - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
  - Name might change.
  - Signature might change.
  - Functionality might change.
  - pgTap tests might be missing.
  - Might need c/c++ coding.
  - May lack documentation.
  - Documentation if any might need to be rewritten.
  - Documentation examples might need to be automatically generated.
  - Might need a lot of feedback from the comunity.
  - Might depend on a proposed function of pgRouting
  - Might depend on a deprecated function of pgRouting

Availability

- Version 3.0.0
  - New **experimental** function

Description

The transitive_closure() function transforms the input graph g into the transitive closure graph tc.

This implementation can only be used with a **directed** graph with no cycles i.e. directed acyclic graph.

The main characteristics are:

- Process is valid for directed acyclic graphs only. otherwise it will throw warnings.
- The returned values are not ordered:
- Running time: $O(|V||E|)$

Signatures

Summary

The pgr_transitiveClosure function has the following signature:

```
pgr_transitiveClosure(Edges SQL)
RETURNS SETOF (id, vid, target_array)
```

Example:
Complete Graph of 3 vertexs

```
SELECT * FROM pgr_transitiveclosure(
  'SELECT id,source,target,cost,reverse_cost FROM edge_table1'
);
 seq | vid | target_array
-----+-----+--------------
   1 |   0 | {1,3,2}
   2 |   1 | {3,2}
   3 |   3 | {2}
   4 |   2 | {}
(4 rows)
```

Parameters

Column	Type	Description
Edges SQL	TEXT	SQL query as described in **Inner query**

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.

Column	Type	Default	Description
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

RETURNS SETOF (seq, vid, target_array)

The function returns a single row. The columns of the row are:

Column	Type	Description
seq	INTEGER	Sequential value starting from **1**.
vid	BIGINT	Identifier of the vertex.
target_array	ARRAY[BIGINT]	Array of identifiers of the vertices that are reachable from vertex v.

Additional Examples

Example:
Some sub graphs of the sample data

```
SELECT * FROM pgr_transitiveclosure(
  'SELECT id,source,target,cost,reverse_cost FROM edge_table where id=2'
);
 seq | vid | target_array
-----+-----+--------------
   1 |   2 | {}
   2 |   3 | {2}
(2 rows)

SELECT * FROM pgr_transitiveclosure(
  'SELECT id,source,target,cost,reverse_cost FROM edge_table where id=3'
);
 seq | vid | target_array
-----+-----+--------------
   1 |   3 | {}
   2 |   4 | {3}
(2 rows)

SELECT * FROM pgr_transitiveclosure(
  'SELECT id,source,target,cost,reverse_cost FROM edge_table where id=2 or id=3'
);
 seq | vid | target_array
-----+-----+--------------
   1 |   2 | {}
   2 |   3 | {2}
   3 |   4 | {3,2}
(3 rows)

SELECT * FROM pgr_transitiveclosure(
  'SELECT id,source,target,cost,reverse_cost FROM edge_table where id=11'
);
 seq | vid | target_array
-----+-----+--------------
   1 |   6 | {11}
   2 |  11 | {}
(2 rows)

-- q3
SELECT * FROM pgr_transitiveclosure(
  'SELECT id,source,target,cost,reverse_cost FROM edge_table where cost=-1 or reverse_cost=-1'
);
 seq | vid | target_array
-----+-----+---------------
   1 |   2 | {}
   2 |   3 | {11,12,6,2}
   3 |   4 | {11,12,3,6,2}
   4 |   6 | {11,12}
   5 |  11 | {12}
   6 |  10 | {11,12}
   7 |  12 | {}
(7 rows)
```

See Also

- **https://en.wikipedia.org/wiki/Transitive_closure**
- The queries use the **Sample Data** network.

Indices and tables

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- **Supported versions: Latest (3.2) 3.1 3.0**

pgr_turnRestrictedPath - Experimental

pgr_turnRestrictedPath

Warning

Possible server crash

- These functions might create a server crash

Warning

Experimental functions

- They are not officially of the current release.
- They likely will not be officially be part of the next release:

- The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
- Name might change.
- Signature might change.
- Functionality might change.
- pgTap tests might be missing.
- Might need c/c++ coding.
- May lack documentation.
- Documentation if any might need to be rewritten.
- Documentation examples might need to be automatically generated.
- Might need a lot of feedback from the comunity.
- Might depend on a proposed function of pgRouting
- Might depend on a deprecated function of pgRouting

Availability

- Version 3.0.0
  - New **Experimental** function

Description

- TBD

Signatures

- TBD

Parameters

- TBD

Inner query

- TBD

Result Columns

- TBD

Additional Examples

Example:

See Also

Indices and tables

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- **Supported versions: Latest (3.2)**

pgr_lengauerTarjanDominatorTree -Experimental

`pgr_lengauerTarjanDominatorTree` — Returns the immediate dominator of all vertices.

Boost Graph Inside

Warning

Possible server crash

- These functions might create a server crash

Warning

Experimental functions

- They are not officially of the current release.
- They likely will not be officially be part of the next release:
  - The functions might not make use of ANY-INTEGER and ANY-NUMERICAL
  - Name might change.
  - Signature might change.
  - Functionality might change.
  - pgTap tests might be missing.
  - Might need c/c++ coding.
  - May lack documentation.
  - Documentation if any might need to be rewritten.
  - Documentation examples might need to be automatically generated.
  - Might need a lot of feedback from the comunity.
  - Might depend on a proposed function of pgRouting
  - Might depend on a deprecated function of pgRouting

Availability

- Version 3.2.0
  - New **experimental** function

Description

The algorithm calculates the *immidiate dominator* of each vertex called **idom**, once **idom** of each vertex is calculated then by making every **idom** of each vertex as its parent, the dominator tree can be built.

The main Characteristics are:

- The algorithm works in directed graph only.
- The returned values are not ordered.
- The algorithm returns *idom* of each vertex.
- If the *root vertex* not present in the graph then it returns empty set.
- Running time: \(O((V+E)log(V+E))\)

Signatures

Summary

```
pgr_lengauerTarjanDominatorTree(Edges SQL, root vertex) -- Experimental on v3.2
RETURNS SET OF (seq, vertex_id, idom)
OR EMPTY SET
```

Example:
The lengauerTarjanDominatorTree with root vertex \(1\)

```
SELECT * FROM pgr_lengauertarjandominatortree(
    $$SELECT id,source,target,cost,reverse_cost FROM edge_table$$,
    1
);
 seq | vertex_id | idom
-----+-----------+------
   1 |         1 |    0
   2 |         2 |    1
   3 |         3 |    4
   4 |         4 |    9
   5 |         5 |    2
   6 |         6 |    5
   7 |         7 |    8
   8 |         8 |    5
   9 |         9 |    5
  10 |        10 |    5
  11 |        11 |    5
  12 |        12 |    5
  13 |        13 |   10
  14 |        14 |    0
  15 |        15 |    0
  16 |        16 |    0
  17 |        17 |    0
(17 rows)
```

Parameters

Column	Type	Description
Edges SQL	TEXT	SQL query as described above.
root vertex	BIGINT	Identifier of the starting vertex.

Inner query

Column	Type	Default	Description
id	ANY-INTEGER		Identifier of the edge.
source	ANY-INTEGER		Identifier of the first end point vertex of the edge.
target	ANY-INTEGER		Identifier of the second end point vertex of the edge.
cost	ANY-NUMERICAL		Weight of the edge *(source, target)* • When negative: edge *(source, target)* does not exist, therefore it's not part of the graph.
reverse_cost	ANY-NUMERICAL	-1	Weight of the edge *(target, source)*, • When negative: edge *(target, source)* does not exist, therefore it's not part of the graph.

Where:

ANY-INTEGER:
SMALLINT, INTEGER, BIGINT
ANY-NUMERICAL:
SMALLINT, INTEGER, BIGINT, REAL, FLOAT

Result Columns

Returns set of (seq, vertex_id,idom)

Column	Type	Description
seq	INTEGER	Sequential value starting from **1**.
vertex_id	BIGINT	Identifier of vertex .
idom	BIGINT	Immediate dominator of vertex.

Additional Examples

The examples in this section use the following **Network for queries marked as directed and cost and reverse_cost columns are used**

Example:
When the edge is disonnectd from graph then it will returns immidiate dominator of all other vertex as zero.

```
SELECT * FROM pgr_lengauertarjandominatortree(
    $$SELECT id,source,target,cost,reverse_cost FROM edge_table$$,
    16
);
 seq | vertex_id | idom
-----+-----------+------
   1 |         1 |    0
   2 |         2 |    0
   3 |         3 |    0
   4 |         4 |    0
   5 |         5 |    0
   6 |         6 |    0
   7 |         7 |    0
   8 |         8 |    0
   9 |         9 |    0
  10 |        10 |    0
  11 |        11 |    0
  12 |        12 |    0
  13 |        13 |    0
  14 |        14 |    0
  15 |        15 |    0
  16 |        16 |    0
  17 |        17 |   16
(17 rows)
```

See Also

- **Boost: lengauerTarjanDominatorTree algorithm documentation**
- **Wikipedia: dominator tree**
- **Sample Data** network.

Indices and tables

See Also

Indices and tables

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Release Notes

- **Supported versions: Latest (3.2) 3.1 3.0**
- **Unsupported versions: 2.6 2.5 2.4 2.3 2.2 2.1 2.0**

Release Notes

To see the full list of changes check the list of**Git commits** on Github.

Contents

pgRouting 3.2.2 Release Notes

To see all issues & pull requests closed by this release see the**Git closed milestone for 3.2.2** on Github.

Issues

- **#2093**: Compilation on Visual Studio
- **#2189**: Build error on RHEL 7

pgRouting 3.2.1 Release Notes

To see all issues & pull requests closed by this release see the**Git closed milestone for 3.2.1** on Github.

Issues

- **#1883**: pgr_TSPEuclidean crashes connection on Windows
  - The solution is to use Boost::graph::metric_tsp_approx
  - To not break user's code the optional parameters related to the TSP Annaeling are ignored
  - The function with the annaeling optional parameters is deprecated

pgRouting 3.2.0 Release Notes

To see all issues & pull requests closed by this release see the**Git closed milestone for 3.2.0** on Github.

Build

- **#1850**: Change Boost min version to 1.56
  - Removing support for Boost v1.53, v1.54 & v1.55

New experimental functions

- pgr_bellmanFord(Combinations)
- pgr_binaryBreadthFirstSearch(Combinations)
- pgr_bipartite
- pgr_dagShortestPath(Combinations)
- pgr_depthFirstSearch
- Dijkstra Near
  - pgr_dijkstraNearCost
    - pgr_dijkstraNear(One to Many)
    - pgr_dijkstraNear(Many to One)
    - pgr_dijkstraNear(Many to Many)
    - pgr_dijkstraNear(Combinations)
  - pgr_dijkstraNearCost
    - pgr_dijkstraNearCost(One to Many)
    - pgr_dijkstraNearCost(Many to One)
    - pgr_dijkstraNearCost(Many to Many)
    - pgr_dijkstraNearCost(Combinations)
- pgr_edwardMoore(Combinations)
- pgr_isPlanar
- pgr_lengauerTarjanDominatorTree
- pgr_makeConnected
- Flow
  - pgr_maxFlowMinCost(Combinations)
  - pgr_maxFlowMinCost_Cost(Combinations)
- pgr_sequentialVertexColoring

New proposed functions

- Astar
  - pgr_aStar(Combinations)
  - pgr_aStarCost(Combinations)
- Bidirectional Astar
  - pgr_bdAstar(Combinations)
  - pgr_bdAstarCost(Combinations)
- Bidirectional Dijkstra
  - pgr_bdDijkstra(Combinations)
  - pgr_bdDijkstraCost(Combinations)
- Flow
  - pgr_boykovKolmogorov(Combinations)
  - pgr_edgeDisjointPaths(Combinations)
  - pgr_edmondsKarp(Combinations)
  - pgr_maxFlow(Combinations)
  - pgr_pushRelabel(Combinations)
- pgr_withPoints(Combinations)
- pgr_withPointsCost(Combinations)

pgRouting 3.1.4 Release Notes

To see all issues & pull requests closed by this release see the**Git closed milestone for 3.1.4** on Github.

Issues fixes

- **#2189**: Build error on RHEL 7

pgRouting 3.1.3 Release Notes

To see all issues & pull requests closed by this release see the**Git closed milestone for 3.1.3** on Github.

Issues fixes

- **#1825**: Boost versions are not honored
- **#1849**: Boost 1.75.0 geometry “point_xy.hpp” build error on macOS environment
- **#1861**: vrp functions crash server

pgRouting 3.1.2 Release Notes

To see all issues & pull requests closed by this release see the**Git closed milestone for 3.1.2** on Github.

Issues fixes

- **#1304**: FreeBSD 12 64-bit crashes on pgr_vrOneDepot tests Experimental Function
- **#1356**: tools/testers/pg_prove_tests.sh fails when PostgreSQL port is not passed
- **#1725**: Server crash on pgr_pickDeliver and pgr_vrpOneDepot on openbsd
- **#1760**: TSP server crash on ubuntu 20.04 #1760
- **#1770**: Remove warnings when using clang compiler

pgRouting 3.1.1 Release Notes

To see all issues & pull requests closed by this release see the**Git closed milestone for 3.1.1** on Github.

Issues fixes

- **#1733**: pgr_bdAstar fails when source or target vertex does not exist in the graph
- **#1647**: Linear Contraction contracts self loops
- **#1640**: pgr_withPoints fails when points_sql is empty
- **#1616**: Path evaluation on C++ not updated before the results go back to C
- **#1300**: pgr_chinesePostman crash on test data

pgRouting 3.1.0 Release Notes

To see all issues & pull requests closed by this release see the**Git closed milestone for 3.1.0** on Github.

New proposed functions

- pgr_dijkstra(combinations)
- pgr_dijkstraCost(combinations)

Build changes

- Minimal requirement for Sphinx: version 1.8

pgRouting 3.0.6 Release Notes

To see all issues & pull requests closed by this release see the **Git closed milestone for 3.0.6** on Github.

Issues fixes

- **#2189**: Build error on RHEL 7

pgRouting 3.0.5 Release Notes

To see all issues & pull requests closed by this release see the **Git closed milestone for 3.0.5** on Github.

Backport issues fixes

- **#1825**: Boost versions are not honored
- **#1849**: Boost 1.75.0 geometry “point_xy.hpp” build error on macOS environment
- **#1861**: vrp functions crash server

pgRouting 3.0.4 Release Notes

To see all issues & pull requests closed by this release see the **Git closed milestone for 3.0.4** on Github.

Backport issues fixes

- **#1304**: FreeBSD 12 64-bit crashes on pgr_vrOneDepot tests Experimental Function
- **#1356**: tools/testers/pg_prove_tests.sh fails when PostgreSQL port is not passed
- **#1725**: Server crash on pgr_pickDeliver and pgr_vrpOneDepot on openbsd
- **#1760**: TSP server crash on ubuntu 20.04 #1760
- **#1770**: Remove warnings when using clang compiler

pgRouting 3.0.3 Release Notes

Backport issues fixes

- **#1733**: pgr_bdAstar fails when source or target vertex does not exist in the graph
- **#1647**: Linear Contraction contracts self loops
- **#1640**: pgr_withPoints fails when points_sql is empty
- **#1616**: Path evaluation on C++ not updated before the results go back to C
- **#1300**: pgr_chinesePostman crash on test data

pgRouting 3.0.2 Release Notes

To see all issues & pull requests closed by this release see the **Git closed milestone for 3.0.2** on Github.

Issues fixes

- **#1378**: Visual Studio build failing

pgRouting 3.0.1 Release Notes

To see all issues & pull requests closed by this release see the **Git closed milestone for 3.0.1** on Github.

Issues fixes

- **#232**: Honor client cancel requests in C /C++ code

pgRouting 3.0.0 Release Notes

To see all issues & pull requests closed by this release see the **Git closed milestone for 3.0.0** on Github.

Fixed Issues

- **#1153**: Renamed pgr_eucledianTSP to pgr_TSPeuclidean
- **#1188**: Removed CGAL dependency
- **#1002**: Fixed contraction issues:
  - **#1004**: Contracts when forbidden vertices do not belong to graph
  - **#1005**: Intermideate results eliminated
  - **#1006**: No loss of information

New functions

- Kruskal family
  - pgr_kruskal
  - pgr_kruskalBFS
  - pgr_kruskalDD
  - pgr_kruskalDFS
- Prim family
  - pgr_prim
  - pgr_primDD
  - pgr_primDFS
  - pgr_primBFS

Proposed moved to official on pgRouting

- aStar Family
  - pgr_aStar(one to many)
  - pgr_aStar(many to one)
  - pgr_aStar(many to many)
  - pgr_aStarCost(one to one)
  - pgr_aStarCost(one to many)
  - pgr_aStarCost(many to one)
  - pgr_aStarCost(many to many)
  - pgr_aStarCostMatrix(one to one)
  - pgr_aStarCostMatrix(one to many)
  - pgr_aStarCostMatrix(many to one)
  - pgr_aStarCostMatrix(many to many)
- bdAstar Family
  - pgr_bdAstar(one to many)
  - pgr_bdAstar(many to one)
  - pgr_bdAstar(many to many)
  - pgr_bdAstarCost(one to one)
  - pgr_bdAstarCost(one to many)
  - pgr_bdAstarCost(many to one)
  - pgr_bdAstarCost(many to many)
  - pgr_bdAstarCostMatrix(one to one)
  - pgr_bdAstarCostMatrix(one to many)
  - pgr_bdAstarCostMatrix(many to one)
  - pgr_bdAstarCostMatrix(many to many)
- bdDijkstra Family
  - pgr_bdDijkstra(one to many)
  - pgr_bdDijkstra(many to one)
  - pgr_bdDijkstra(many to many)
  - pgr_bdDijkstraCost(one to one)
  - pgr_bdDijkstraCost(one to many)
  - pgr_bdDijkstraCost(many to one)
  - pgr_bdDijkstraCost(many to many)
  - pgr_bdDijkstraCostMatrix(one to one)
  - pgr_bdDijkstraCostMatrix(one to many)
  - pgr_bdDijkstraCostMatrix(many to one)
  - pgr_bdDijkstraCostMatrix(many to many)
- Flow Family
  - pgr_pushRelabel(one to one)
  - pgr_pushRelabel(one to many)
  - pgr_pushRelabel(many to one)
  - pgr_pushRelabel(many to many)
  - pgr_edmondsKarp(one to one)
  - pgr_edmondsKarp(one to many)

    - pgr_edmondsKarp(many to one)
    - pgr_edmondsKarp(many to many)
    - pgr_boykovKolmogorov (one to one)
    - pgr_boykovKolmogorov (one to many)
    - pgr_boykovKolmogorov (many to one)
    - pgr_boykovKolmogorov (many to many)
    - pgr_maxCardinalityMatching
    - pgr_maxFlow
    - pgr_edgeDisjointPaths(one to one)
    - pgr_edgeDisjointPaths(one to many)
    - pgr_edgeDisjointPaths(many to one)
    - pgr_edgeDisjointPaths(many to many)
- Components family
    - pgr_connectedComponents
    - pgr_strongComponents
    - pgr_biconnectedComponents
    - pgr_articulationPoints
    - pgr_bridges
- Contraction:
    - Removed unnecessary column seq
    - Bug Fixes

New Experimental functions

- pgr_maxFlowMinCost
- pgr_maxFlowMinCost_Cost
- pgr_extractVertices
- pgr_turnRestrictedPath
- pgr_stoerWagner
- pgr_dagShortestpath
- pgr_topologicalSort
- pgr_transitiveClosure
- VRP category
    - pgr_pickDeliverEuclidean
    - pgr_pickDeliver
- Chinese Postman family
    - pgr_chinesePostman
    - pgr_chinesePostmanCost
- Breadth First Search family
    - pgr_breadthFirstSearch
    - pgr_binaryBreadthFirstSearch
- Bellman Ford family
    - pgr_bellmanFord
    - pgr_edwardMoore

Moved to legacy

- Experimental functions
    - pgr_labelGraph - Use the components family of functions instead.
    - Max flow - functions were renamed on v2.5.0
        - pgr_maxFlowPushRelabel
        - pgr_maxFlowBoykovKolmogorov
        - pgr_maxFlowEdmondsKarp
        - pgr_maximumcardinalitymatching
    - VRP
        - pgr_gsoc_vrppdtw
- TSP old signatures
- pgr_pointsAsPolygon
- pgr_alphaShape old signature

pgRouting 2.6.3 Release Notes

To see the issues closed by this release see the **Git closed milestone for 2.6.3** on Github.

Bug fixes

- **#1219** Implicit cast for via_path integer to text

- **#1193** Fixed pgr_pointsAsPolygon breaking when comparing strings in WHERE clause
- **#1185** Improve FindPostgreSQL.cmake

pgRouting 2.6.2 Release Notes

To see the issues closed by this release see the **Git closed milestone for 2.6.2** on Github.

Bug fixes

- **#1152** Fixes driving distance when vertex is not part of the graph
- **#1098** Fixes windows test
- **#1165** Fixes build for python3 and perl5

pgRouting 2.6.1 Release Notes

To see the issues closed by this release see the **Git closed milestone for 2.6.1** on Github.

- Fixes server crash on several functions.
    - pgr_floydWarshall
    - pgr_johnson
    - pgr_astar
    - pgr_bdAstar
    - pgr_bdDijstra
    - pgr_alphashape
    - pgr_dijkstraCostMatrix
    - pgr_dijkstra
    - pgr_dijkstraCost
    - pgr_drivingDistance
    - pgr_KSP
    - pgr_dijkstraVia (proposed)
    - pgr_boykovKolmogorov (proposed)
    - pgr_edgeDisjointPaths (proposed)
    - pgr_edmondsKarp (proposed)
    - pgr_maxCardinalityMatch (proposed)
    - pgr_maxFlow (proposed)
    - pgr_withPoints (proposed)
    - pgr_withPointsCost (proposed)
    - pgr_withPointsKSP (proposed)
    - pgr_withPointsDD (proposed)
    - pgr_withPointsCostMatrix (proposed)
    - pgr_contractGraph (experimental)
    - pgr_pushRelabel (experimental)
    - pgr_vrpOneDepot (experimental)
    - pgr_gsoc_vrppdtw (experimental)
    - Fixes for deprecated functions where also applied but not tested
- Removed compilation warning for g++8
- Fixed a fallthrugh on Astar and bdAstar.

pgRouting 2.6.0 Release Notes

To see the issues closed by this release see the **Git closed milestone for 2.6.0** on Github.

New fexperimental functions

- pgr_lineGraphFull

Bug fixes

- Fix pgr_trsp(text,integer,double precision,integer,double precision,boolean,boolean[,text])
    - without restrictions
        - calls pgr_dijkstra when both end points have a fraction IN (0,1)
        - calls pgr_withPoints when at least one fraction NOT IN (0,1)
    - with restrictions
        - calls original trsp code

Internal code

- Cleaned the internal code of trsp(text,integer,integer,boolean,boolean [, text])
  - Removed the use of pointers
  - Internal code can accept BIGINT
- Cleaned the internal code of withPoints

pgRouting 2.5.5 Release Notes

To see the issues closed by this release see the **Git closed milestone for 2.5.5** on Github.

Bug fixes

- Fixes driving distance when vertex is not part of the graph
- Fixes windows test
- Fixes build for python3 and perl5

pgRouting 2.5.4 Release Notes

To see the issues closed by this release see the **Git closed milestone for 2.5.4** on Github.

- Fixes server crash on several functions.
  - pgr_floydWarshall
  - pgr_johnson
  - pgr_astar
  - pgr_bdAstar
  - pgr_bdDijstra
  - pgr_alphashape
  - pgr_dijkstraCostMatrix
  - pgr_dijkstra
  - pgr_dijkstraCost
  - pgr_drivingDistance
  - pgr_KSP
  - pgr_dijkstraVia (proposed)
  - pgr_boykovKolmogorov (proposed)
  - pgr_edgeDisjointPaths (proposed)
  - pgr_edmondsKarp (proposed)
  - pgr_maxCardinalityMatch (proposed)
  - pgr_maxFlow (proposed)
  - pgr_withPoints (proposed)
  - pgr_withPointsCost (proposed)
  - pgr_withPointsKSP (proposed)
  - pgr_withPointsDD (proposed)
  - pgr_withPointsCostMatrix (proposed)
  - pgr_contractGraph (experimental)
  - pgr_pushRelabel (experimental)
  - pgr_vrpOneDepot (experimental)
  - pgr_gsoc_vrppdtw (experimental)
  - Fixes for deprecated functions where also applied but not tested
- Removed compilation warning for g++8
- Fixed a fallthrugh on Astar and bdAstar.

pgRouting 2.5.3 Release Notes

To see the issues closed by this release see the **Git closed milestone for 2.5.3** on Github.

Bug fixes

- Fix for postgresql 11: Removed a compilation error when compiling with postgreSQL

pgRouting 2.5.2 Release Notes

To see the issues closed by this release see the **Git closed milestone for 2.5.2** on Github.

Bug fixes

- Fix for postgresql 10.1: Removed a compiler condition

pgRouting 2.5.1 Release Notes

To see the issues closed by this release see the **Git closed milestone for 2.5.1** on Github.

Bug fixes

- Fixed prerequisite minimum version of: cmake

pgRouting 2.5.0 Release Notes

To see the issues closed by this release see the **Git closed issues for 2.5.0** on Github.

enhancement:

- pgr_version is now on SQL language

Breaking change on:

- pgr_edgeDisjointPaths:
  - Added path_id, cost and agg_cost columns on the result
  - Parameter names changed
  - The many version results are the union of the one to one version

New Signatures:

- pgr_bdAstar(one to one)

New Proposed functions

- pgr_bdAstar(one to many)
- pgr_bdAstar(many to one)
- pgr_bdAstar(many to many)
- pgr_bdAstarCost(one to one)
- pgr_bdAstarCost(one to many)
- pgr_bdAstarCost(many to one)
- pgr_bdAstarCost(many to many)
- pgr_bdAstarCostMatrix
- pgr_bdDijkstra(one to many)
- pgr_bdDijkstra(many to one)
- pgr_bdDijkstra(many to many)
- pgr_bdDijkstraCost(one to one)
- pgr_bdDijkstraCost(one to many)
- pgr_bdDijkstraCost(many to one)
- pgr_bdDijkstraCost(many to many)
- pgr_bdDijkstraCostMatrix
- pgr_lineGraph
- pgr_lineGraphFull
- pgr_connectedComponents
- pgr_strongComponents
- pgr_biconnectedComponents
- pgr_articulationPoints
- pgr_bridges

Deprecated Signatures

- pgr_bdastar - use pgr_bdAstar instead

Renamed Functions

- pgr_maxFlowPushRelabel - use pgr_pushRelabel instead
- pgr_maxFlowEdmondsKarp -use pgr_edmondsKarp instead
- pgr_maxFlowBoykovKolmogorov - use pgr_boykovKolmogorov instead
- pgr_maximumCardinalityMatching - use pgr_maxCardinalityMatch instead

Deprecated function

- pgr_pointToEdgeNode

pgRouting 2.4.2 Release Notes

To see the issues closed by this release see the **Git closed milestone for 2.4.2** on Github.

Improvement

- Works for postgreSQL 10

Bug fixes

- Fixed: Unexpected error column “cname”
- Replace __linux__ with __GLIBC__ for glibc-specific headers and functions

pgRouting 2.4.1 Release Notes

To see the issues closed by this release see the **Git closed milestone for 2.4.1** on Github.

Bug fixes

- Fixed compiling error on macOS
- Condition error on pgr_withPoints

pgRouting 2.4.0 Release Notes

To see the issues closed by this release see the **Git closed issues for 2.4.0** on Github.

New Signatures

- pgr_bdDijkstra

New Proposed Signatures

- pgr_maxFlow
- pgr_astar(one to many)
- pgr_astar(many to one)
- pgr_astar(many to many)
- pgr_astarCost(one to one)
- pgr_astarCost(one to many)
- pgr_astarCost(many to one)
- pgr_astarCost(many to many)
- pgr_astarCostMatrix

Deprecated Signatures

- pgr_bddijkstra - use pgr_bdDijkstra instead

Deprecated Functions

- pgr_pointsToVids

Bug fixes

- Bug fixes on proposed functions
  - pgr_withPointsKSP: fixed ordering
- TRSP original code is used with no changes on the compilation warnings

pgRouting 2.3.2 Release Notes

To see the issues closed by this release see the **Git closed issues for 2.3.2** on Github.

Bug Fixes

- Fixed pgr_gsoc_vrppdtw crash when all orders fit on one truck.
- Fixed pgr_trsp:
  - Alternate code is not executed when the point is in reality a vertex
  - Fixed ambiguity on seq

pgRouting 2.3.1 Release Notes

To see the issues closed by this release see the **Git closed issues for 2.3.1** on Github.

Bug Fixes

- Leaks on proposed max_flow functions
- Regression error on pgr_trsp
- Types discrepancy on pgr_createVerticesTable

pgRouting 2.3.0 Release Notes

To see the issues closed by this release see the **Git closed issues for 2.3.0** on Github.

New Signatures

- pgr_TSP
- pgr_aStar

New Functions

- pgr_eucledianTSP

New Proposed functions

- pgr_dijkstraCostMatrix
- pgr_withPointsCostMatrix
- pgr_maxFlowPushRelabel(one to one)
- pgr_maxFlowPushRelabel(one to many)
- pgr_maxFlowPushRelabel(many to one)
- pgr_maxFlowPushRelabel(many to many)
- pgr_maxFlowEdmondsKarp(one to one)
- pgr_maxFlowEdmondsKarp(one to many)
- pgr_maxFlowEdmondsKarp(many to one)
- pgr_maxFlowEdmondsKarp(many to many)
- pgr_maxFlowBoykovKolmogorov (one to one)
- pgr_maxFlowBoykovKolmogorov (one to many)
- pgr_maxFlowBoykovKolmogorov (many to one)
- pgr_maxFlowBoykovKolmogorov (many to many)
- pgr_maximumCardinalityMatching
- pgr_edgeDisjointPaths(one to one)
- pgr_edgeDisjointPaths(one to many)
- pgr_edgeDisjointPaths(many to one)
- pgr_edgeDisjointPaths(many to many)
- pgr_contractGraph

Deprecated Signatures

- pgr_tsp - use pgr_TSP or pgr_eucledianTSP instead
- pgr_astar - use pgr_aStar instead

Deprecated Functions

- pgr_flip_edges
- pgr_vidsToDmatrix
- pgr_pointsToDMatrix
- pgr_textToPoints

pgRouting 2.2.4 Release Notes

To see the issues closed by this release see the **Git closed issues for 2.2.4** on Github.

Bug Fixes

- Bogus uses of extern “C”
- Build error on Fedora 24 + GCC 6.0
- Regression error pgr_nodeNetwork

pgRouting 2.2.3 Release Notes

To see the issues closed by this release see the **Git closed issues for 2.2.3** on Github.

Bug Fixes

- Fixed compatibility issues with PostgreSQL 9.6.

pgRouting 2.2.2 Release Notes

To see the issues closed by this release see the **Git closed issues for 2.2.2** on Github.

Bug Fixes

- Fixed regression error on pgr_drivingDistance

pgRouting 2.2.1 Release Notes

To see the issues closed by this release see the **Git closed issues for 2.2.1** on Github.

Bug Fixes

- Server crash fix on pgr_alphaShape
- Bug fix on With Points family of functions

pgRouting 2.2.0 Release Notes

To see the issues closed by this release see the **Git closed issues for 2.2.0** on Github.

Improvements

- pgr_nodeNetwork
  - Adding a row_where and outall optional parameters
- Signature fix
  - pgr_dijkstra – to match what is documented

New Functions

- pgr_floydWarshall
- pgr_Johnson
- pgr_dijkstraCost(one to one)
- pgr_dijkstraCost(one to many)
- pgr_dijkstraCost(many to one)
- pgr_dijkstraCost(many to many)

Proposed functionality

- pgr_withPoints(one to one)
- pgr_withPoints(one to many)
- pgr_withPoints(many to one)
- pgr_withPoints(many to many)
- pgr_withPointsCost(one to one)
- pgr_withPointsCost(one to many)
- pgr_withPointsCost(many to one)
- pgr_withPointsCost(many to many)
- pgr_withPointsDD(single vertex)
- pgr_withPointsDD(multiple vertices)
- pgr_withPointsKSP
- pgr_dijkstraVia

Deprecated functions:

- pgr_apspWarshall use pgr_floydWarshall instead
- pgr_apspJohnson use pgr_Johnson instead
- pgr_kDijkstraCost use pgr_dijkstraCost instead
- pgr_kDijkstraPath use pgr_dijkstra instead

Renamed and deprecated function

- pgr_makeDistanceMatrix renamed to _pgr_makeDistanceMatrix

pgRouting 2.1.0 Release Notes

To see the issues closed by this release see the **Git closed issues for 2.1.0** on Github.

New Signatures

- pgr_dijkstra(one to many)
- pgr_dijkstra(many to one)
- pgr_dijkstra(many to many)
- pgr_drivingDistance(multiple vertices)

Refactored

- pgr_dijkstra(one to one)
- pgr_ksp
- pgr_drivingDistance(single vertex)

Improvements

- pgr_alphaShape function now can generate better (multi)polygon with holes and alpha parameter.

Proposed functionality

- Proposed functions from Steve Woodbridge, (Classified as Convenience by the author.)
  - pgr_pointToEdgeNode - convert a point geometry to a vertex_id based on closest edge.
  - pgr_flipEdges - flip the edges in an array of geometries so the connect end to end.
  - pgr_textToPoints - convert a string of x,y;x,y;… locations into point geometries.
  - pgr_pointsToVids - convert an array of point geometries into vertex ids.
  - pgr_pointsToDMatrix - Create a distance matrix from an array of points.
  - pgr_vidsToDMatrix - Create a distance matrix from an array of vertix_id.
  - pgr_vidsToDMatrix - Create a distance matrix from an array of vertix_id.
- Added proposed functions from GSoc Projects:
  - pgr_vrppdtw
  - pgr_vrponedepot

Deprecated functions

- pgr_getColumnName
- pgr_getTableName
- pgr_isColumnCndexed
- pgr_isColumnInTable
- pgr_quote_ident
- pgr_versionless
- pgr_startPoint
- pgr_endPoint
- pgr_pointToId

No longer supported

- Removed the 1.x legacy functions

Bug Fixes

- Some bug fixes in other functions

Refactoring Internal Code

- A C and C++ library for developer was created
  - encapsulates postgreSQL related functions
  - encapsulates Boost.Graph graphs
    - Directed Boost.Graph
    - Undirected Boost.graph.
  - allow any-integer in the id’s
  - allow any-numerical on the cost/reverse_cost columns

- Instead of generating many libraries: - All functions are encapsulated in one library - The library has the prefix 2-1-0

pgRouting 2.0.1 Release Notes

Minor bug fixes.

Bug Fixes

- No track of the bug fixes were kept.

pgRouting 2.0.0 Release Notes

To see the issues closed by this release see the **Git closed issues for 2.0.0** on Github.

With the release of pgRouting 2.0.0 the library has abandoned backwards compatibility to **pgRouting 1.x Release Notes** releases. The main Goals for this release are:

- Major restructuring of pgRouting.
- Standardization of the function naming
- Preparation of the project for future development.

As a result of this effort:

- pgRouting has a simplified structure
- Significant new functionality has being added
- Documentation has being integrated
- Testing has being integrated
- And made it easier for multiple developers to make contributions.

Important Changes

- Graph Analytics - tools for detecting and fixing connection some problems in a graph
- A collection of useful utility functions
- Two new All Pairs Short Path algorithms (pgr_apspJohnson, pgr_apspWarshall)
- Bi-directional Dijkstra and A-star search algorithms (pgr_bdAstar, pgr_bdDijkstra)
- One to many nodes search (pgr_kDijkstra)
- K alternate paths shortest path (pgr_ksp)
- New TSP solver that simplifies the code and the build process (pgr_tsp), dropped “Gaul Library” dependency
- Turn Restricted shortest path (pgr_trsp) that replaces Shooting Star
- Dropped support for Shooting Star
- Built a test infrastructure that is run before major code changes are checked in
- Tested and fixed most all of the outstanding bugs reported against 1.x that existing in the 2.0-dev code base.
- Improved build process for Windows
- Automated testing on Linux and Windows platforms trigger by every commit
- Modular library design
- Compatibility with PostgreSQL 9.1 or newer
- Compatibility with PostGIS 2.0 or newer
- Installs as PostgreSQL EXTENSION
- Return types re factored and unified
- Support for table SCHEMA in function parameters
- Support for `st_` PostGIS function prefix
- Added `pgr_` prefix to functions and types
- Better documentation: **https://docs.pgrouting.org**
- shooting_star is discontinued

pgRouting 1.x Release Notes

To see the issues closed by this release see the **Git closed issues for 1.x** on Github. The following release notes have been copied from the previous `RELEASE_NOTES` file and are kept as a reference.

Changes for release 1.05

- Bug fixes

Changes for release 1.03

- Much faster topology creation
- Bug fixes

Changes for release 1.02

- Shooting* bug fixes
- Compilation problems solved

Changes for release 1.01

- Shooting* bug fixes

Changes for release 1.0

- Core and extra functions are separated
- Cmake build process
- Bug fixes

Changes for release 1.0.0b

- Additional SQL file with more simple names for wrapper functions
- Bug fixes

Changes for release 1.0.0a

- Shooting* shortest path algorithm for real road networks
- Several SQL bugs were fixed

Changes for release 0.9.9

- PostgreSQL 8.2 support
- Shortest path functions return empty result if they could not find any path

Changes for release 0.9.8

- Renumbering scheme was added to shortest path functions
- Directed shortest path functions were added
- routing_postgis.sql was modified to use dijkstra in TSP search

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