# **Psycopg Documentation**

Release 2.9.10

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Psycopg is the most popular PostgreSQL database adapter for the Python programming language. Its main features are the complete implementation of the Python DB API 2.0 specification and the thread safety (several threads can share the same connection). It was designed for heavily multi-threaded applications that create and destroy lots of cursors and make a large number of concurrent INSERTs or UPDATEs.

Psycopg 2 is mostly implemented in C as a libpq wrapper, resulting in being both efficient and secure. It features client-side and *server-side* cursors, *asynchronous communication* and *notifications*, *COPY* support. Many Python types are supported out-of-the-box and *adapted to matching PostgreSQL data types*; adaptation can be extended and customized thanks to a flexible *objects adaptation system*.

Psycopg 2 is both Unicode and Python 3 friendly.

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**CHAPTER** 

ONE

### INSTALLATION

Psycopg is a PostgreSQL adapter for the Python programming language. It is a wrapper for the libpq, the official PostgreSQL client library.

# 1.1 Quick Install

For most operating systems, the quickest way to install Psycopg is using the wheel package available on PyPI:

```
$ pip install psycopg2-binary
```

This will install a pre-compiled binary version of the module which does not require the build or runtime prerequisites described below. Make sure to use an up-to-date version of **pip** (you can upgrade it using something like **pip** install -U pip).

You may then import the psycopg2 package, as usual:

```
import psycopg2

# Connect to your postgres DB
conn = psycopg2.connect("dbname=test user=postgres")

# Open a cursor to perform database operations
cur = conn.cursor()

# Execute a query
cur.execute("SELECT * FROM my_data")

# Retrieve query results
records = cur.fetchall()
```

# 1.1.1 psycopg vs psycopg-binary

The psycopg2-binary package is meant for beginners to start playing with Python and PostgreSQL without the need to meet the build requirements.

If you are the maintainer of a published package depending on psycopg2 you shouldn't use psycopg2-binary as a module dependency. For production use you are advised to use the source distribution.

The binary packages come with their own versions of a few C libraries, among which libpq and libssl, which will be used regardless of other libraries available on the client: upgrading the system libraries will not upgrade the libraries used by psycopg2. Please build psycopg2 from source if you want to maintain binary upgradeability.

### Warning

The psycopg2 wheel package comes packaged, among the others, with its own libssl binary. This may create conflicts with other extension modules binding with libssl as well, for instance with the Python ssl module: in some cases, under concurrency, the interaction between the two libraries may result in a segfault. In case of doubts you are advised to use a package built from source.

# 1.1.2 Change in binary packages between Psycopg 2.7 and 2.8

In version 2.7.x, **pip install psycopg2** would have tried to install automatically the binary package of Psycopg. Because of concurrency problems binary packages have displayed, psycopg2-binary has become a separate package, and from 2.8 it has become the only way to install the binary package.

If you are using Psycopg 2.7 and you want to disable the use of wheel binary packages, relying on the system libraries available on your client, you can use the **pip** --no-binary option, e.g.:

```
$ pip install --no-binary :all: psycopg2
```

which can be specified in your requirements.txt files too, e.g. use:

```
psycopg2>=2.7,<2.8 --no-binary psycopg2
```

to use the last bugfix release of the psycopg2 2.7 package, specifying to always compile it from source. Of course in this case you will have to meet the *build prerequisites*.

# 1.2 Prerequisites

The current psycopg2 implementation supports:

- Python versions from 3.8 to 3.13
- PostgreSQL server versions from 7.4 to 17
- PostgreSQL client library version from 9.1

### **1** Note

Not all the psycopg2 versions support all the supported Python versions.

Please see the *release notes* to verify when the support for a new Python version was added and when the support for an old Python version was removed.

# 1.2.1 Build prerequisites

The build prerequisites are to be met in order to install Psycopg from source code, from a source distribution package, GitHub or from PyPI.

Psycopg is a C wrapper around the libpq PostgreSQL client library. To install it from sources you will need:

- · A C compiler.
- The Python header files. They are usually installed in a package such as **python-dev** or **python3-dev**. A message such as *error*: *Python.h*: *No such file or directory* is an indication that the Python headers are missing.
- The libpq header files. They are usually installed in a package such as **libpq-dev**. If you get an *error*: *libpq-fe.h*: *No such file or directory* you are missing them.
- The **pg\_config** program: it is usually installed by the **libpq-dev** package but sometimes it is not in a PATH directory. Having it in the PATH greatly streamlines the installation, so try running **pg\_config** --version: if it returns an error or an unexpected version number then locate the directory containing the **pg\_config** shipped with the right libpq version (usually /usr/lib/postgresql/X.Y/bin/) and add it to the PATH:

```
$ export PATH=/usr/lib/postgresql/X.Y/bin/:$PATH
```

You only need **pg\_config** to compile **psycopg2**, not for its regular usage.

Once everything is in place it's just a matter of running the standard:

```
$ pip install psycopg2
```

or, from the directory containing the source code:

```
$ python setup.py build
$ python setup.py install
```

# 1.2.2 Runtime requirements

Unless you compile psycopg2 as a static library, or you install it from a self-contained wheel package, it will need the libpq library at runtime (usually distributed in a libpq.so or libpq.dll file). psycopg2 relies on the host OS to find the library if the library is installed in a standard location there is usually no problem; if the library is in a non-standard location you will have to tell Psycopg how to find it, which is OS-dependent (for instance setting a suitable LD\_LIBRARY\_PATH on Linux).

### **1** Note

The libpq header files used to compile psycopg2 should match the version of the library linked at runtime. If you get errors about missing or mismatching libraries when importing psycopg2 check (e.g. using ldd) if the module psycopg2/\_psycopg.so is linked to the right libpq.so.

### 1 Note

Whatever version of libpq psycopg2 is compiled with, it will be possible to connect to PostgreSQL servers of any supported version: just install the most recent libpq version or the most practical, without trying to match it to the version of the PostgreSQL server you will have to connect to.

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# 1.3 Non-standard builds

If you have less standard requirements such as:

- creating a debug build,
- using **pg\_config** not in the PATH,

then take a look at the setup.cfg file.

Some of the options available in setup.cfg are also available as command line arguments of the build\_ext sub-command. For instance you can specify an alternate **pg\_config** location using:

```
$ python setup.py build_ext --pg-config /path/to/pg_config build
```

Use python setup.py build\_ext --help to get a list of the options supported.

# 1.3.1 Creating a debug build

In case of problems, Psycopg can be configured to emit detailed debug messages, which can be very useful for diagnostics and to report a bug. In order to create a debug package:

- Download and unpack the Psycopg source package (the .tar.gz package).
- Edit the setup.cfg file adding the PSYCOPG\_DEBUG flag to the define option.
- Compile and install the package.
- Set the PSYCOPG\_DEBUG environment variable:

```
$ export PSYCOPG_DEBUG=1
```

• Run your program (making sure that the psycopg2 package imported is the one you just compiled and not e.g. the system one): you will have a copious stream of informations printed on stderr.

# 1.3.2 Non-standard Python Implementation

The *psycopg2* package is the current mature implementation of the adapter: it is a C extension and as such it is only compatible with CPython. If you want to use Psycopg on a different Python implementation (PyPy, Jython, IronPython) there is a couple of alternative:

- a Ctypes port, but it is not as mature as the C implementation yet and it is not as feature-complete;
- a CFFI port which is currently more used and reported more efficient on PyPy, but please be careful of its version numbers because they are not aligned to the official psycopg2 ones and some features may differ.

# 1.4 Running the test suite

Once psycopg2 is installed you can run the test suite to verify it is working correctly. From the source directory, you can run:

```
$ python -c "import tests; tests.unittest.main(defaultTest='tests.test_suite')" --verbose
```

The tests run against a database called psycopg2\_test on UNIX socket and the standard port. You can configure a different database to run the test by setting the environment variables:

- PSYCOPG2\_TESTDB
- PSYCOPG2\_TESTDB\_HOST
- PSYCOPG2\_TESTDB\_PORT
- PSYCOPG2\_TESTDB\_USER

The database should already exist before running the tests.

# 1.5 If you still have problems

Try the following. *In order:* 

- Read again the Build prerequisites.
- Read the FAQ.
- Google for psycopg2 your error message. Especially useful the week after the release of a new OS X version.
- Write to the Mailing List.
- If you think that you have discovered a bug, test failure or missing feature please raise a ticket in the bug tracker.
- Complain on your blog or on Twitter that psycopg2 is the worst package ever and about the quality time you have wasted figuring out the correct ARCHFLAGS. Especially useful from the Starbucks near you.

### **BASIC MODULE USAGE**

The basic Psycopg usage is common to all the database adapters implementing the DB API 2.0 protocol. Here is an interactive session showing some of the basic commands:

```
>>> import psycopg2
# Connect to an existing database
>>> conn = psycopg2.connect("dbname=test user=postgres")
# Open a cursor to perform database operations
>>> cur = conn.cursor()
# Execute a command: this creates a new table
>>> cur.execute("CREATE TABLE test (id serial PRIMARY KEY, num integer, data varchar);")
# Pass data to fill a query placeholders and let Psycopg perform
# the correct conversion (no more SQL injections!)
>>> cur.execute("INSERT INTO test (num, data) VALUES (%s, %s)",
         (100, "abc'def"))
# Query the database and obtain data as Python objects
>>> cur.execute("SELECT * FROM test;")
>>> cur.fetchone()
(1, 100, "abc'def")
# Make the changes to the database persistent
>>> conn.commit()
# Close communication with the database
>>> cur.close()
>>> conn.close()
```

The main entry points of Psycopg are:

- The function *connect()* creates a new database session and returns a new *connection* instance.
- The class *connection* encapsulates a database session. It allows to:
  - create new *cursor* instances using the *cursor()* method to execute database commands and queries,
  - terminate transactions using the methods *commit()* or *rollback()*.
- The class *cursor* allows interaction with the database:
  - send commands to the database using methods such as execute() and executemany(),

 retrieve data from the database by iteration or using methods such as fetchone(), fetchmany(), fetchall().

# 2.1 Passing parameters to SQL queries

Psycopg converts Python variables to SQL values using their types: the Python type determines the function used to convert the object into a string representation suitable for PostgreSQL. Many standard Python types are already *adapted* to the correct SQL representation.

Passing parameters to an SQL statement happens in functions such as *cursor.execute()* by using %s placeholders in the SQL statement, and passing a sequence of values as the second argument of the function. For example the Python function call:

is converted into a SQL command similar to:

```
INSERT INTO some_table (an_int, a_date, a_string)
VALUES (10, '2005-11-18', '0''Reilly');
```

Named arguments are supported too using %(name) s placeholders in the query and specifying the values into a mapping. Using named arguments allows to specify the values in any order and to repeat the same value in several places in the query:

```
>>> cur.execute("""
... INSERT INTO some_table (an_int, a_date, another_date, a_string)
... VALUES (%(int)s, %(date)s, %(str)s);
... """,
... {'int': 10, 'str': "O'Reilly", 'date': datetime.date(2005, 11, 18)})
```

Using characters %, (, ) in the argument names is not supported.

When parameters are used, in order to include a literal % in the query you can use the %% string:

```
>>> cur.execute("SELECT (%s % 2) = 0 AS even", (10,)) # WRONG
>>> cur.execute("SELECT (%s %% 2) = 0 AS even", (10,)) # correct
```

While the mechanism resembles regular Python strings manipulation, there are a few subtle differences you should care about when passing parameters to a query.

• The Python string operator % *must not be used*: the execute() method accepts a tuple or dictionary of values as second parameter. *Never use* % *or* + *to merge values into queries*:

```
>>> cur.execute("INSERT INTO numbers VALUES (%s, %s)" % (10, 20)) # WRONG
>>> cur.execute("INSERT INTO numbers VALUES (%s, %s)", (10, 20)) # correct
```

• For positional variables binding, *the second argument must always be a sequence*, even if it contains a single variable (remember that Python requires a comma to create a single element tuple):

```
>>> cur.execute("INSERT INTO foo VALUES (%s)", "bar") # WRONG
>>> cur.execute("INSERT INTO foo VALUES (%s)", ("bar")) # WRONG
>>> cur.execute("INSERT INTO foo VALUES (%s)", ("bar",)) # correct
>>> cur.execute("INSERT INTO foo VALUES (%s)", ["bar"]) # correct
```

• The placeholder *must not be quoted*. Psycopg will add quotes where needed:

```
>>> cur.execute("INSERT INTO numbers VALUES ('%s')", (10,)) # WRONG
>>> cur.execute("INSERT INTO numbers VALUES (%s)", (10,)) # correct
```

• The variables placeholder *must always be a* %s, even if a different placeholder (such as a %d for integers or %f for floats) may look more appropriate:

```
>>> cur.execute("INSERT INTO numbers VALUES (%d)", (10,)) # WRONG
>>> cur.execute("INSERT INTO numbers VALUES (%s)", (10,)) # correct
```

• Only query values should be bound via this method: it shouldn't be used to merge table or field names to the query (Psycopg will try quoting the table name as a string value, generating invalid SQL). If you need to generate dynamically SQL queries (for instance choosing dynamically a table name) you can use the facilities provided by the psycopg2.sql module:

```
>>> cur.execute("INSERT INTO %s VALUES (%s)", ('numbers', 10)) # WRONG
>>> cur.execute( # correct
... SQL("INSERT INTO {} VALUES (%s)").format(Identifier('numbers')),
... (10,))
```

# 2.1.1 The problem with the query parameters

The SQL representation of many data types is often different from their Python string representation. The typical example is with single quotes in strings: in SQL single quotes are used as string literal delimiters, so the ones appearing inside the string itself must be escaped, whereas in Python single quotes can be left unescaped if the string is delimited by double quotes.

Because of the difference, sometime subtle, between the data types representations, a naïve approach to query strings composition, such as using Python strings concatenation, is a recipe for *terrible* problems:

```
>>> SQL = "INSERT INTO authors (name) VALUES ('%s');" # NEVER DO THIS
>>> data = ("O'Reilly", )
>>> cur.execute(SQL % data) # THIS WILL FAIL MISERABLY
ProgrammingError: syntax error at or near "Reilly"
LINE 1: INSERT INTO authors (name) VALUES ('O'Reilly')
```

If the variables containing the data to send to the database come from an untrusted source (such as a form published on a web site) an attacker could easily craft a malformed string, either gaining access to unauthorized data or performing destructive operations on the database. This form of attack is called SQL injection and is known to be one of the most widespread forms of attack to database servers. Before continuing, please print this page as a memo and hang it onto your desk.

Psycopg can *automatically convert Python objects to and from SQL literals*: using this feature your code will be more robust and reliable. We must stress this point:

### **A** Warning

Never, **never**, **NEVER** use Python string concatenation (+) or string parameters interpolation (%) to pass variables to a SQL query string. Not even at gunpoint.

The correct way to pass variables in a SQL command is using the second argument of the execute() method:

```
>>> SQL = "INSERT INTO authors (name) VALUES (%s);" # Note: no quotes
>>> data = ("0'Reilly", )
>>> cur.execute(SQL, data) # Note: no % operator
```

# 2.1.2 Values containing backslashes and LIKE

Unlike in Python, the backslash (\) is not used as an escape character *except* in patterns used with LIKE and ILIKE where they are needed to escape the % and \_ characters.

This can lead to confusing situations:

```
>>> path = r'C:\Users\Bobby.Tables'
>>> cur.execute('INSERT INTO mytable(path) VALUES (%s)', (path,))
>>> cur.execute('SELECT * FROM mytable WHERE path LIKE %s', (path,))
>>> cur.fetchall()
[]
```

The solution is to specify an ESCAPE character of '' (empty string) in your LIKE query:

```
>>> cur.execute("SELECT * FROM mytable WHERE path LIKE %s ESCAPE ''", (path,))
```

# 2.2 Adaptation of Python values to SQL types

Many standard Python types are adapted into SQL and returned as Python objects when a query is executed.

The following table shows the default mapping between Python and PostgreSQL types:

The mapping is fairly customizable: see *Adapting new Python types to SQL syntax* and *Type casting of SQL types into Python objects*. You can also find a few other specialized adapters in the *psycopg2.extras* module.

# 2.2.1 Constants adaptation

Python None and boolean values True and False are converted into the proper SQL literals:

```
>>> cur.mogrify("SELECT %s, %s, %s;", (None, True, False))
'SELECT NULL, true, false;'
```

# 2.2.2 Numbers adaptation

Python numeric objects int, long, float, Decimal are converted into a PostgreSQL numerical representation:

```
>>> cur.mogrify("SELECT %s, %s, %s, %s;", (10, 10L, 10.0, Decimal("10.00")))
'SELECT 10, 10, 10.0, 10.00;'
```

Reading from the database, integer types are converted into int, floating point types are converted into float, numeric/decimal are converted into Decimal.

### 1 Note

Sometimes you may prefer to receive numeric data as float instead, for performance reason or ease of manipulation: you can configure an adapter to *cast PostgreSQL numeric to Python float*. This of course may imply a loss of precision.

```
➢ See also
PostgreSQL numeric types
```

# 2.2.3 Strings adaptation

Python str and unicode are converted into the SQL string syntax. unicode objects (str in Python 3) are encoded in the connection *encoding* before sending to the backend: trying to send a character not supported by the encoding will result in an error. Data is usually received as str (*i.e.* it is *decoded* on Python 3, left *encoded* on Python 2). However it is possible to receive unicode on Python 2 too: see *Unicode handling*.

### Unicode handling

Psycopg can exchange Unicode data with a PostgreSQL database. Python unicode objects are automatically *encoded* in the client encoding defined on the database connection (the PostgreSQL encoding, available in *connection*. *encoding*, is translated into a Python encoding using the *encodings* mapping):

```
>>> print(u, type(u))
àèiòù€ <type 'unicode'>
>>> cur.execute("INSERT INTO test (num, data) VALUES (%s,%s);", (74, u))
```

When reading data from the database, in Python 2 the strings returned are usually 8 bit str objects encoded in the database client encoding:

```
>>> print(conn.encoding)
UTF8

>>> cur.execute("SELECT data FROM test WHERE num = 74")
>>> x = cur.fetchone()[0]
>>> print(x, type(x), repr(x))
àèiòù€ <type 'str'> '\xc3\xa0\xc3\xa8\xc3\xac\xc3\xb2\xc3\xb9\xe2\x82\xac'
```

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```
>>> conn.set_client_encoding('LATIN9')
>>> cur.execute("SELECT data FROM test WHERE num = 74")
>>> x = cur.fetchone()[0]
>>> print(type(x), repr(x))
<type 'str'> '\xe0\xe8\xec\xf2\xf9\xa4'
```

In Python 3 instead the strings are automatically *decoded* in the connection *encoding*, as the str object can represent Unicode characters. In Python 2 you must register a *typecaster* in order to receive unicode objects:

```
>>> psycopg2.extensions.register_type(psycopg2.extensions.UNICODE, cur)
>>> cur.execute("SELECT data FROM test WHERE num = 74")
>>> x = cur.fetchone()[0]
>>> print(x, type(x), repr(x))
àèiòù€ <type 'unicode'> u'\xe0\xe8\xec\xf2\xf9\u20ac'
```

In the above example, the *UNICODE* typecaster is registered only on the cursor. It is also possible to register typecasters on the connection or globally: see the function *register\_type()* and *Type casting of SQL types into Python objects* for details.

### 1 Note

In Python 2, if you want to uniformly receive all your database input in Unicode, you can register the related typecasters globally as soon as Psycopg is imported:

```
import psycopg2.extensions
psycopg2.extensions.register_type(psycopg2.extensions.UNICODE)
psycopg2.extensions.register_type(psycopg2.extensions.UNICODEARRAY)
and forget about this story.
```

### 1 Note

In some cases, on Python 3, you may want to receive bytes instead of str, without undergoing to any decoding. This is especially the case if the data in the database is in mixed encoding. The *BYTES* caster is what you neeed:

```
import psycopg2.extensions
psycopg2.extensions.register_type(psycopg2.extensions.BYTES, conn)
psycopg2.extensions.register_type(psycopg2.extensions.BYTESARRAY, conn)
cur = conn.cursor()
cur.execute("select %s::text", (u"\infty",))
cur.fetchone()[0]
b'\xe2\x82\xac'
```

# 2.2.4 Binary adaptation

Python types representing binary objects are converted into PostgreSQL binary string syntax, suitable for bytea fields. Such types are buffer (only available in Python 2), memoryview, bytearray, and bytes (only in Python 3: the name is available in Python 2 but it's only an alias for the type str). Any object implementing the Revised Buffer Protocol should be usable as binary type. Received data is returned as buffer (in Python 2) or memoryview (in Python 3).

Changed in version 2.4: only strings were supported before.

Changed in version 2.4.1: can parse the 'hex' format from 9.0 servers without relying on the version of the client library.



In Python 2, if you have binary data in a str object, you can pass them to a bytea field using the *psycopg2.Binary* wrapper:

### Warning

Since version 9.0 PostgreSQL uses by default a new "hex" format to emit bytea fields. Starting from Psycopg 2.4.1 the format is correctly supported. If you use a previous version you will need some extra care when receiving bytea from PostgreSQL: you must have at least libpq 9.0 installed on the client or alternatively you can set the bytea\_output configuration parameter to escape, either in the server configuration file or in the client session (using a query such as SET bytea\_output TO escape;) before receiving binary data.

### 2.2.5 Date/Time objects adaptation

Python builtin datetime, date, time, timedelta are converted into PostgreSQL's timestamp[tz], date, time[tz], interval data types. Time zones are supported too.

```
>>> dt = datetime.datetime.now()
>>> dt
datetime.datetime(2010, 2, 8, 1, 40, 27, 425337)
```

```
>>> cur.mogrify("SELECT %s, %s, %s;", (dt, dt.date(), dt.time()))
"SELECT '2010-02-08T01:40:27.425337', '2010-02-08', '01:40:27.425337';"
```

```
>>> cur.mogrify("SELECT %s;", (dt - datetime.datetime(2010,1,1),))
"SELECT '38 days 6027.425337 seconds';"
```

### See also

PostgreSQL date/time types

### Time zones handling

The PostgreSQL type timestamp with time zone (a.k.a. timestamptz) is converted into Python datetime objects.

```
>>> cur.execute("SET TIME ZONE 'Europe/Rome'") # UTC + 1 hour
>>> cur.execute("SELECT '2010-01-01 10:30:45'::timestamptz")
>>> cur.fetchone()[0]
datetime.datetime(2010, 1, 1, 10, 30, 45,
    tzinfo=datetime.timezone(datetime.timedelta(seconds=3600)))
```

### 1 Note

Before Python 3.7, the datetime module only supported timezones with an integer number of minutes. A few historical time zones had seconds in the UTC offset: these time zones will have the offset rounded to the nearest minute, with an error of up to 30 seconds, on Python versions before 3.7.

```
>>> cur.execute("SET TIME ZONE 'Asia/Calcutta'") # offset was +5:21:10
>>> cur.execute("SELECT '1900-01-01 10:30:45'::timestamptz")
>>> cur.fetchone()[0].tzinfo
# On Python 3.6: 5h, 21m
datetime.timezone(datetime.timedelta(0, 19260))
# On Python 3.7 and following: 5h, 21m, 10s
datetime.timezone(datetime.timedelta(seconds=19270))
```

Changed in version 2.2.2: timezones with seconds are supported (with rounding). Previously such timezones raised an error.

Changed in version 2.9: timezones with seconds are supported without rounding.

Changed in version 2.9: use datetime.timezone as default tzinfo object instead of FixedOffsetTimezone.

### Infinite dates handling

PostgreSQL can store the representation of an "infinite" date, timestamp, or interval. Infinite dates are not available to Python, so these objects are mapped to date.max, datetime.max, interval.max. Unfortunately the mapping cannot be bidirectional so these dates will be stored back into the database with their values, such as 9999-12-31.

It is possible to create an alternative adapter for dates and other objects to map date.max to infinity, for instance:

```
class InfDateAdapter:
    def __init__(self, wrapped):
        self.wrapped = wrapped
    def getquoted(self):
        if self.wrapped == datetime.date.max:
            return b"'infinity'::date"
        elif self.wrapped == datetime.date.min:
            return b"'-infinity'::date"
        else:
            return psycopg2.extensions.DateFromPy(self.wrapped).getquoted()

psycopg2.extensions.register_adapter(datetime.date, InfDateAdapter)
```

Of course it will not be possible to write the value of date.max in the database anymore: infinity will be stored instead.

### Time handling

The PostgreSQL time and Python time types are not fully bidirectional.

Within PostgreSQL, the time type's maximum value of 24:00:00 is treated as 24-hours later than the minimum value of 00:00:00.

```
>>> cur.execute("SELECT '24:00:00'::time - '00:00:00'::time")
>>> cur.fetchone()[0]
datetime.timedelta(days=1)
```

However, Python's time only supports times until 23:59:59. Retrieving a value of 24:00:00 results in a time of 00:00:00.

```
>>> cur.execute("SELECT '24:00:00'::time, '00:00:00'::time")
>>> cur.fetchone()
(datetime.time(0, 0), datetime.time(0, 0))
```

# 2.2.6 Lists adaptation

Python lists are converted into PostgreSQL ARRAYs:

```
>>> cur.mogrify("SELECT %s;", ([10, 20, 30], ))
'SELECT ARRAY[10,20,30];'
```

### 1 Note

You can use a Python list as the argument of the IN operator using the PostgreSQL ANY operator.

```
ids = [10, 20, 30]
cur.execute("SELECT * FROM data WHERE id = ANY(%s);", (ids,))
```

Furthermore ANY can also work with empty lists, whereas IN () is a SQL syntax error.

### 1 Note

Reading back from PostgreSQL, arrays are converted to lists of Python objects as expected, but only if the items are of a known type. Arrays of unknown types are returned as represented by the database (e.g. {a,b,c}). If you want to convert the items into Python objects you can easily create a typecaster for *array of unknown types*.

### 2.2.7 Tuples adaptation

Python tuples are converted into a syntax suitable for the SQL IN operator and to represent a composite type:

```
>>> cur.mogrify("SELECT %s IN %s;", (10, (10, 20, 30)))
'SELECT 10 IN (10, 20, 30);'
```

#### 1 Note

SQL doesn't allow an empty list in the IN operator, so your code should guard against empty tuples. Alternatively you can *use a Python list*.

If you want PostgreSQL composite types to be converted into a Python tuple/namedtuple you can use the register\_composite() function.

Added in version 2.0.6: the tuple IN adaptation.

Changed in version 2.0.14: the tuple IN adapter is always active. In previous releases it was necessary to import the *extensions* module to have it registered.

Changed in version 2.3: namedtuple instances are adapted like regular tuples and can thus be used to represent composite types.

# 2.3 Transactions control

In Psycopg transactions are handled by the *connection* class. By default, the first time a command is sent to the database (using one of the *cursor*s created by the connection), a new transaction is created. The following database commands will be executed in the context of the same transaction – not only the commands issued by the first cursor, but the ones issued by all the cursors created by the same connection. Should any command fail, the transaction will be aborted and no further command will be executed until a call to the *rollback()* method.

The connection is responsible for terminating its transaction, calling either the <code>commit()</code> or <code>rollback()</code> method. Committed changes are immediately made persistent in the database. If the connection is closed (using the <code>close()</code> method) or destroyed (using del or by letting it fall out of scope) while a transaction is in progress, the server will discard the transaction. However doing so is not advisable: middleware such as PgBouncer may see the connection closed uncleanly and dispose of it.

It is possible to set the connection in *autocommit* mode: this way all the commands executed will be immediately committed and no rollback is possible. A few commands (e.g. CREATE DATABASE, VACUUM, CALL on stored procedures using transaction control...) require to be run outside any transaction: in order to be able to run these commands from Psycopg, the connection must be in autocommit mode: you can use the *autocommit* property.

# **A** Warning

By default even a simple SELECT will start a transaction: in long-running programs, if no further action is taken, the session will remain "idle in transaction", an undesirable condition for several reasons (locks are held by the session, tables bloat…). For long lived scripts, either make sure to terminate a transaction as soon as possible or use an autocommit connection.

A few other transaction properties can be set session-wide by the connection: for instance it is possible to have read-only transactions or change the isolation level. See the <code>set\_session()</code> method for all the details.

### 2.3.1 with statement

Starting from version 2.5, psycopg2's connections and cursors are *context managers* and can be used with the with statement:

```
with psycopg2.connect(DSN) as conn:
    with conn.cursor() as curs:
        curs.execute(SQL)
```

When a connection exits the with block, if no exception has been raised by the block, the transaction is committed. In case of exception the transaction is rolled back.

When a cursor exits the with block it is closed, releasing any resource eventually associated with it. The state of the transaction is not affected.

A connection can be used in more than one with statement and each with block is effectively wrapped in a separate transaction:

```
conn = psycopg2.connect(DSN)

with conn:
    with conn.cursor() as curs:
        curs.execute(SQL1)

with conn:
    with conn.cursor() as curs:
        curs.execute(SQL2)

conn.close()
```

### Warning

Unlike file objects or other resources, exiting the connection's with block **doesn't close the connection**, but only the transaction associated to it. If you want to make sure the connection is closed after a certain point, you should still use a try-catch block:

```
conn = psycopg2.connect(DSN)
try:
    # connection usage
finally:
    conn.close()
```

Changed in version 2.9: with connection starts a transaction also on autocommit connections.

### 2.4 Server side cursors

When a database query is executed, the Psycopg *cursor* usually fetches all the records returned by the backend, transferring them to the client process. If the query returns a huge amount of data, a proportionally large amount of memory will be allocated by the client.

If the dataset is too large to be practically handled on the client side, it is possible to create a *server side* cursor. Using this kind of cursor it is possible to transfer to the client only a controlled amount of data, so that a large dataset can be examined without keeping it entirely in memory.

Server side cursor are created in PostgreSQL using the DECLARE command and subsequently handled using MOVE, FETCH and CLOSE commands.

Psycopg wraps the database server side cursor in *named cursors*. A named cursor is created using the *cursor()* method specifying the *name* parameter. Such cursor will behave mostly like a regular cursor, allowing the user to move in the dataset using the *scrol1()* method and to read the data using *fetchone()* and *fetchmany()* methods. Normally you can only scroll forward in a cursor: if you need to scroll backwards you should declare your cursor *scrollable*.

Named cursors are also *iterable* like regular cursors. Note however that before Psycopg 2.4 iteration was performed fetching one record at time from the backend, resulting in a large overhead. The attribute *itersize* now controls how many records are fetched at time during the iteration: the default value of 2000 allows to fetch about 100KB per roundtrip assuming records of 10-20 columns of mixed number and strings; you may decrease this value if you are dealing with huge records.

Named cursors are usually created WITHOUT HOLD, meaning they live only as long as the current transaction. Trying to fetch from a named cursor after a <code>commit()</code> or to create a named cursor when the connection is in <code>autocommit</code> mode will result in an exception. It is possible to create a WITH HOLD cursor by specifying a True value for the <code>withhold</code> parameter to <code>cursor()</code> or by setting the <code>withhold</code> attribute to True before calling <code>execute()</code> on the cursor. It is extremely important to always <code>close()</code> such cursors, otherwise they will continue to hold server-side resources until the connection will be eventually closed. Also note that while WITH HOLD cursors lifetime extends well after <code>commit()</code>, calling <code>rollback()</code> will automatically close the cursor.

### 1 Note

It is also possible to use a named cursor to consume a cursor created in some other way than using the DECLARE executed by *execute()*. For example, you may have a PL/pgSQL function returning a cursor:

```
CREATE FUNCTION reffunc(refcursor) RETURNS refcursor AS $$
BEGIN

OPEN $1 FOR SELECT col FROM test;
RETURN $1;
END;
$$ LANGUAGE plpgsql;
```

You can read the cursor content by calling the function with a regular, non-named, Psycopg cursor:

```
cur1 = conn.cursor()
cur1.callproc('reffunc', ['curname'])
```

and then use a named cursor in the same transaction to "steal the cursor":

```
cur2 = conn.cursor('curname')
for record in cur2:  # or cur2.fetchone, fetchmany...
    # do something with record
    pass
```

# 2.5 Thread and process safety

The Psycopg module and the *connection* objects are *thread-safe*: many threads can access the same database either using separate sessions and creating a *connection* per thread or using the same connection and creating separate *cursors*. In DB API 2.0 parlance, Psycopg is *level 2 thread safe*.

The difference between the above two approaches is that, using different connections, the commands will be executed in different sessions and will be served by different server processes. On the other hand, using many cursors on the same connection, all the commands will be executed in the same session (and in the same transaction if the connection is not in *autocommit* mode), but they will be serialized.

The above observations are only valid for regular threads: they don't apply to forked processes nor to green threads. libpq connections shouldn't be used by a forked processes, so when using a module such as multiprocessing or a forking web deploy method such as FastCGI make sure to create the connections *after* the fork.

Connections shouldn't be shared either by different green threads: see Support for coroutine libraries for further details.

# 2.6 Using COPY TO and COPY FROM

Psycopg *cursor* objects provide an interface to the efficient PostgreSQL *COPY* command to move data from files to tables and back.

Currently no adaptation is provided between Python and PostgreSQL types on COPY: the file can be any Python file-like object but its format must be in the format accepted by PostgreSQL COPY command (data format, escaped characters, etc).

The methods exposed are:

### copy\_from()

Reads data *from* a file-like object appending them to a database table (COPY table FROM file syntax). The source file must provide both read() and readline() method.

### copy\_to()

Writes the content of a table *to* a file-like object (COPY table TO file syntax). The target file must have a write() method.

### copy\_expert()

Allows to handle more specific cases and to use all the COPY features available in PostgreSQL.

Please refer to the documentation of the single methods for details and examples.

# 2.7 Access to PostgreSQL large objects

PostgreSQL offers support for large objects, which provide stream-style access to user data that is stored in a special large-object structure. They are useful with data values too large to be manipulated conveniently as a whole.

Psycopg allows access to the large object using the *lobject* class. Objects are generated using the *connection*. *lobject()* factory method. Data can be retrieved either as bytes or as Unicode strings.

Psycopg large object support efficient import/export with file system files using the lo\_import() and lo\_export() libpq functions.

Changed in version 2.6: added support for large objects greater than 2GB. Note that the support is enabled only if all the following conditions are verified:

• the Python build is 64 bits;

- the extension was built against at least libpq 9.3;
- the server version is at least PostgreSQL 9.3 (*server\_version* must be >= 90300).

If Psycopg was built with 64 bits large objects support (i.e. the first two conditions above are verified), the psycopg2. \_\_version\_\_ constant will contain the lo64 flag. If any of the condition is not met several lobject methods will fail if the arguments exceed 2GB.

# 2.8 Two-Phase Commit protocol support

Added in version 2.3.

Psycopg exposes the two-phase commit features available since PostgreSQL 8.1 implementing the *two-phase commit* extensions proposed by the DB API 2.0.

The DB API 2.0 model of two-phase commit is inspired by the XA specification, according to which transaction IDs are formed from three components:

- a format ID (non-negative 32 bit integer)
- a global transaction ID (string not longer than 64 bytes)
- a branch qualifier (string not longer than 64 bytes)

For a particular global transaction, the first two components will be the same for all the resources. Every resource will be assigned a different branch qualifier.

According to the DB API 2.0 specification, a transaction ID is created using the *connection.xid()* method. Once you have a transaction id, a distributed transaction can be started with *connection.tpc\_begin()*, prepared using *tpc\_prepare()* and completed using *tpc\_commit()* or *tpc\_rollback()*. Transaction IDs can also be retrieved from the database using *tpc\_recover()* and completed using the above tpc\_commit() and tpc\_rollback().

PostgreSQL doesn't follow the XA standard though, and the ID for a PostgreSQL prepared transaction can be any string up to 200 characters long. Psycopg's *Xid* objects can represent both XA-style transactions IDs (such as the ones created by the xid() method) and PostgreSQL transaction IDs identified by an unparsed string.

The format in which the Xids are converted into strings passed to the database is the same employed by the PostgreSQL JDBC driver: this should allow interoperation between tools written in Python and in Java. For example a recovery tool written in Python would be able to recognize the components of transactions produced by a Java program.

For further details see the documentation for the above methods.

**CHAPTER** 

THREE

### THE PSYCOPG2 MODULE CONTENT

The module interface respects the standard defined in the DB API 2.0.

psycopq2.connect(dsn=None, connection factory=None, cursor factory=None, async=False, \\*\\*kwargs)

Create a new database session and return a new connection object.

The connection parameters can be specified as a libpq connection string using the *dsn* parameter:

```
conn = psycopg2.connect("dbname=test user=postgres password=secret")
```

or using a set of keyword arguments:

```
conn = psycopg2.connect(dbname="test", user="postgres", password="secret")
```

or using a mix of both: if the same parameter name is specified in both sources, the *kwargs* value will have precedence over the *dsn* value. Note that either the *dsn* or at least one connection-related keyword argument is required.

The basic connection parameters are:

- dbname the database name (database is a deprecated alias)
- user user name used to authenticate
- password password used to authenticate
- host database host address (defaults to UNIX socket if not provided)
- port connection port number (defaults to 5432 if not provided)

Any other connection parameter supported by the client library/server can be passed either in the connection string or as a keyword. The PostgreSQL documentation contains the complete list of the supported parameters. Also note that the same parameters can be passed to the client library using environment variables.

Using the *connection\_factory* parameter a different class or connections factory can be specified. It should be a callable object taking a *dsn* string argument. See *Connection and cursor factories* for details. If a *cursor\_factory* is specified, the connection's *cursor\_factory* is set to it. If you only need customized cursors you can use this parameter instead of subclassing a connection.

Using *async*=True an asynchronous connection will be created: see *Asynchronous support* to know about advantages and limitations. *async*\_ is a valid alias for the Python version where async is a keyword.

Changed in version 2.4.3: any keyword argument is passed to the connection. Previously only the basic parameters (plus sslmode) were supported as keywords.

Changed in version 2.5: added the *cursor\_factory* parameter.

Changed in version 2.7: both *dsn* and keyword arguments can be specified.

Changed in version 2.7: added async alias.

### See also

- parse\_dsn
- libpq connection string syntax
- · libpq supported connection parameters
- libpq supported environment variables

### **1** DB API extension

The non-connection-related keyword parameters are Psycopg extensions to the DB API 2.0.

### psycopg2.apilevel

String constant stating the supported DB API level. For psycopg2 is 2.0.

### psycopg2.threadsafety

Integer constant stating the level of thread safety the interface supports. For *psycopg2* is 2, i.e. threads can share the module and the connection. See *Thread and process safety* for details.

### psycopg2.paramstyle

String constant stating the type of parameter marker formatting expected by the interface. For *psycopg2* is pyformat. See also *Passing parameters to SQL queries*.

### psycopg2.\_\_libpq\_version\_\_

Integer constant reporting the version of the libpq library this psycopg2 module was compiled with (in the same format of *server\_version*). If this value is greater or equal than 90100 then you may query the version of the actually loaded library using the *libpq\_version()* function.

# 3.1 Exceptions

In compliance with the DB API 2.0, the module makes informations about errors available through the following exceptions:

### exception psycopg2.Warning

Exception raised for important warnings like data truncations while inserting, etc. It is a subclass of the Python StandardError (Exception on Python 3).

### exception psycopg2.Error

Exception that is the base class of all other error exceptions. You can use this to catch all errors with one single except statement. Warnings are not considered errors and thus not use this class as base. It is a subclass of the Python StandardError (Exception on Python 3).

### pgerror

String representing the error message returned by the backend, None if not available.

### pgcode

String representing the error code returned by the backend, None if not available. The *errorcodes* module contains symbolic constants representing PostgreSQL error codes.

#### cursor

The cursor the exception was raised from; None if not applicable.

### diag

A *Diagnostics* object containing further information about the error.

Added in version 2.5.

### **11** DB API extension

The *pgerror*, *pgcode*, *cursor*, and *diag* attributes are Psycopg extensions.

### exception psycopg2.InterfaceError

Exception raised for errors that are related to the database interface rather than the database itself. It is a subclass of *Error*.

### exception psycopg2.DatabaseError

Exception raised for errors that are related to the database. It is a subclass of *Error*.

### exception psycopg2.DataError

Exception raised for errors that are due to problems with the processed data like division by zero, numeric value out of range, etc. It is a subclass of *DatabaseError*.

### exception psycopg2.OperationalError

Exception raised for errors that are related to the database's operation and not necessarily under the control of the programmer, e.g. an unexpected disconnect occurs, the data source name is not found, a transaction could not be processed, a memory allocation error occurred during processing, etc. It is a subclass of *DatabaseError*.

### exception psycopg2.IntegrityError

Exception raised when the relational integrity of the database is affected, e.g. a foreign key check fails. It is a subclass of *DatabaseError*.

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### exception psycopg2.InternalError

Exception raised when the database encounters an internal error, e.g. the cursor is not valid anymore, the transaction is out of sync, etc. It is a subclass of *DatabaseError*.

### exception psycopg2.ProgrammingError

Exception raised for programming errors, e.g. table not found or already exists, syntax error in the SQL statement, wrong number of parameters specified, etc. It is a subclass of *DatabaseError*.

### exception psycopg2.NotSupportedError

Exception raised in case a method or database API was used which is not supported by the database, e.g. requesting a rollback() on a connection that does not support transaction or has transactions turned off. It is a subclass of *DatabaseError*.

### **10** DB API extension

Psycopg actually raises a different exception for each SQLSTATE error returned by the database: the classes are available in the <code>psycopg2.errors</code> module. Every exception class is a subclass of one of the exception classes defined here though, so they don't need to be trapped specifically: trapping Error or DatabaseError is usually what needed to write a generic error handler; trapping a specific error such as <code>NotNullViolation</code> can be useful to write specific exception handlers.

This is the exception inheritance layout:

### StandardError

|\_\_ Warning
|\_\_ Error
|\_\_ InterfaceError
|\_\_ DatabaseError
|\_\_ DataError
|\_\_ OperationalError
|\_\_ IntegrityError
|\_ InternalError
|\_ ProgrammingError
|\_ NotSupportedError

# 3.2 Type Objects and Constructors

### 1 Note

This section is mostly copied verbatim from the DB API 2.0 specification. While these objects are exposed in compliance to the DB API, Psycopg offers very accurate tools to convert data between Python and PostgreSQL formats. See *Adapting new Python types to SQL syntax* and *Type casting of SQL types into Python objects* 

Many databases need to have the input in a particular format for binding to an operation's input parameters. For example, if an input is destined for a DATE column, then it must be bound to the database in a particular string format. Similar problems exist for "Row ID" columns or large binary items (e.g. blobs or RAW columns). This presents problems for Python since the parameters to the .execute\*() method are untyped. When the database module sees a Python string object, it doesn't know if it should be bound as a simple CHAR column, as a raw BINARY item, or as a DATE.

To overcome this problem, a module must provide the constructors defined below to create objects that can hold special values. When passed to the cursor methods, the module can then detect the proper type of the input parameter and bind

### it accordingly.

A Cursor Object's description attribute returns information about each of the result columns of a query. The type\_code must compare equal to one of Type Objects defined below. Type Objects may be equal to more than one type code (e.g. DATETIME could be equal to the type codes for date, time and timestamp columns; see the Implementation Hints below for details).

The module exports the following constructors and singletons:

### psycopg2.Date(year, month, day)

This function constructs an object holding a date value.

### psycopg2.Time(hour, minute, second)

This function constructs an object holding a time value.

### psycopg2. Timestamp(year, month, day, hour, minute, second)

This function constructs an object holding a time stamp value.

### psycopg2.DateFromTicks(ticks)

This function constructs an object holding a date value from the given ticks value (number of seconds since the epoch; see the documentation of the standard Python time module for details).

### psycopg2.TimeFromTicks(ticks)

This function constructs an object holding a time value from the given ticks value (number of seconds since the epoch; see the documentation of the standard Python time module for details).

### psycopg2.TimestampFromTicks(ticks)

This function constructs an object holding a time stamp value from the given ticks value (number of seconds since the epoch; see the documentation of the standard Python time module for details).

### psycopg2.Binary(string)

This function constructs an object capable of holding a binary (long) string value.

### **1** Note

All the adapters returned by the module level factories (Binary, Date, Time, Timestamp and the \*FromTicks variants) expose the wrapped object (a regular Python object such as datetime) in an adapted attribute.

### psycopg2.STRING

This type object is used to describe columns in a database that are string-based (e.g. CHAR).

### psycopg2.BINARY

This type object is used to describe (long) binary columns in a database (e.g. LONG, RAW, BLOBs).

### psycopg2.NUMBER

This type object is used to describe numeric columns in a database.

### psycopg2.DATETIME

This type object is used to describe date/time columns in a database.

### psycopg2.ROWID

This type object is used to describe the "Row ID" column in a database.

**CHAPTER** 

**FOUR** 

# THE CONNECTION CLASS

#### class connection

Handles the connection to a PostgreSQL database instance. It encapsulates a database session.

Connections are created using the factory function *connect()*.

Connections are thread safe and can be shared among many threads. See *Thread and process safety* for details.

Connections can be used as context managers. Note that a context wraps a transaction: if the context exits with success the transaction is committed, if it exits with an exception the transaction is rolled back. Note that the connection is not closed by the context and it can be used for several contexts.

```
conn = psycopg2.connect(DSN)
with conn:
    with conn.cursor() as curs:
        curs.execute(SQL1)
with conn:
    with conn.cursor() as curs:
        curs.execute(SQL2)
# leaving contexts doesn't close the connection
conn.close()
```

cursor(name=None, cursor\_factory=None, scrollable=None, withhold=False)

Return a new *cursor* object using the connection.

If *name* is specified, the returned cursor will be a *server side cursor* (also known as *named cursor*). Otherwise it will be a regular *client side* cursor. By default a named cursor is declared without SCROLL option and WITHOUT HOLD: set the argument or property *scrollable* to True/False and or *withhold* to True to change the declaration.

The name can be a string not valid as a PostgreSQL identifier: for example it may start with a digit and contain non-alphanumeric characters and quotes.

Changed in version 2.4: previously only valid PostgreSQL identifiers were accepted as cursor name.

The *cursor\_factory* argument can be used to create non-standard cursors. The class returned must be a subclass of *psycopg2.extensions.cursor*. See *Connection and cursor factories* for details. A default factory for the connection can also be specified using the *cursor\_factory* attribute.

Changed in version 2.4.3: added the withhold argument.

Changed in version 2.5: added the scrollable argument.

### **10** DB API extension

All the function arguments are Psycopg extensions to the DB API 2.0.

### commit()

Commit any pending transaction to the database.

By default, Psycopg opens a transaction before executing the first command: if commit() is not called, the effect of any data manipulation will be lost.

The connection can be also set in "autocommit" mode: no transaction is automatically open, commands have immediate effect. See *Transactions control* for details.

Changed in version 2.5: if the connection is used in a with statement, the method is automatically called if no exception is raised in the with block.

### rollback()

Roll back to the start of any pending transaction. Closing a connection without committing the changes first will cause an implicit rollback to be performed.

Changed in version 2.5: if the connection is used in a with statement, the method is automatically called if an exception is raised in the with block.

### close()

Close the connection now (rather than whenever del is executed). The connection will be unusable from this point forward; an *InterfaceError* will be raised if any operation is attempted with the connection. The same applies to all cursor objects trying to use the connection. Note that closing a connection without committing the changes first will cause any pending change to be discarded as if a ROLLBACK was performed (unless a different isolation level has been selected: see *set\_isolation\_level()*).

Changed in version 2.2: previously an explicit ROLLBACK was issued by Psycopg on close(). The command could have been sent to the backend at an inappropriate time, so Psycopg currently relies on the backend to implicitly discard uncommitted changes. Some middleware are known to behave incorrectly though when the connection is closed during a transaction (when *status* is *STATUS\_IN\_TRANSACTION*), e.g. PgBouncer reports an unclean server and discards the connection. To avoid this problem you can ensure to terminate the transaction with a *commit()/rollback()* before closing.

### **Exceptions as connection class attributes**

The connection also exposes as attributes the same exceptions available in the *psycopg2* module. See *Exceptions*.

### Two-phase commit support methods

Added in version 2.3.

### See also

Two-Phase Commit protocol support for an introductory explanation of these methods.

Note that PostgreSQL supports two-phase commit since release 8.1: these methods raise NotSupportedError if used with an older version server.

### xid(format\_id, gtrid, bqual)

Returns a *Xid* instance to be passed to the tpc\_\*() methods of this connection. The argument types and constraints are explained in *Two-Phase Commit protocol support*.

The values passed to the method will be available on the returned object as the members *format\_id*, *gtrid*, *bqual*. The object also allows accessing to these members and unpacking as a 3-items tuple.

### tpc\_begin(xid)

Begins a TPC transaction with the given transaction ID xid.

This method should be called outside of a transaction (i.e. nothing may have executed since the last *commit()* or *rollback()* and *connection.status* is *STATUS\_READY*).

Furthermore, it is an error to call commit() or rollback() within the TPC transaction: in this case a *ProgrammingError* is raised.

The xid may be either an object returned by the xid() method or a plain string: the latter allows to create a transaction using the provided string as PostgreSQL transaction id. See also  $tpc\_recover$ ().

### tpc\_prepare()

Performs the first phase of a transaction started with  $tpc\_begin()$ . A ProgrammingError is raised if this method is used outside of a TPC transaction.

After calling tpc\_prepare(), no statements can be executed until tpc\_commit() or tpc\_rollback() will be called. The reset() method can be used to restore the status of the connection to STATUS\_READY: the transaction will remain prepared in the database and will be possible to finish it with tpc\_commit(xid) and tpc\_rollback(xid).



the PREPARE TRANSACTION PostgreSQL command.

# tpc\_commit([xid])

When called with no arguments, tpc\_commit() commits a TPC transaction previously prepared with tpc\_prepare().

If tpc\_commit() is called prior to tpc\_prepare(), a single phase commit is performed. A transaction manager may choose to do this if only a single resource is participating in the global transaction.

When called with a transaction ID *xid*, the database commits the given transaction. If an invalid transaction ID is provided, a *ProgrammingError* will be raised. This form should be called outside of a transaction, and is intended for use in recovery.

On return, the TPC transaction is ended.



the COMMIT PREPARED PostgreSQL command.

# tpc\_rollback([xid])

When called with no arguments, tpc\_rollback() rolls back a TPC transaction. It may be called before or after tpc\_prepare().

When called with a transaction ID *xid*, it rolls back the given transaction. If an invalid transaction ID is provided, a *ProgrammingError* is raised. This form should be called outside of a transaction, and is intended for use in recovery.

On return, the TPC transaction is ended.



the ROLLBACK PREPARED PostgreSQL command.

### tpc\_recover()

Returns a list of *Xid* representing pending transactions, suitable for use with *tpc\_commit()* or *tpc\_rollback()*.

If a transaction was not initiated by Psycopg, the returned Xids will have attributes *format\_id* and *bqual* set to None and the *gtrid* set to the PostgreSQL transaction ID: such Xids are still usable for recovery. Psycopg uses the same algorithm of the PostgreSQL JDBC driver to encode a XA triple in a string, so transactions initiated by a program using such driver should be unpacked correctly.

Xids returned by tpc\_recover() also have extra attributes *prepared*, *owner*, *database* populated with the values read from the server.



the pg\_prepared\_xacts system view.

### **1** DB API extension

The above methods are the only ones defined by the DB API 2.0 protocol. The Psycopg connection objects exports the following additional methods and attributes.

### closed

Read-only integer attribute: 0 if the connection is open, nonzero if it is closed or broken.

### cancel()

Cancel the current database operation.

The method interrupts the processing of the current operation. If no query is being executed, it does nothing. You can call this function from a different thread than the one currently executing a database operation, for instance if you want to cancel a long running query if a button is pushed in the UI. Interrupting query execution will cause the cancelled method to raise a <code>QueryCanceledError</code>. Note that the termination of the query is not guaranteed to succeed: see the documentation for <code>PQcancel()</code>.

Added in version 2.3.

### reset()

Reset the connection to the default.

The method rolls back an eventual pending transaction and executes the PostgreSQL RESET and SET SESSION AUTHORIZATION to revert the session to the default values. A two-phase commit transaction prepared using  $tpc\_prepare()$  will remain in the database available for recover.

Added in version 2.0.12.

### dsn

Read-only string containing the connection string used by the connection.

If a password was specified in the connection string it will be obscured.

#### Transaction control methods and attributes.

**set\_session**(*isolation\_level=None*, *readonly=None*, *deferrable=None*, *autocommit=None*)

Set one or more parameters for the next transactions or statements in the current session.

#### **Parameters**

- **isolation\_level** set the isolation level for the next transactions/statements. The value can be one of the literal values READ UNCOMMITTED, READ COMMITTED, REPEATABLE READ, SERIALIZABLE or the equivalent *constant* defined in the *extensions* module.
- **readonly** if True, set the connection to read only; read/write if False.
- **deferrable** if True, set the connection to deferrable; non deferrable if False. Only available from PostgreSQL 9.1.
- **autocommit** switch the connection to autocommit mode: not a PostgreSQL session setting but an alias for setting the *autocommit* attribute.

Arguments set to None (the default for all) will not be changed. The parameters *isolation\_level*, *readonly* and *deferrable* also accept the string DEFAULT as a value: the effect is to reset the parameter to the server default. Defaults are defined by the server configuration: see values for default\_transaction\_isolation, default\_transaction\_read\_only, default\_transaction\_deferrable.

The function must be invoked with no transaction in progress.



SET TRANSACTION for further details about the behaviour of the transaction parameters in the server.

#### Added in version 2.4.2.

Changed in version 2.7: Before this version, the function would have set default\_transaction\_\* attribute in the current session; this implementation has the problem of not playing well with external connection pooling working at transaction level and not resetting the state of the session: changing the default transaction would pollute the connections in the pool and create problems to other applications using the same pool.

Starting from 2.7, if the connection is not autocommit, the transaction characteristics are issued together with BEGIN and will leave the default\_transaction\_\* settings untouched. For example:

```
conn.set_session(readonly=True)
```

will not change default\_transaction\_read\_only, but following transaction will start with a BEGIN READ ONLY. Conversely, using:

```
conn.set_session(readonly=True, autocommit=True)
```

will set default\_transaction\_read\_only to on and rely on the server to apply the read only state to whatever transaction, implicit or explicit, is executed in the connection.

#### autocommit

Read/write attribute: if True, no transaction is handled by the driver and every statement sent to the backend has immediate effect; if False a new transaction is started at the first command execution: the methods <code>commit()</code> or <code>rollback()</code> must be manually invoked to terminate the transaction.

The autocommit mode is useful to execute commands requiring to be run outside a transaction, such as CREATE DATABASE or VACUUM.

The default is False (manual commit) as per DBAPI specification.

#### Warning

By default, any query execution, including a simple SELECT will start a transaction: for long-running programs, if no further action is taken, the session will remain "idle in transaction", an undesirable condition for several reasons (locks are held by the session, tables bloat...). For long lived scripts, either ensure to terminate a transaction as soon as possible or use an autocommit connection.

Added in version 2.4.2.

#### isolation\_level

Return or set the transaction isolation level for the current session. The value is one of the Isolation level constants defined in the psycopg2. extensions module. On set it is also possible to use one of the literal values READ UNCOMMITTED, READ COMMITTED, REPEATABLE READ, SERIALIZABLE, DEFAULT.

Changed in version 2.7: the property is writable.

Changed in version 2.7: the default value for isolation\_level is ISOLATION\_LEVEL\_DEFAULT; previously the property would have queried the server and returned the real value applied. To know this value you can run a query such as show transaction\_isolation. Usually the default value is READ COMMITTED, but this may be changed in the server configuration.

This value is now entirely separate from the autocommit property: in previous version, if autocommit was set to True this property would have returned ISOLATION\_LEVEL\_AUTOCOMMIT; it will now return the server isolation level.

#### readonly

Return or set the read-only status for the current session. Available values are True (new transactions will be in read-only mode), False (new transactions will be writable), None (use the default configured for the server by default\_transaction\_read\_only).

Added in version 2.7.

#### deferrable

Return or set the deferrable status for the current session. Available values are True (new transactions will be in deferrable mode), False (new transactions will be in non deferrable mode), None (use the default configured for the server by default\_transaction\_deferrable).

Added in version 2.7.

#### set\_isolation\_level(level)



#### On the second of the second

This is a legacy method mixing isolation\_level and autocommit. Using the respective properties is a better option.

Set the transaction isolation level for the current session. The level defines the different phenomena that can happen in the database between concurrent transactions.

The value set is an integer: symbolic constants are defined in the module psycopg2.extensions: see Isolation level constants for the available values.

The default level is *ISOLATION\_LEVEL\_DEFAULT*: at this level a transaction is automatically started the first time a database command is executed. If you want an *autocommit* mode, switch to *ISOLATION\_LEVEL\_AUTOCOMMIT* before executing any command:

```
>>> conn.set_isolation_level(psycopg2.extensions.ISOLATION_LEVEL_AUTOCOMMIT)
```

See also *Transactions control*.

#### encoding

### set\_client\_encoding(enc)

Read or set the client encoding for the current session. The default is the encoding defined by the database. It should be one of the characters set supported by PostgreSQL

#### notices

A list containing all the database messages sent to the client during the session.

Changed in version 2.7: The notices attribute is writable: the user may replace it with any Python object exposing an append() method. If appending raises an exception the notice is silently dropped.

To avoid a leak in case excessive notices are generated, only the last 50 messages are kept. This check is only in place if the notices attribute is a list: if any other object is used it will be up to the user to guard from leakage.

You can configure what messages to receive using PostgreSQL logging configuration parameters such as log\_statement, client\_min\_messages, log\_min\_duration\_statement etc.

#### notifies

List of *Notify* objects containing asynchronous notifications received by the session.

For other details see Asynchronous notifications.

Changed in version 2.3: Notifications are instances of the Notify object. Previously the list was composed by 2 items tuples (*pid*, *channel*) and the payload was not accessible. To keep backward compatibility, Notify objects can still be accessed as 2 items tuples.

Changed in version 2.7: The notifies attribute is writable: the user may replace it with any Python object exposing an append() method. If appending raises an exception the notification is silently dropped.

#### cursor\_factory

The default cursor factory used by *cursor()* if the parameter is not specified.

Added in version 2.5.

#### info

A ConnectionInfo object exposing information about the native libpq connection.

Added in version 2.8.

#### status

A read-only integer representing the status of the connection. Symbolic constants for the values are defined in the module <code>psycopg2.extensions</code>: see *Connection status constants* for the available values.

The status is undefined for closed connections.

lobject([oid[, mode[, new\_oid[, new\_file[, lobject\_factory]]]]])

Return a new database large object as a lobject instance.

See Access to PostgreSQL large objects for an overview.

#### **Parameters**

- oid The OID of the object to read or write. 0 to create a new large object and and have its OID assigned automatically.
- mode Access mode to the object, see below.
- **new\_oid** Create a new object using the specified OID. The function raises *OperationalError* if the OID is already in use. Default is 0, meaning assign a new one automatically.
- **new\_file** The name of a file to be imported in the database (using the lo\_import() function)
- **lobject\_factory** Subclass of *lobject* to be instantiated.

Available values for mode are:

| mode | meaning  |
|------|--|
| r    | Open for read only   |
| W    | Open for write only  |
| rw   | Open for read/write  |
| n    | Don't open the file  |
| b    | Don't decode read data (return data as str in Python 2 or bytes in Python 3)                                     |
| t    | Decode read data according to <i>connection.encoding</i> (return data as unicode in Python 2 or str in Python 3) |

b and t can be specified together with a read/write mode. If neither b nor t is specified, the default is b in Python 2 and t in Python 3.

Added in version 2.0.8.

Changed in version 2.4: added b and t mode and unicode support.

#### Methods related to asynchronous support

Added in version 2.2.



Asynchronous support and Support for coroutine libraries.

#### async

#### async\_

Read only attribute: 1 if the connection is asynchronous, 0 otherwise.

Changed in version 2.7: added the async\_ alias for Python versions where async is a keyword.

#### poll()

Used during an asynchronous connection attempt, or when a cursor is executing a query on an asynchronous connection, make communication proceed if it wouldn't block.

Return one of the constants defined in *Poll constants*. If it returns *POLL\_OK* then the connection has been established or the query results are available on the client. Otherwise wait until the file descriptor returned by *fileno()* is ready to read or to write, as explained in *Asynchronous support*. *poll()* should be also used by the function installed by *set\_wait\_callback()* as explained in *Support for coroutine libraries*.

pol1() is also used to receive asynchronous notifications from the database: see Asynchronous notifications from further details.

#### fileno()

Return the file descriptor underlying the connection: useful to read its status during asynchronous communication.

#### isexecuting()

Return True if the connection is executing an asynchronous operation.

#### Interoperation with other C API modules

#### pgconn\_ptr

Return the internal PGconn\* as integer. Useful to pass the libpq raw connection structure to C functions, e.g. via ctypes:

```
>>> import ctypes
>>> import ctypes.util
>>> libpq = ctypes.pydll.LoadLibrary(ctypes.util.find_library('pq'))
>>> libpq.PQserverVersion.argtypes = [ctypes.c_void_p]
>>> libpq.PQserverVersion.restype = ctypes.c_int
>>> libpq.PQserverVersion(conn.pgconn_ptr)
90611
```

Added in version 2.8.

#### get\_native\_connection()

Return the internal PGconn\* wrapped in a PyCapsule object. This is only useful for passing the libpq raw connection associated to this connection object to other C-level modules that may have a use for it.

```
Python C API Capsules docs.
```

Added in version 2.8.

#### informative methods of the native connection



#### Note

These methods are better accessed using the *info* attributes and may be dropped in future versions.

#### get\_transaction\_status()

Also available as info.transaction\_status.

Return the current session transaction status as an integer. Symbolic constants for the values are defined in the module psycopg2.extensions: see Transaction status constants for the available values.



#### See also

libpq docs for PQtransactionStatus() for details.

#### protocol\_version

Also available as info.protocol\_version.

A read-only integer representing frontend/backend protocol being used. Currently Psycopg supports only protocol 3, which allows connection to PostgreSQL server from version 7.4. Psycopg versions previous than 2.3 support both protocols 2 and 3.



#### See also

libpq docs for PQprotocolVersion() for details.

Added in version 2.0.12.

#### server version

Also available as info. server version.

A read-only integer representing the backend version.

The number is formed by converting the major, minor, and revision numbers into two-decimal-digit numbers and appending them together. For example, version 8.1.5 will be returned as 80105.



### See also

libpq docs for PQserverVersion() for details.

Added in version 2.0.12.

#### get\_backend\_pid()

Also available as info.backend\_pid.

Returns the process ID (PID) of the backend server process you connected to. Note that if you use a connection pool service such as PgBouncer this value will not be updated if your connection is switched to a different backend.

Note that the PID belongs to a process executing on the database server host, not the local host!

#### See also

libpq docs for PQbackendPID() for details.

Added in version 2.0.8.

#### get\_parameter\_status(parameter)

Also available as info.parameter\_status().

Look up a current parameter setting of the server.

Potential values for parameter are: server\_version, server\_encoding, client\_encoding, is\_superuser, session\_authorization, DateStyle, TimeZone, integer\_datetimes, and standard\_conforming\_strings.

If server did not report requested parameter, return None.

#### See also

libpq docs for PQparameterStatus() for details.

Added in version 2.0.12.

#### get\_dsn\_parameters()

Also available as info.dsn\_parameters.

Get the effective dsn parameters for the connection as a dictionary.

The *password* parameter is removed from the result.

Example:

```
>>> conn.get_dsn_parameters()
{'dbname': 'test', 'user': 'postgres', 'port': '5432', 'sslmode': 'prefer'}
```

Requires libpq >= 9.3.

#### **♂** See also

libpq docs for PQconninfo() for details.

Added in version 2.7.

**CHAPTER** 

**FIVE** 

### THE CURSOR CLASS

#### class cursor

Allows Python code to execute PostgreSQL command in a database session. Cursors are created by the *connection.cursor()* method: they are bound to the connection for the entire lifetime and all the commands are executed in the context of the database session wrapped by the connection.

Cursors created from the same connection are not isolated, i.e., any changes done to the database by a cursor are immediately visible by the other cursors. Cursors created from different connections can or can not be isolated, depending on the connections' *isolation level*. See also *rollback()* and *commit()* methods.

Cursors are *not* thread safe: a multithread application can create many cursors from the same connection and should use each cursor from a single thread. See *Thread and process safety* for details.

Cursors can be used as context managers: leaving the context will close the cursor.

```
with conn.cursor() as curs:
    curs.execute(SQL)
# the cursor is now closed
```

#### description

Read-only attribute describing the result of a query. It is a sequence of *Column* instances, each one describing one result column in order. The attribute is None for operations that do not return rows or if the cursor has not had an operation invoked via the *execute*\*() methods yet.

For compatibility with the DB-API, every object can be unpacked as a 7-items sequence: the attributes retuned this way are the following. For further details and other attributes available check the *Column* documentation.

- 0. name: the name of the column returned.
- 1. type\_code: the PostgreSQL OID of the column.
- 2. *display\_size*: the actual length of the column in bytes.
- 3. internal\_size: the size in bytes of the column associated to this column on the server.
- 4. precision: total number of significant digits in columns of type NUMERIC. None for other types.
- 5. scale: count of decimal digits in the fractional part in columns of type NUMERIC. None for other types.
- 6. *null\_ok*: always None as not easy to retrieve from the libpq.

Changed in version 2.4: if possible, columns descriptions are named tuple instead of regular tuples.

Changed in version 2.8: columns descriptions are instances of Column, exposing extra attributes.

#### close()

Close the cursor now (rather than whenever del is executed). The cursor will be unusable from this point forward; an *InterfaceError* will be raised if any operation is attempted with the cursor.

Changed in version 2.5: if the cursor is used in a with statement, the method is automatically called at the end of the with block.

#### closed

Read-only boolean attribute: specifies if the cursor is closed (True) or not (False).

#### 1 DB API extension

The *closed* attribute is a Psycopg extension to the DB API 2.0.

Added in version 2.0.7.

#### connection

Read-only attribute returning a reference to the *connection* object on which the cursor was created.

#### name

Read-only attribute containing the name of the cursor if it was created as named cursor by *connection*. *cursor()*, or None if it is a client side cursor. See *Server side cursors*.

#### **1** DB API extension

The *name* attribute is a Psycopg extension to the DB API 2.0.

#### scrollable

Read/write attribute: specifies if a named cursor is declared SCROLL, hence is capable to scroll backwards (using *scrol1()*). If True, the cursor can be scrolled backwards, if False it is never scrollable. If None (default) the cursor scroll option is not specified, usually but not always meaning no backward scroll (see the DECLARE notes).

#### 1 Note

set the value before calling <code>execute()</code> or use the <code>connection.cursor()</code> <code>scrollable</code> parameter, otherwise the value will have no effect.

Added in version 2.5.

#### **1** DB API extension

The *scrollable* attribute is a Psycopg extension to the DB API 2.0.

#### withhold

Read/write attribute: specifies if a named cursor lifetime should extend outside of the current transaction, i.e., it is possible to fetch from the cursor even after a *connection.commit()* (but not after a *connection.rollback()*). See *Server side cursors* 

#### 1 Note

set the value before calling <code>execute()</code> or use the <code>connection.cursor()</code> withhold parameter, otherwise the value will have no effect.

Added in version 2.4.3.

#### **1** DB API extension

The withhold attribute is a Psycopg extension to the DB API 2.0.

#### Commands execution methods

#### execute(query, vars=None)

Execute a database operation (query or command).

Parameters may be provided as sequence or mapping and will be bound to variables in the operation. Variables are specified either with positional (%s) or named (%(name)s) placeholders. See *Passing parameters to SQL queries*.

The method returns None. If a query was executed, the returned values can be retrieved using fetch\*() methods.

#### executemany(query, vars\_list)

Execute a database operation (query or command) against all parameter tuples or mappings found in the sequence *vars\_list*.

The function is mostly useful for commands that update the database: any result set returned by the query is discarded.

Parameters are bounded to the query using the same rules described in the execute() method.

```
>>> nums = ((1,), (5,), (10,))
>>> cur.executemany("INSERT INTO test (num) VALUES (%s)", nums)
>>> tuples = ((123, "foo"), (42, "bar"), (23, "baz"))
>>> cur.executemany("INSERT INTO test (num, data) VALUES (%s, %s)", tuples)
```

#### **A** Warning

In its current implementation this method is not faster than executing <code>execute()</code> in a loop. For better performance you can use the functions described in *Fast execution helpers*.

### callproc(procname[, parameters])

Call a stored database procedure with the given name. The sequence of parameters must contain one entry for each argument that the procedure expects. Overloaded procedures are supported. Named parameters can be used by supplying the parameters as a dictionary.

This function is, at present, not DBAPI-compliant. The return value is supposed to consist of the sequence of parameters with modified output and input/output parameters. In future versions, the DBAPI-compliant return value may be implemented, but for now the function returns None.

The procedure may provide a result set as output. This is then made available through the standard  $fetch^*()$  methods.

Changed in version 2.7: added support for named arguments.

#### 1 Note

callproc() can only be used with PostgreSQL functions, not with the procedures introduced in PostgreSQL 11, which require the CALL statement to run. Please use a normal <code>execute()</code> to run them.

### mogrify(operation[, parameters])

Return a query string after arguments binding. The string returned is exactly the one that would be sent to the database running the <code>execute()</code> method or similar.

The returned string is always a bytes string.

```
>>> cur.mogrify("INSERT INTO test (num, data) VALUES (%s, %s)", (42, 'bar'))
"INSERT INTO test (num, data) VALUES (42, E'bar')"
```

#### **1** DB API extension

The mogrify() method is a Psycopg extension to the DB API 2.0.

#### setinputsizes(sizes)

This method is exposed in compliance with the DB API 2.0. It currently does nothing but it is safe to call it

#### Results retrieval methods

The following methods are used to read data from the database after an execute() call.

#### 1 Note

*cursor* objects are iterable, so, instead of calling explicitly *fetchone()* in a loop, the object itself can be used:

```
>>> cur.execute("SELECT * FROM test;")
>>> for record in cur:
... print(record)
...
(1, 100, "abc'def")
(2, None, 'dada')
(3, 42, 'bar')
```

Changed in version 2.4: iterating over a *named cursor* fetches *itersize* records at time from the backend. Previously only one record was fetched per roundtrip, resulting in a large overhead.

#### fetchone()

Fetch the next row of a query result set, returning a single tuple, or None when no more data is available:

```
>>> cur.execute("SELECT * FROM test WHERE id = %s", (3,))
>>> cur.fetchone()
(3, 42, 'bar')
```

A *ProgrammingError* is raised if the previous call to *execute\*()* did not produce any result set or no call was issued yet.

### **fetchmany**([size=cursor.arraysize])

Fetch the next set of rows of a query result, returning a list of tuples. An empty list is returned when no more rows are available.

The number of rows to fetch per call is specified by the parameter. If it is not given, the cursor's *arraysize* determines the number of rows to be fetched. The method should try to fetch as many rows as indicated by the size parameter. If this is not possible due to the specified number of rows not being available, fewer rows may be returned:

```
>>> cur.execute("SELECT * FROM test;")
>>> cur.fetchmany(2)
[(1, 100, "abc'def"), (2, None, 'dada')]
>>> cur.fetchmany(2)
[(3, 42, 'bar')]
>>> cur.fetchmany(2)
[]
```

A *ProgrammingError* is raised if the previous call to *execute\*()* did not produce any result set or no call was issued yet.

Note there are performance considerations involved with the size parameter. For optimal performance, it is usually best to use the *arraysize* attribute. If the size parameter is used, then it is best for it to retain the same value from one *fetchmany()* call to the next.

#### fetchall()

Fetch all (remaining) rows of a query result, returning them as a list of tuples. An empty list is returned if there is no more record to fetch.

```
>>> cur.execute("SELECT * FROM test;")
>>> cur.fetchall()
[(1, 100, "abc'def"), (2, None, 'dada'), (3, 42, 'bar')]
```

A *ProgrammingError* is raised if the previous call to *execute\*()* did not produce any result set or no call was issued yet.

```
scroll(value[, mode='relative'])
```

Scroll the cursor in the result set to a new position according to mode.

If mode is relative (default), value is taken as offset to the current position in the result set, if set to absolute, value states an absolute target position.

If the scroll operation would leave the result set, a *ProgrammingError* is raised and the cursor position is not changed.

#### 1 Note

According to the DB API 2.0, the exception raised for a cursor out of bound should have been IndexError. The best option is probably to catch both exceptions in your code:

```
try:
    cur.scroll(1000 * 1000)
except (ProgrammingError, IndexError), exc:
    deal_with_it(exc)
```

The method can be used both for client-side cursors and *server-side cursors*. Server-side cursors can usually scroll backwards only if declared *scrollable*. Moving out-of-bound in a server-side cursor doesn't result in an exception, if the backend doesn't raise any (Postgres doesn't tell us in a reliable way if we went out of bound).

#### arraysize

This read/write attribute specifies the number of rows to fetch at a time with *fetchmany()*. It defaults to 1 meaning to fetch a single row at a time.

#### itersize

Read/write attribute specifying the number of rows to fetch from the backend at each network roundtrip during *iteration* on a *named cursor*. The default is 2000.

Added in version 2.4.

#### **1** DB API extension

The *itersize* attribute is a Psycopg extension to the DB API 2.0.

#### rowcount

This read-only attribute specifies the number of rows that the last <code>execute\*()</code> produced (for DQL (Data Query Language) statements like SELECT) or affected (for DML (Data Manipulation Language) statements like UPDATE or INSERT).

The attribute is -1 in case no execute\*() has been performed on the cursor or the row count of the last operation if it can't be determined by the interface.



The DB API 2.0 interface reserves to redefine the latter case to have the object return None instead of -1 in future versions of the specification.

#### rownumber

This read-only attribute provides the current 0-based index of the cursor in the result set or None if the index cannot be determined.

The index can be seen as index of the cursor in a sequence (the result set). The next fetch operation will fetch the row indexed by *rownumber* in that sequence.

#### lastrowid

This read-only attribute provides the OID of the last row inserted by the cursor. If the table wasn't created with OID support or the last operation is not a single record insert, the attribute is set to None.



PostgreSQL currently advices to not create OIDs on the tables and the default for CREATE TABLE is to not support them. The INSERT ... RETURNING syntax available from PostgreSQL 8.3 allows more flexibility.

#### query

Read-only attribute containing the body of the last query sent to the backend (including bound arguments) as bytes string. None if no query has been executed yet:

```
>>> cur.execute("INSERT INTO test (num, data) VALUES (%s, %s)", (42, 'bar'))
>>> cur.query
"INSERT INTO test (num, data) VALUES (42, E'bar')"
```

### **1** DB API extension

The *query* attribute is a Psycopg extension to the DB API 2.0.

#### statusmessage

Read-only attribute containing the message returned by the last command:

```
>>> cur.execute("INSERT INTO test (num, data) VALUES (%s, %s)", (42, 'bar'))
>>> cur.statusmessage
'INSERT 0 1'
```

#### **1** DB API extension

The *statusmessage* attribute is a Psycopg extension to the DB API 2.0.

### cast(oid, s)

Convert a value from the PostgreSQL string representation to a Python object.

Use the most specific of the typecasters registered by register\_type().

Added in version 2.4.

#### **1** DB API extension

The *cast()* method is a Psycopg extension to the DB API 2.0.

### tzinfo\_factory

The time zone factory used to handle data types such as TIMESTAMP WITH TIME ZONE. It should be a tzinfo object. Default is datetime.timezone.

Changed in version 2.9: previously the default factory was psycopg2.tz.FixedOffsetTimezone.

#### nextset()

This method is not supported (PostgreSQL does not have multiple data sets) and will raise a NotSupportedError exception.

#### setoutputsize(size | , column | )

This method is exposed in compliance with the DB API 2.0. It currently does nothing but it is safe to call it.

#### **COPY-related methods**

Efficiently copy data from file-like objects to the database and back. See *Using COPY TO and COPY FROM* for an overview.

#### 1 DB API extension

The COPY command is a PostgreSQL extension to the SQL standard. As such, its support is a Psycopg extension to the DB API 2.0.

 $copy_from(file, table, sep=\t', null=\t', size=8192, columns=None)$ 

Read data *from* the file-like object *file* appending them to the table named *table*.

#### **Parameters**

- **file** file-like object to read data from. It must have both read() and readline() methods.
- table name of the table to copy data into.
- sep columns separator expected in the file. Defaults to a tab.
- **null** textual representation of NULL in the file. The default is the two characters string \N.
- **size** size of the buffer used to read from the file.
- **columns** iterable with name of the columns to import. The length and types should match the content of the file to read. If not specified, it is assumed that the entire table matches the file structure.

#### Example:

```
>>> f = StringIO("42\tfoo\n74\tbar\n")
>>> cur.copy_from(f, 'test', columns=('num', 'data'))
>>> cur.execute("select * from test where id > 5;")
>>> cur.fetchall()
[(6, 42, 'foo'), (7, 74, 'bar')]
```

Changed in version 2.0.6: added the *columns* parameter.

Changed in version 2.4: data read from files implementing the io.TextIOBase interface are encoded in the connection *encoding* when sent to the backend.

Changed in version 2.9: the table and fields names are now quoted. If you need to specify a schema-qualified table please use *copy\_expert()*.

```
copy_to(file, table, sep=\\t', null=\\\\\\\\\\', columns=None)
```

Write the content of the table named *table to* the file-like object *file*. See *Using COPY TO and COPY FROM* for an overview.

#### **Parameters**

- **file** file-like object to write data into. It must have a write() method.
- **table** name of the table to copy data from.
- **sep** columns separator expected in the file. Defaults to a tab.
- **null** textual representation of NULL in the file. The default is the two characters string \N.

• **columns** – iterable with name of the columns to export. If not specified, export all the columns.

#### Example:

```
>>> cur.copy_to(sys.stdout, 'test', sep="|")
1|100|abc'def
2|\N|dada
...
```

Changed in version 2.0.6: added the *columns* parameter.

Changed in version 2.4: data sent to files implementing the io.TextIOBase interface are decoded in the connection *encoding* when read from the backend.

Changed in version 2.9: the table and fields names are now quoted. If you need to specify a schema-qualified table please use *copy\_expert()*.

```
copy_expert(sql, file, size=8192)
```

Submit a user-composed COPY statement. The method is useful to handle all the parameters that PostgreSQL makes available (see COPY command documentation).

#### **Parameters**

- **sql** the COPY statement to execute.
- **file** a file-like object to read or write (according to *sql*).
- size size of the read buffer to be used in COPY FROM.

The sql statement should be in the form COPY table TO STDOUT to export table to the file object passed as argument or COPY table FROM STDIN to import the content of the file object into table. If you need to compose a COPY statement dynamically (because table, fields, or query parameters are in Python variables) you may use the objects provided by the psycopg2.sq1 module.

*file* must be a readable file-like object (as required by  $copy\_from()$ ) for sql statement COPY ... FROM STDIN or a writable one (as required by  $copy\_to()$ ) for COPY ... TO STDOUT.

#### Example:

```
>>> cur.copy_expert("COPY test TO STDOUT WITH CSV HEADER", sys.stdout)
id,num,data
1,100,abc'def
2,,dada
...
```

Added in version 2.0.6.

Changed in version 2.4: files implementing the io.TextIOBase interface are dealt with using Unicode data instead of bytes.

### Interoperation with other C API modules

### pgresult\_ptr

Return the cursor's internal PGresult\* as integer. Useful to pass the libpq raw result structure to C functions, e.g. via ctypes:

```
>>> import ctypes
>>> libpq = ctypes.pydll.LoadLibrary(ctypes.util.find_library('pq'))
>>> libpq.PQcmdStatus.argtypes = [ctypes.c_void_p]
>>> libpq.PQcmdStatus.restype = ctypes.c_char_p

>>> curs.execute("select 'x'")
>>> libpq.PQcmdStatus(curs.pgresult_ptr)
b'SELECT 1'
```

Added in version 2.8.

### MORE ADVANCED TOPICS

### 6.1 Connection and cursor factories

Psycopg exposes two new-style classes that can be sub-classed and expanded to adapt them to the needs of the programmer: <code>psycopg2.extensions.cursor</code> and <code>psycopg2.extensions.connection</code>. The <code>connection</code> class is usually sub-classed only to provide an easy way to create customized cursors but other uses are possible. <code>cursor</code> is much more interesting, because it is the class where query building, execution and result type-casting into Python variables happens.

The extras module contains several examples of connection and cursor subclasses.

#### 1 Note

If you only need a customized cursor class, since Psycopg 2.5 you can use the *cursor\_factory* parameter of a regular connection instead of creating a new connection subclass.

An example of cursor subclass performing logging is:

```
import psycopg2
import psycopg2.extensions
import logging
class LoggingCursor(psycopg2.extensions.cursor):
    def execute(self, sql, args=None):
        logger = logging.getLogger('sql_debug')
        logger.info(self.mogrify(sql, args))
        try:
            psycopg2.extensions.cursor.execute(self, sql, args)
        except Exception, exc:
            logger.error("%s: %s" % (exc.__class__.__name__, exc))
            raise
conn = psycopg2.connect(DSN)
cur = conn.cursor(cursor_factory=LoggingCursor)
cur.execute("INSERT INTO mytable VALUES (%s, %s, %s);",
             (10, 20, 30))
```

### 6.2 Adapting new Python types to SQL syntax

Any Python class or type can be adapted to an SQL string. Adaptation mechanism is similar to the Object Adaptation proposed in the PEP 246 and is exposed by the <code>psycopg2.extensions.adapt()</code> function.

The *execute()* method adapts its arguments to the *ISQLQuote* protocol. Objects that conform to this protocol expose a *getquoted()* method returning the SQL representation of the object as a string (the method must return bytes in Python 3). Optionally the conform object may expose a *prepare()* method.

There are two basic ways to have a Python object adapted to SQL:

- the object itself is conform, or knows how to make itself conform. Such object must expose a \_\_conform\_\_() method that will be called with the protocol object as argument. The object can check that the protocol is ISQLQuote, in which case it can return self (if the object also implements getquoted()) or a suitable wrapper object. This option is viable if you are the author of the object and if the object is specifically designed for the database (i.e. having Psycopg as a dependency and polluting its interface with the required methods doesn't bother you). For a simple example you can take a look at the source code for the psycopg2.extras.Inet object.
- If implementing the ISQLQuote interface directly in the object is not an option (maybe because the object to adapt comes from a third party library), you can use an *adaptation function*, taking the object to be adapted as argument and returning a conforming object. The adapter must be registered via the <code>register\_adapter()</code> function. A simple example wrapper is <code>psycopg2.extras.UUID\_adapter</code> used by the <code>register\_uuid()</code> function.

A convenient object to write adapters is the *AsIs* wrapper, whose getquoted() result is simply the str()ing conversion of the wrapped object.

Example: mapping of a Point class into the point PostgreSQL geometric type:

The above function call results in the SQL command:

```
INSERT INTO atable (apoint) VALUES ('(1.23, 4.56)');
```

## 6.3 Type casting of SQL types into Python objects

PostgreSQL objects read from the database can be adapted to Python objects through an user-defined adapting function. An adapter function takes two arguments: the object string representation as returned by PostgreSQL and the cursor currently being read, and should return a new Python object. For example, the following function parses the PostgreSQL point representation into the previously defined Point class:

```
>>> def cast_point(value, cur):
...     if value is None:
...         return None
...
...     # Convert from (f1, f2) syntax using a regular expression.
...     m = re.match(r"\(([^\)]+),([^\)]+)\)", value)
...     if m:
...         return Point(float(m.group(1)), float(m.group(2)))
...     else:
...         raise InterfaceError("bad point representation: %r" % value)
```

In order to create a mapping from a PostgreSQL type (either standard or user-defined), its OID must be known. It can be retrieved either by the second column of the *cursor.description*:

```
>>> cur.execute("SELECT NULL::point")
>>> point_oid = cur.description[0][1]
>>> point_oid
600
```

or by querying the system catalog for the type name and namespace (the namespace for system objects is pg\_catalog):

```
>>> cur.execute("""
... SELECT pg_type.oid
... FROM pg_type JOIN pg_namespace
... ON typnamespace = pg_namespace.oid
... WHERE typname = %(typename)s
... AND nspname = %(namespace)s""",
... {'typename': 'point', 'namespace': 'pg_catalog'})
>>> point_oid = cur.fetchone()[0]
>>> point_oid
600
```

After you know the object OID, you can create and register the new type:

```
>>> POINT = psycopg2.extensions.new_type((point_oid,), "POINT", cast_point)
>>> psycopg2.extensions.register_type(POINT)
```

The <code>new\_type()</code> function binds the object OIDs (more than one can be specified) to the adapter function. <code>register\_type()</code> completes the spell. Conversion is automatically performed when a column whose type is a registered OID is read:

```
>>> cur.execute("SELECT '(10.2,20.3)'::point")
>>> point = cur.fetchone()[0]
>>> print(type(point), point.x, point.y)
<class 'Point'> 10.2 20.3
```

A typecaster created by new\_type() can be also used with new\_array\_type() to create a typecaster converting a PostgreSQL array into a Python list.

### 6.4 Asynchronous notifications

Psycopg allows asynchronous interaction with other database sessions using the facilities offered by PostgreSQL commands LISTEN and NOTIFY. Please refer to the PostgreSQL documentation for examples about how to use this form of communication.

Notifications are instances of the *Notify* object made available upon reception in the *connection.notifies* list. Notifications can be sent from Python code simply executing a NOTIFY command in an *execute()* call.

Because of the way sessions interact with notifications (see NOTIFY documentation), you should keep the connection in *autocommit* mode if you wish to receive or send notifications in a timely manner.

Notifications are received after every query execution. If the user is interested in receiving notifications but not in performing any query, the *poll()* method can be used to check for new messages without wasting resources.

A simple application could poll the connection from time to time to check if something new has arrived. A better strategy is to use some I/O completion function such as select() to sleep until awakened by the kernel when there is some data to read on the connection, thereby using no CPU unless there is something to read:

```
import select
import psycopg2
import psycopg2.extensions
conn = psycopg2.connect(DSN)
conn.set_isolation_level(psycopg2.extensions.ISOLATION_LEVEL_AUTOCOMMIT)
curs = conn.cursor()
curs.execute("LISTEN test;")
print("Waiting for notifications on channel 'test'")
while True:
    if select.select([conn],[],[],5) == ([],[],[]):
        print("Timeout")
    else:
        conn.poll()
        while conn.notifies:
            notify = conn.notifies.pop(0)
            print("Got NOTIFY:", notify.pid, notify.channel, notify.payload)
```

Running the script and executing a command such as NOTIFY test, 'hello' in a separate **psql** shell, the output may look similar to:

```
Waiting for notifications on channel 'test'
Timeout
Got NOTIFY: 6535 test hello
Timeout
...
```

Note that the payload is only available from PostgreSQL 9.0: notifications received from a previous version server will have the *payload* attribute set to the empty string.

Changed in version 2.3: Added *Notify* object and handling notification payload.

Changed in version 2.7: The *notifies* attribute is writable: it is possible to replace it with any object exposing an append() method. An useful example would be to use a deque object.

## 6.5 Asynchronous support

Added in version 2.2.

Psycopg can issue asynchronous queries to a PostgreSQL database. An asynchronous communication style is established passing the parameter *async*=1 to the *connect()* function: the returned connection will work in *asynchronous mode*.

In asynchronous mode, a Psycopg connection will rely on the caller to poll the socket file descriptor, checking if it is ready to accept data or if a query result has been transferred and is ready to be read on the client. The caller can use the method <code>fileno()</code> to get the connection file descriptor and <code>poll()</code> to make communication proceed according to the current connection state.

The following is an example loop using methods fileno() and poll() together with the Python select() function in order to carry on asynchronous operations with Psycopg:

The above loop of course would block an entire application: in a real asynchronous framework, select() would be called on many file descriptors waiting for any of them to be ready. Nonetheless the function can be used to connect to a PostgreSQL server only using nonblocking commands and the connection obtained can be used to perform further nonblocking queries. After poll() has returned *POLL\_OK*, and thus wait() has returned, the connection can be safely used:

```
>>> aconn = psycopg2.connect(database='test', async=1)
>>> wait(aconn)
>>> acurs = aconn.cursor()
```

Note that there are a few other requirements to be met in order to have a completely non-blocking connection attempt: see the libpq documentation for PQconnectStart().

The same loop should be also used to perform nonblocking queries: after sending a query via <code>execute()</code> or <code>callproc()</code>, call <code>poll()</code> on the connection available from <code>cursor.connection</code> until it returns <code>POLL\_OK</code>, at which point the query has been completely sent to the server and, if it produced data, the results have been transferred to the client and available using the regular cursor methods:

```
>>> acurs.execute("SELECT pg_sleep(5); SELECT 42;")
>>> wait(acurs.connection)
>>> acurs.fetchone()[0]
42
```

When an asynchronous query is being executed, *connection.isexecuting()* returns True. Two cursors can't execute concurrent queries on the same asynchronous connection.

There are several limitations in using asynchronous connections: the connection is always in *autocommit* mode and it is not possible to change it. So a transaction is not implicitly started at the first query and is not possible to use methods

commit() and rollback(): you can manually control transactions using execute() to send database commands such as BEGIN, COMMIT and ROLLBACK. Similarly set\_session() can't be used but it is still possible to invoke the SET command with the proper default\_transaction\_... parameter.

With asynchronous connections it is also not possible to use set\_client\_encoding(), executemany(), large objects, named cursors.

*COPY commands* are not supported either in asynchronous mode, but this will be probably implemented in a future release.

### 6.6 Support for coroutine libraries

Added in version 2.2.

Psycopg can be used together with coroutine-based libraries and participate in cooperative multithreading.

Coroutine-based libraries (such as Eventlet or gevent) can usually patch the Python standard library in order to enable a coroutine switch in the presence of blocking I/O: the process is usually referred as making the system *green*, in reference to the green threads.

Because Psycopg is a C extension module, it is not possible for coroutine libraries to patch it: Psycopg instead enables cooperative multithreading by allowing the registration of a *wait callback* using the *psycopg2.extensions.*  $set\_wait\_callback()$  function. When a wait callback is registered, Psycopg will use libpq non-blocking calls instead of the regular blocking ones, and will delegate to the callback the responsibility to wait for the socket to become readable or writable.

Working this way, the caller does not have the complete freedom to schedule the socket check whenever they want as with an *asynchronous connection*, but has the advantage of maintaining a complete DB API 2.0 semantics: from the point of view of the end user, all Psycopg functions and objects will work transparently in the coroutine environment (blocking the calling green thread and giving other green threads the possibility to be scheduled), allowing non modified code and third party libraries (such as SQLAlchemy) to be used in coroutine-based programs.

#### **A** Warning

Psycopg connections are not *green thread safe* and can't be used concurrently by different green threads. Trying to execute more than one command at time using one cursor per thread will result in an error (or a deadlock on versions before 2.4.2).

Therefore, programmers are advised to either avoid sharing connections between coroutines or to use a library-friendly lock to synchronize shared connections, e.g. for pooling.

Coroutine libraries authors should provide a callback implementation (and possibly a method to register it) to make Psycopg as green as they want. An example callback (using select() to block) is provided as <code>psycopg2.extras.wait\_select()</code>: it boils down to something similar to:

```
def wait_select(conn):
    while True:
        state = conn.poll()
        if state == extensions.POLL_OK:
            break
        elif state == extensions.POLL_READ:
            select.select([conn.fileno()], [], [])
        elif state == extensions.POLL_WRITE:
            select.select([], [conn.fileno()], [])
```

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```
else:
    raise OperationalError("bad state from poll: %s" % state)
```

Providing callback functions for the single coroutine libraries is out of psycopg2 scope, as the callback can be tied to the libraries' implementation details. You can check the psycogreen project for further informations and resources about the topic.



*COPY commands* are currently not supported when a wait callback is registered, but they will be probably implemented in a future release.

Large objects are not supported either: they are not compatible with asynchronous connections.

### 6.7 Replication protocol support

Added in version 2.7.

Modern PostgreSQL servers (version 9.0 and above) support replication. The replication protocol is built on top of the client-server protocol and can be operated using libpq, as such it can be also operated by psycopg2. The replication protocol can be operated on both synchronous and *asynchronous* connections.

Server version 9.4 adds a new feature called *Logical Replication*.

#### See also

• PostgreSQL Streaming Replication Protocol

### 6.7.1 Logical replication Quick-Start

You must be using PostgreSQL server version 9.4 or above to run this quick start.

Make sure that replication connections are permitted for user postgres in pg\_hba.conf and reload the server configuration. You also need to set wal\_level=logical and max\_wal\_senders, max\_replication\_slots to value greater than zero in postgresql.conf (these changes require a server restart). Create a database psycopg2\_test.

Then run the following code to quickly try the replication support out. This is not production code – it's only intended as a simple demo of logical replication:

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```
cur.start_replication(slot_name='pytest', decode=True)
except psycopg2.ProgrammingError:
   cur.create_replication_slot('pytest', output_plugin='test_decoding')
   cur.start_replication(slot_name='pytest', decode=True)
class DemoConsumer(object):
   def __call__(self, msg):
       print(msg.payload)
        msg.cursor.send_feedback(flush_lsn=msg.data_start)
democonsumer = DemoConsumer()
print("Starting streaming, press Control-C to end...", file=sys.stderr)
   cur.consume_stream(democonsumer)
except KeyboardInterrupt:
   cur.close()
   conn.close()
  print("The slot 'pytest' still exists. Drop it with "
      "SELECT pg_drop_replication_slot('pytest'); if no longer needed.",
      file=sys.stderr)
   print("WARNING: Transaction logs will accumulate in pg_xlog "
      "until the slot is dropped.", file=sys.stderr)
```

You can now make changes to the psycopg2\_test database using a normal psycopg2 session, psq1, etc. and see the logical decoding stream printed by this demo client.

This will continue running until terminated with Control-C.

For the details see Replication support objects.

### PSYCOPG2.EXTENSIONS - EXTENSIONS TO THE DB API

The module contains a few objects and function extending the minimum set of functionalities defined by the DB API 2.0.

### 7.1 Classes definitions

Instances of these classes are usually returned by factory functions or attributes. Their definitions are exposed here to allow subclassing, introspection etc.

#### **class** psycopg2.extensions.**connection**(*dsn*, *async=False*)

Is the class usually returned by the *connect()* function. It is exposed by the extensions module in order to allow subclassing to extend its behaviour: the subclass should be passed to the *connect()* function using the *connection\_factory* parameter. See also *Connection and cursor factories*.

For a complete description of the class, see *connection*.

Changed in version 2.7: async\_ can be used as alias for async.

#### class psycopg2.extensions.cursor(conn, name=None)

It is the class usually returned by the *connection.cursor()* method. It is exposed by the extensions module in order to allow subclassing to extend its behaviour: the subclass should be passed to the cursor() method using the cursor\_factory parameter. See also *Connection and cursor factories*.

For a complete description of the class, see *cursor*.

```
class psycopg2.extensions.lobject(conn[, oid[, mode[, new_oid[, new_file]]]])
```

Wrapper for a PostgreSQL large object. See Access to PostgreSQL large objects for an overview.

The class can be subclassed: see the *connection.lobject()* to know how to specify a lobject subclass.

Added in version 2.0.8.

#### oid

Database OID of the object.

#### mode

The mode the database was open. See *connection.lobject()* for a description of the available modes.

#### read(bytes=-1)

Read a chunk of data from the current file position. If -1 (default) read all the remaining data.

The result is an Unicode string (decoded according to *connection.encoding*) if the file was open in t mode, a bytes string for b mode.

Changed in version 2.4: added Unicode support.

#### write(str)

Write a string to the large object. Return the number of bytes written. Unicode strings are encoded in the *connection.encoding* before writing.

Changed in version 2.4: added Unicode support.

#### export(file\_name)

Export the large object content to the file system.

The method uses the efficient lo\_export() libpq function.

#### **seek**(offset, whence=0)

Set the lobject current position.

Changed in version 2.6: added support for *offset* > 2GB.

#### tell()

Return the lobject current position.

Added in version 2.2.

Changed in version 2.6: added support for return value > 2GB.

#### truncate(len=0)

Truncate the lobject to the given size.

The method will only be available if Psycopg has been built against libpq from PostgreSQL 8.3 or later and can only be used with PostgreSQL servers running these versions. It uses the lo\_truncate() libpq function.

Added in version 2.2.

Changed in version 2.6: added support for len > 2GB.

#### Warning

If Psycopg is built with <code>lo\_truncate()</code> support or with the 64 bits API support (resp. from PostgreSQL versions 8.3 and 9.3) but at runtime an older version of the dynamic library is found, the <code>psycopg2</code> module will fail to import. See <code>the lo\_truncate FAQ</code> about the problem.

#### close()

Close the object.

#### closed

Boolean attribute specifying if the object is closed.

#### unlink()

Close the object and remove it from the database.

#### class psycopg2.extensions.ConnectionInfo(connection)

Details about the native PostgreSQL database connection.

This class exposes several informative functions about the status of the libpq connection.

Objects of this class are exposed as the *connection.info* attribute.

Added in version 2.8.

#### dbname

The database name of the connection.



libpq docs for PQdb() for details.

#### user

The user name of the connection.



libpq docs for PQuser() for details.

### password

The password of the connection.

#### See also

libpq docs for PQpass() for details.

#### host

The server host name of the connection.

This can be a host name, an IP address, or a directory path if the connection is via Unix socket. (The path case can be distinguished because it will always be an absolute path, beginning with /.)

#### See also

libpq docs for PQhost() for details.

#### port

The port of the connection.

#### **Type**

int

#### See also

libpq docs for PQport() for details.

#### options

The command-line options passed in the connection request.

### See also

libpq docs for PQoptions() for details.

#### dsn\_parameters

The effective connection parameters.

```
Type dict
```

The results include values which weren't explicitly set by the connection string, such as defaults, environment variables, etc. The *password* parameter is removed from the results.

#### → See also

libpq docs for PQconninfo() for details.

#### Example:

```
>>> conn.info.dsn_parameters {'dbname': 'test', 'user': 'postgres', 'port': '5432', 'sslmode': 'prefer'}
```

Requires libpq >= 9.3.

#### status

The status of the connection.

```
Type int
```

#### → See also

libpq docs for PQstatus() for details.

#### transaction\_status

The current in-transaction status of the connection.

Symbolic constants for the values are defined in the module *psycopg2.extensions*: see *Transaction status constants* for the available values.

# Type int

#### See also

libpq docs for PQtransactionStatus() for details.

### parameter\_status(name)

Looks up a current parameter setting of the server.

#### **Parameters**

**name** (str) – The name of the parameter to return.

#### Returns

The parameter value, None if the parameter is unknown.

### Return type

str

#### See also

libpq docs for PQparameterStatus() for details.

#### protocol\_version

The frontend/backend protocol being used.

Type int

#### See also

libpq docs for PQprotocolVersion() for details.

Currently Psycopg supports only protocol 3, which allows connection to PostgreSQL server from version 7.4. Psycopg versions previous than 2.3 support both protocols 2 and 3.

#### server\_version

Returns an integer representing the server version.

Type int

#### See also

libpq docs for PQserverVersion() for details.

The number is formed by converting the major, minor, and revision numbers into two-decimal-digit numbers and appending them together. After PostgreSQL 10 the minor version was dropped, so the second group of digits is always 00. For example, version 9.3.5 will be returned as 90305, version 10.2 as 100002.

#### error\_message

The error message most recently generated by an operation on the connection.

None if there is no current message.

#### See also

libpq docs for PQerrorMessage() for details.

#### socket

The file descriptor number of the connection socket to the server.

Type int

### See also

libpq docs for PQsocket() for details.

#### backend\_pid

The process ID (PID) of the backend process you connected to.

### Type

int

#### See also

libpq docs for PQbackendPID() for details.

#### needs\_password

The connection authentication method required a password, but none was available.

#### **Type**

bool

#### See also

libpq docs for PQconnectionNeedsPassword() for details.

#### used\_password

The connection authentication method used a password.

#### Type

bool

#### See also

libpq docs for PQconnectionUsedPassword() for details.

#### ssl\_in\_use

True if the connection uses SSL, False if not.

Only available if psycopg was built with libpq >= 9.5; raise NotSupportedError otherwise.

### Type

bool

#### See also

libpq docs for PQsslInUse() for details.

#### ssl\_attribute(name)

Returns SSL-related information about the connection.

#### **Parameters**

**name** (str) – The name of the attribute to return.

#### Returns

The attribute value, None if unknown.

#### **Return type**

str

Only available if psycopg was built with libpq >= 9.5; raise NotSupportedError otherwise.

Valid names are available in ssl\_attribute\_names.

#### See also

libpq docs for PQsslAttribute() for details.

#### ssl\_attribute\_names

The list of the SSL attribute names available.

#### **Type**

list of str

Only available if psycopg was built with libpq >= 9.5; raise NotSupportedError otherwise.

#### See also

libpq docs for PQsslAttributeNames() for details.

#### class psycopg2.extensions.Column(\\*args, \\*\\*kwargs)

Description of one result column, exposed as items of the cursor.description sequence.

Added in version 2.8: in previous version the description attribute was a sequence of simple tuples or named-tuples.

#### name

The name of the column returned.

### type\_code

The PostgreSQL OID of the column. You can use the pg\_type system table to get more informations about the type. This is the value used by Psycopg to decide what Python type use to represent the value. See also *Type casting of SQL types into Python objects*.

### display\_size

Supposed to be the actual length of the column in bytes. Obtaining this value is computationally intensive, so it is always None.

Changed in version 2.8: It was previously possible to obtain this value using a compiler flag at builtin.

#### internal\_size

The size in bytes of the column associated to this column on the server. Set to a negative value for variable-size types See also PQfsize.

#### precision

Total number of significant digits in columns of type NUMERIC. None for other types.

#### scale

Count of decimal digits in the fractional part in columns of type NUMERIC. None for other types.

#### null\_ok

Always None as not easy to retrieve from the libpq.

#### table\_oid

The oid of the table from which the column was fetched (matching pg\_class.oid). None if the column is not a simple reference to a table column. See also PQftable.

Added in version 2.8.

### table\_column

The number of the column (within its table) making up the result (matching pg\_attribute.attnum, so it will start from 1). None if the column is not a simple reference to a table column. See also POftablecol.

Added in version 2.8.

### class psycopg2.extensions.Notify(pid, channel, payload=")

A notification received from the backend.

Notify instances are made available upon reception on the *notifies* member of the listening connection. The object can be also accessed as a 2 items tuple returning the members (*pid*, *channel*) for backward compatibility.

See Asynchronous notifications for details.

Added in version 2.3.

#### channel

The name of the channel to which the notification was sent.

#### payload

The payload message of the notification.

Attaching a payload to a notification is only available since PostgreSQL 9.0: for notifications received from previous versions of the server this member is always the empty string.

#### pid

The ID of the backend process that sent the notification.

Note: if the sending session was handled by Psycopg, you can use backend\_pid to know its PID.

#### class psycopg2.extensions.Xid(format\_id, gtrid, bqual)

A transaction identifier used for two-phase commit.

Usually returned by the connection methods xid() and  $tpc\_recover()$ . Xid instances can be unpacked as a 3-item tuples containing the items ( $format\_id$ , gtrid, bqual). The str() of the object returns the transaction ID used in the commands sent to the server.

See Two-Phase Commit protocol support for an introduction.

Added in version 2.3.

#### static from\_string(s)

Create a Xid object from a string representation. Static method.

If s is a PostgreSQL transaction ID produced by a XA transaction, the returned object will have <code>format\_id</code>, <code>gtrid</code>, <code>bqual</code> set to the values of the preparing XA id. Otherwise only the <code>gtrid</code> is populated with the unparsed string. The operation is the inverse of the one performed by <code>str(xid)</code>.

#### bqual

Branch qualifier of the transaction.

In a XA transaction every resource participating to a transaction receives a distinct branch qualifier. None if the transaction doesn't follow the XA standard.

#### database

Database the recovered transaction belongs to.

#### format\_id

Format ID in a XA transaction.

A non-negative 32 bit integer. None if the transaction doesn't follow the XA standard.

#### gtrid

Global transaction ID in a XA transaction.

If the transaction doesn't follow the XA standard, it is the plain transaction ID used in the server commands.

#### owner

Name of the user who prepared a recovered transaction.

#### prepared

Timestamp (with timezone) in which a recovered transaction was prepared.

#### class psycopg2.extensions.Diagnostics(exception)

Details from a database error report.

The object is returned by the *diag* attribute of the Error object. All the information available from the PQresultErrorField() function are exposed as attributes by the object, e.g. the severity attribute returns the PG\_DIAG\_SEVERITY code. Please refer to the PostgreSQL documentation for the meaning of all the attributes.

Added in version 2.5.

The attributes currently available are:

column\_name

constraint\_name

context

datatype\_name

internal\_position

internal\_query

message\_detail

message\_hint

message\_primary

schema\_name

severity

severity\_nonlocalized

source\_file

source\_function

source\_line

sqlstate

statement\_position

#### table\_name

A string with the error field if available; None if not available. The attribute value is available only if the error sent by the server: not all the fields are available for all the errors and for all the server versions.

Added in version 2.8: The severity\_nonlocalized attribute.

### 7.2 SQL adaptation protocol objects

Psycopg provides a flexible system to adapt Python objects to the SQL syntax (inspired to the **PEP 246**), allowing serialization in PostgreSQL. See *Adapting new Python types to SQL syntax* for a detailed description. The following objects deal with Python objects adaptation:

```
psycopg2.extensions.adapt(obj)
```

Return the SQL representation of *obj* as an *ISQLQuote*. Raise a *ProgrammingError* if how to adapt the object is unknown. In order to allow new objects to be adapted, register a new adapter for it using the *register\_adapter()* function.

The function is the entry point of the adaptation mechanism: it can be used to write adapters for complex objects by recursively calling adapt() on its components.

#### psycopg2.extensions.register\_adapter(class, adapter)

Register a new adapter for the objects of class class.

adapter should be a function taking a single argument (the object to adapt) and returning an object conforming to the *ISQLQuote* protocol (e.g. exposing a getquoted() method). The *AsIs* is often useful for this task.

Once an object is registered, it can be safely used in SQL queries and by the adapt () function.

### class psycopg2.extensions.ISQLQuote(wrapped\_object)

Represents the SQL adaptation protocol. Objects conforming this protocol should implement a *getquoted()* and optionally a *prepare()* method.

Adapters may subclass ISQLQuote, but is not necessary: it is enough to expose a getquoted() method to be conforming.

#### \_wrapped

The wrapped object passes to the constructor

#### getquoted()

Subclasses or other conforming objects should return a valid SQL string representing the wrapped object. In Python 3 the SQL must be returned in a bytes object. The ISQLQuote implementation does nothing.

#### prepare(conn)

Prepare the adapter for a connection. The method is optional: if implemented, it will be invoked before getquoted() with the connection to adapt for as argument.

A conform object can implement this method if the SQL representation depends on any server parameter, such as the server version or the standard\_conforming\_string setting. Container objects may store the connection and use it to recursively prepare contained objects: see the implementation for <code>psycopg2.extensions.SQL\_IN</code> for a simple example.

### class psycopg2.extensions.AsIs(object)

Adapter conform to the *ISQLQuote* protocol useful for objects whose string representation is already valid as SQL representation.

#### getquoted()

Return the str() conversion of the wrapped object.

```
>>> AsIs(42).getquoted()
'42'
```

#### class psycopg2.extensions.QuotedString(str)

Adapter conform to the ISQLQuote protocol for string-like objects.

### getquoted()

Return the string enclosed in single quotes. Any single quote appearing in the string is escaped by doubling it according to SQL string constants syntax. Backslashes are escaped too.

```
>>> QuotedString(r"0'Reilly").getquoted()
"'0''Reilly'"
```

### class psycopg2.extensions.Binary(str)

Adapter conform to the *ISQLQuote* protocol for binary objects.

### getquoted()

Return the string enclosed in single quotes. It performs the same escaping of the QuotedString adapter, plus it knows how to escape non-printable chars.

```
>>> Binary("\x00\x08\x0F").getquoted()
"'\\\\000\\\\010\\\\017'"
```

Changed in version 2.0.14: previously the adapter was not exposed by the extensions module. In older versions it can be imported from the implementation module psycopg2.\_psycopg.

```
class psycopg2.extensions.Boolean
class psycopg2.extensions.Float
class psycopg2.extensions.SQL_IN
     Specialized adapters for builtin objects.
class psycopg2.extensions.DateFromPy
class psycopg2.extensions.TimeFromPy
class psycopg2.extensions.TimestampFromPy
class psycopg2.extensions.IntervalFromPy
     Specialized adapters for Python datetime objects.
```

psycopg2.extensions.adapters

Dictionary of the currently registered object adapters. Use register\_adapter() to add an adapter for a new type.

# 7.3 Database types casting functions

These functions are used to manipulate type casters to convert from PostgreSQL types to Python objects. See Type casting of SQL types into Python objects for details.

```
psycopg2.extensions.new_type(oids, name, adapter)
```

Create a new type caster to convert from a PostgreSQL type to a Python object. The object created must be registered using register\_type() to be used.

### **Parameters**

- oids tuple of OIDs of the PostgreSQL type to convert.
- name the name of the new type adapter.
- **adapter** the adaptation function.

The object OID can be read from the cursor. description attribute or by querying from the PostgreSQL catalog.

adapter should have signature fun(value, cur) where value is the string representation returned by PostgreSQL and cur is the cursor from which data are read. In case of NULL, value will be None. The adapter should return the converted object.

See Type casting of SQL types into Python objects for an usage example.

```
psycopg2.extensions.new_array_type(oids, name, base_caster)
```

Create a new type caster to convert from a PostgreSQL array type to a list of Python object. The object created must be registered using  $register\_type()$  to be used.

### **Parameters**

- **oids** tuple of OIDs of the PostgreSQL type to convert. It should probably contain the oid of the array type (e.g. the typarray field in the pg\_type table).
- **name** the name of the new type adapter.
- base\_caster a Psycopg typecaster, e.g. created using the new\_type() function. The caster should be able to parse a single item of the desired type.

Added in version 2.4.3.

# 1 Note

The function can be used to create a generic array typecaster, returning a list of strings: just use *psycopg2*. *STRING* as base typecaster. For instance, if you want to receive an array of macaddr from the database, each address represented by string, you can use:

# psycopg2.extensions.register\_type(obj[, scope])

Register a type caster created using new\_type().

If *scope* is specified, it should be a *connection* or a *cursor*: the type caster will be effective only limited to the specified object. Otherwise it will be globally registered.

### psycopg2.extensions.string\_types

The global register of type casters.

### psycopg2.extensions.encodings

Mapping from PostgreSQL encoding to Python encoding names. Used by Psycopg when adapting or casting unicode strings. See *Unicode handling*.

# 7.4 Additional exceptions

The module exports a few exceptions in addition to the standard ones defined by the DB API 2.0.

### 1 Note

From psycopg 2.8 these error classes are also exposed by the psycopg2.errors module.

### exception psycopg2.extensions.QueryCanceledError

(subclasses OperationalError)

Error related to SQL query cancellation. It can be trapped specifically to detect a timeout.

Added in version 2.0.7.

### exception psycopg2.extensions.TransactionRollbackError

(subclasses OperationalError)

Error causing transaction rollback (deadlocks, serialization failures, etc). It can be trapped specifically to detect a deadlock.

Added in version 2.0.7.

# 7.5 Coroutines support functions

These functions are used to set and retrieve the callback function for cooperation with coroutine libraries.

Added in version 2.2.

### psycopg2.extensions.set\_wait\_callback(f)

Register a callback function to block waiting for data.

The callback should have signature fun(conn) and is called to wait for data available whenever a blocking function from the libpq is called. Use set\_wait\_callback(None) to revert to the original behaviour (i.e. using blocking libpq functions).

The function is an hook to allow coroutine-based libraries (such as Eventlet or gevent) to switch when Psycopg is blocked, allowing other coroutines to run concurrently.

See wait\_select() for an example of a wait callback implementation.

### psycopg2.extensions.get\_wait\_callback()

Return the currently registered wait callback.

Return None if no callback is currently registered.

# 7.6 Other functions

# psycopg2.extensions.libpq\_version()

Return the version number of the libpq dynamic library loaded as an integer, in the same format of server\_version.

Raise *NotSupportedError* if the psycopg2 module was compiled with a libpq version lesser than 9.1 (which can be detected by the \_\_libpq\_version\_\_ constant).

Added in version 2.7.



libpq docs for PQlibVersion().

```
psycopg2.extensions.make_dsn(dsn=None, \*\*kwargs)
```

Create a valid connection string from arguments.

Put together the arguments in kwargs into a connection string. If dsn is specified too, merge the arguments coming from both the sources. If the same argument name is specified in both the sources, the kwargs value overrides the dsn value.

The input arguments are validated: the output should always be a valid connection string (as far as *parse\_dsn()* is concerned). If not raise *ProgrammingError*.

### Example:

```
>>> from psycopg2.extensions import make_dsn
>>> make_dsn('dbname=foo host=example.com', password="s3cr3t")
'host=example.com password=s3cr3t dbname=foo'
```

Added in version 2.7.

### psycopg2.extensions.parse\_dsn(dsn)

Parse connection string into a dictionary of keywords and values.

Parsing is delegated to the libpq: different versions of the client library may support different formats or parameters (for example, connection URIs are only supported from libpq 9.2). Raise *ProgrammingError* if the *dsn* is not valid.

### Example:

Added in version 2.7.

```
See also
libpq docs for PQconninfoParse().
```

### psycopg2.extensions.quote\_ident(str, scope)

Return quoted identifier according to PostgreSQL quoting rules.

The *scope* must be a *connection* or a *cursor*, the underlying connection encoding is used for any necessary character conversion.

Added in version 2.7.

```
See also
libpq docs for PQescapeIdentifier()
```

psycopg2.extensions.encrypt\_password(password, user, scope=None, algorithm=None)

Return the encrypted form of a PostgreSQL password.

### **Parameters**

- password the cleartext password to encrypt
- **user** the name of the user to use the password for
- **scope** (*connection* or *cursor*) the scope to encrypt the password into; if *algorithm* is md5 it can be None
- algorithm the password encryption algorithm to use

The *algorithm* md5 is always supported. Other algorithms are only supported if the client libpq version is at least 10 and may require a compatible server version: check the PostgreSQL encryption documentation to know the algorithms supported by your server.

Using None as *algorithm* will result in querying the server to know the current server password encryption setting, which is a blocking operation: query the server separately and specify a value for *algorithm* if you want to maintain a non-blocking behaviour.

Added in version 2.8.



PostgreSQL docs for the password\_encryption setting, libpq PQencryptPasswordConn(), PQencryptPassword() functions.

### 7.7 Isolation level constants

Psycopg2 connection objects hold informations about the PostgreSQL transaction isolation level. By default Psycopg doesn't change the default configuration of the server (ISOLATION\_LEVEL\_DEFAULT); the default for PostgreSQL servers is typically READ COMMITTED, but this may be changed in the server configuration files. A different isolation level can be set through the set\_isolation\_level() or set\_session() methods. The level can be set to one of the following constants:

### psycopg2.extensions.ISOLATION\_LEVEL\_AUTOCOMMIT

No transaction is started when commands are executed and no *commit()* or *rollback()* is required. Some PostgreSQL command such as CREATE DATABASE or VACUUM can't run into a transaction: to run such command use:

>>> conn.set\_isolation\_level(ISOLATION\_LEVEL\_AUTOCOMMIT)

See also Transactions control.

### psycopg2.extensions.ISOLATION\_LEVEL\_READ\_UNCOMMITTED

The READ UNCOMMITTED isolation level is defined in the SQL standard but not available in the MVCC (Multiversion concurrency control) model of PostgreSQL: it is replaced by the stricter READ COMMITTED.

### psycopg2.extensions.ISOLATION\_LEVEL\_READ\_COMMITTED

This is usually the default PostgreSQL value, but a different default may be set in the database configuration.

A new transaction is started at the first <code>execute()</code> command on a cursor and at each new <code>execute()</code> after a <code>commit()</code> or a <code>rollback()</code>. The transaction runs in the PostgreSQL READ COMMITTED isolation level: a <code>SELECT</code> query sees only data committed before the query began; it never sees either uncommitted data or changes committed during query execution by concurrent transactions.

### See also

Read Committed Isolation Level in PostgreSQL documentation.

### psycopg2.extensions.ISOLATION\_LEVEL\_REPEATABLE\_READ

As in ISOLATION\_LEVEL\_READ\_COMMITTED, a new transaction is started at the first <code>execute()</code> command. Transactions run at a REPEATABLE READ isolation level: all the queries in a transaction see a snapshot as of the start of the transaction, not as of the start of the current query within the transaction. However applications using this level must be prepared to retry transactions due to serialization failures.

While this level provides a guarantee that each transaction sees a completely stable view of the database, this view will not necessarily always be consistent with some serial (one at a time) execution of concurrent transactions of the same level.

Changed in version 2.4.2: The value was an alias for ISOLATION\_LEVEL\_SERIALIZABLE before. The two levels are distinct since PostgreSQL 9.1



Repeatable Read Isolation Level in PostgreSQL documentation.

### psycopg2.extensions.ISOLATION\_LEVEL\_SERIALIZABLE

As in ISOLATION\_LEVEL\_READ\_COMMITTED, a new transaction is started at the first <code>execute()</code> command. Transactions run at a SERIALIZABLE isolation level. This is the strictest transactions isolation level, equivalent to having the transactions executed serially rather than concurrently. However applications using this level must be prepared to retry transactions due to serialization failures.

Starting from PostgreSQL 9.1, this mode monitors for conditions which could make execution of a concurrent set of serializable transactions behave in a manner inconsistent with all possible serial (one at a time) executions of those transaction. In previous version the behaviour was the same of the REPEATABLE READ isolation level.



Serializable Isolation Level in PostgreSQL documentation.

### psycopg2.extensions.ISOLATION\_LEVEL\_DEFAULT

A new transaction is started at the first <code>execute()</code> command, but the isolation level is not explicitly selected by Psycopg: the server will use whatever level is defined in its configuration or by statements executed within the session outside Pyscopg control. If you want to know what the value is you can use a query such as <code>show transaction\_isolation</code>.

Added in version 2.7.

# 7.8 Transaction status constants

These values represent the possible status of a transaction: the current value can be read using the connection.info.transaction\_status property.

### psycopg2.extensions.TRANSACTION\_STATUS\_IDLE

The session is idle and there is no current transaction.

### psycopg2.extensions.TRANSACTION\_STATUS\_ACTIVE

A command is currently in progress.

### psycopg2.extensions.TRANSACTION\_STATUS\_INTRANS

The session is idle in a valid transaction block.

### psycopg2.extensions.TRANSACTION\_STATUS\_INERROR

The session is idle in a failed transaction block.

### psycopg2.extensions.TRANSACTION\_STATUS\_UNKNOWN

Reported if the connection with the server is bad.

# 7.9 Connection status constants

These values represent the possible status of a connection: the current value can be read from the status attribute.

It is possible to find the connection in other status than the one shown below. Those are the only states in which a working connection is expected to be found during the execution of regular Python client code: other states are for internal usage and Python code should not rely on them.

### psycopg2.extensions.STATUS\_READY

Connection established. No transaction in progress.

### psycopg2.extensions.STATUS\_BEGIN

Connection established. A transaction is currently in progress.

### psycopg2.extensions.STATUS\_IN\_TRANSACTION

An alias for STATUS\_BEGIN

### psycopg2.extensions.STATUS\_PREPARED

The connection has been prepared for the second phase in a *two-phase commit* transaction. The connection can't be used to send commands to the database until the transaction is finished with  $tpc\_commit()$  or  $tpc\_rollback()$ .

Added in version 2.3.

# 7.10 Poll constants

Added in version 2.2.

These values can be returned by *connection.poll()* during asynchronous connection and communication. They match the values in the libpq enum PostgresPollingStatusType. See *Asynchronous support* and *Support for coroutine libraries*.

### psycopg2.extensions.POLL\_OK

The data being read is available, or the file descriptor is ready for writing: reading or writing will not block.

```
psycopg2.extensions.POLL_READ
```

Some data is being read from the backend, but it is not available yet on the client and reading would block. Upon receiving this value, the client should wait for the connection file descriptor to be ready *for reading*. For example:

```
select.select([conn.fileno()], [], [])
```

```
psycopg2.extensions.POLL_WRITE
```

Some data is being sent to the backend but the connection file descriptor can't currently accept new data. Upon receiving this value, the client should wait for the connection file descriptor to be ready *for writing*. For example:

```
select.select([], [conn.fileno()], [])
```

```
psycopg2.extensions.POLL_ERROR
```

There was a problem during connection polling. This value should actually never be returned: in case of poll error usually an exception containing the relevant details is raised.

# 7.11 Additional database types

The extensions module includes typecasters for many standard PostgreSQL types. These objects allow the conversion of returned data into Python objects. All the typecasters are automatically registered, except <code>UNICODE</code> and <code>UNICODEARRAY</code>: you can register them using <code>register\_type()</code> in order to receive Unicode objects instead of strings from the database. See <code>Unicode handling</code> for details.

```
psycopg2.extensions.BOOLEAN
psycopg2.extensions.BYTES
psycopg2.extensions.DATE
psycopg2.extensions.DECIMAL
psycopg2.extensions.FLOAT
psycopg2.extensions.INTEGER
psycopg2.extensions.INTERVAL
psycopg2.extensions.LONGINTEGER
psycopg2.extensions.TIME
psycopg2.extensions.UNICODE
```

Typecasters for basic types. Note that a few other ones (BINARY, DATETIME, NUMBER, ROWID, STRING) are exposed by the psycopg2 module for DB API 2.0 compliance.

```
psycopg2.extensions.BINARYARRAY
psycopg2.extensions.BOOLEANARRAY
psycopg2.extensions.BYTESARRAY
psycopg2.extensions.DATEARRAY
psycopg2.extensions.DATETIMEARRAY
psycopg2.extensions.DECIMALARRAY
psycopg2.extensions.FLOATARRAY
psycopg2.extensions.INTEGERARRAY
psycopg2.extensions.INTERVALARRAY
psycopg2.extensions.LONGINTEGERARRAY
psycopg2.extensions.ROWIDARRAY
psycopg2.extensions.STRINGARRAY
psycopg2.extensions.TIMEARRAY
```

### psycopg2.extensions.UNICODEARRAY

Typecasters to convert arrays of sql types into Python lists.

```
psycopg2.extensions.PYDATE
psycopg2.extensions.PYDATETIME
psycopg2.extensions.PYDATETIMETZ
psycopg2.extensions.PYINTERVAL
psycopg2.extensions.PYTIME
psycopg2.extensions.PYDATEARRAY
psycopg2.extensions.PYDATETIMEARRAY
psycopg2.extensions.PYDATETIMETZARRAY
psycopg2.extensions.PYINTERVALARRAY
psycopg2.extensions.PYINTERVALARRAY
psycopg2.extensions.PYTIMEARRAY
```

Typecasters to convert time-related data types to Python datetime objects.

Changed in version 2.2: previously the *DECIMAL* typecaster and the specific time-related typecasters (PY\* and MX\*) were not exposed by the extensions module. In older versions they can be imported from the implementation module psycopg2.\_psycopg.

Added in version 2.7.2: the \*DATETIMETZ\* objects.

Added in version 2.8: the BYTES and BYTESARRAY objects.

# PSYCOPG2.EXTRAS - MISCELLANEOUS GOODIES FOR PSYCOPG 2

This module is a generic place used to hold little helper functions and classes until a better place in the distribution is found.

# 8.1 Connection and cursor subclasses

A few objects that change the way the results are returned by the cursor or modify the object behavior in some other way. Typically cursor subclasses are passed as *cursor\_factory* argument to *connect()* so that the connection's *cursor()* method will generate objects of this class. Alternatively a cursor subclass can be used one-off by passing it as the *cursor\_factory* argument to the cursor() method.

If you want to use a connection subclass you can pass it as the *connection\_factory* argument of the connect() function.

# 8.1.1 Dictionary-like cursor

The dict cursors allow to access to the attributes of retrieved records using an interface similar to the Python dictionaries instead of the tuples.

The records still support indexing as the original tuple:

```
>>> rec[2]
"abc'def"
```

```
class psycopg2.extras.DictCursor(*args, **kwargs)
```

A cursor that keeps a list of column name -> index mappings.

### class psycopg2.extras.DictConnection

A connection that uses *DictCursor* automatically.

# Note Not very useful since Psycopg 2.5: you can use psycopg2.connect(dsn, cursor\_factory=DictCursor) instead of DictConnection.

### class psycopg2.extras.DictRow(cursor)

A row object that allow by-column-name access to data.

# 8.1.2 Real dictionary cursor

```
class psycopg2.extras.RealDictCursor(*args, **kwargs)
```

A cursor that uses a real dict as the base type for rows.

Note that this cursor is extremely specialized and does not allow the normal access (using integer indices) to fetched data. If you need to access database rows both as a dictionary and a list, then use the generic <code>DictCursor</code> instead of <code>RealDictCursor</code>.

### class psycopg2.extras.RealDictConnection

A connection that uses *RealDictCursor* automatically.

```
Note
Not very useful since Psycopg 2.5: you can use psycopg2.connect(dsn, cursor_factory=RealDictCursor) instead of RealDictConnection.
```

### class psycopg2.extras.RealDictRow(\*args, \*\*kwargs)

A dict subclass representing a data record.

### 8.1.3 namedtuple cursor

Added in version 2.3.

### class psycopg2.extras.NamedTupleCursor

A cursor that generates results as namedtuple.

fetch\*() methods will return named tuples instead of regular tuples, so their elements can be accessed both as regular numeric items as well as attributes.

```
>>> nt_cur = conn.cursor(cursor_factory=psycopg2.extras.NamedTupleCursor)
>>> rec = nt_cur.fetchone()
>>> rec
Record(id=1, num=100, data="abc'def")
>>> rec[1]
100
>>> rec.data
"abc'def"
```

### class psycopg2.extras.NamedTupleConnection

A connection that uses *NamedTupleCursor* automatically.

### 1 Note

Not very useful since Psycopg 2.5: you can use *psycopg2.connect*(dsn, cursor\_factory=NamedTupleCursor) instead of NamedTupleConnection.

# 8.1.4 Logging cursor

# ${\bf class} \ {\tt psycopg2.extras.} \\ {\bf Logging Connection}$

A connection that logs all queries to a file or logger object.

### filter(msg, curs)

Filter the query before logging it.

This is the method to overwrite to filter unwanted queries out of the log or to add some extra data to the output. The default implementation just does nothing.

### initialize(logobj)

Initialize the connection to log to logobj.

The logobj parameter can be an open file object or a Logger/LoggerAdapter instance from the standard logging module.

### class psycopg2.extras.LoggingCursor

A cursor that logs queries using its connection logging facilities.

### 1 Note

Queries that are executed with cursor.executemany() are not logged.

### class psycopg2.extras.MinTimeLoggingConnection

A connection that logs queries based on execution time.

This is just an example of how to sub-class <code>LoggingConnection</code> to provide some extra filtering for the logged queries. Both the <code>initialize()</code> and <code>filter()</code> methods are overwritten to make sure that only queries executing for more than mintime ms are logged.

Note that this connection uses the specialized cursor MinTimeLoggingCursor.

### filter(msg, curs)

Filter the query before logging it.

This is the method to overwrite to filter unwanted queries out of the log or to add some extra data to the output. The default implementation just does nothing.

### initialize(logobj, mintime=0)

Initialize the connection to log to logobj.

The logobj parameter can be an open file object or a Logger/LoggerAdapter instance from the standard logging module.

### class psycopg2.extras.MinTimeLoggingCursor

The cursor sub-class companion to MinTimeLoggingConnection.

# 8.2 Replication support objects

See Replication protocol support for an introduction to the topic.

The following replication types are defined:

```
psycopg2.extras.REPLICATION_LOGICAL
```

```
psycopg2.extras.REPLICATION_PHYSICAL
```

```
class psycopg2.extras.LogicalReplicationConnection(*args, **kwargs)
```

This connection factory class can be used to open a special type of connection that is used for logical replication.

Example:

```
from psycopg2.extras import LogicalReplicationConnection
log_conn = psycopg2.connect(dsn, connection_factory=LogicalReplicationConnection)
log_cur = log_conn.cursor()
```

### class psycopg2.extras.PhysicalReplicationConnection(\*args, \*\*kwargs)

This connection factory class can be used to open a special type of connection that is used for physical replication.

Example:

```
from psycopg2.extras import PhysicalReplicationConnection
phys_conn = psycopg2.connect(dsn, connection_factory=PhysicalReplicationConnection)
phys_cur = phys_conn.cursor()
```

Both LogicalReplicationConnection and PhysicalReplicationConnection use ReplicationCursor for actual communication with the server.

The individual messages in the replication stream are represented by *ReplicationMessage* objects (both logical and physical type):

### class psycopg2.extras.ReplicationMessage

A replication protocol message.

### payload

The actual data received from the server.

An instance of either bytes() or unicode(), depending on the value of decode option passed to  $start\_replication()$  on the connection. See  $read\_message()$  for details.

### data\_size

The raw size of the message payload (before possible unicode conversion).

### data\_start

LSN position of the start of the message.

### wal\_end

LSN position of the current end of WAL on the server.

### send\_time

A datetime object representing the server timestamp at the moment when the message was sent.

### cursor

A reference to the corresponding ReplicationCursor object.

### class psycopg2.extras.ReplicationCursor

A cursor used for communication on replication connections.

```
create_replication_slot(slot_name, slot_type=None, output_plugin=None)
```

Create streaming replication slot.

### **Parameters**

- **slot\_name** name of the replication slot to be created
- **slot\_type** type of replication: should be either *REPLICATION\_LOGICAL* or *REPLICATION\_PHYSICAL*
- **output\_plugin** name of the logical decoding output plugin to be used by the slot; required for logical replication connections, disallowed for physical

### Example:

```
log_cur.create_replication_slot("logical1", "test_decoding")
phys_cur.create_replication_slot("physical1")

# either logical or physical replication connection
cur.create_replication_slot("slot1", slot_type=REPLICATION_LOGICAL)
```

When creating a slot on a logical replication connection, a logical replication slot is created by default. Logical replication requires name of the logical decoding output plugin to be specified.

When creating a slot on a physical replication connection, a physical replication slot is created by default. No output plugin parameter is required or allowed when creating a physical replication slot.

In either case the type of slot being created can be specified explicitly using *slot\_type* parameter.

Replication slots are a feature of PostgreSQL server starting with version 9.4.

### drop\_replication\_slot(slot\_name)

Drop streaming replication slot.

### **Parameters**

**slot\_name** – name of the replication slot to drop

### Example:

```
# either logical or physical replication connection
cur.drop_replication_slot("slot1")
```

Replication slots are a feature of PostgreSQL server starting with version 9.4.

```
start_replication(slot_name=None, slot_type=None, start_lsn=0, timeline=0, options=None, decode=False, status interval=10)
```

Start replication on the connection.

### **Parameters**

- **slot\_name** name of the replication slot to use; required for logical replication, physical replication can work with or without a slot
- **slot\_type** type of replication: should be either *REPLICATION\_LOGICAL* or *REPLICATION\_PHYSICAL*
- **start\_lsn** the optional LSN position to start replicating from, can be an integer or a string of hexadecimal digits in the form **XXX/XXX**

- **timeline** WAL history timeline to start streaming from (optional, can only be used with physical replication)
- **options** a dictionary of options to pass to logical replication slot (not allowed with physical replication)
- decode a flag indicating that unicode conversion should be performed on messages received from the server
- **status\_interval** time between feedback packets sent to the server

If a *slot\_name* is specified, the slot must exist on the server and its type must match the replication type used.

If not specified using *slot\_type* parameter, the type of replication is defined by the type of replication connection. Logical replication is only allowed on logical replication connection, but physical replication can be used with both types of connection.

On the other hand, physical replication doesn't require a named replication slot to be used, only logical replication does. In any case logical replication and replication slots are a feature of PostgreSQL server starting with version 9.4. Physical replication can be used starting with 9.0.

If *start\_lsn* is specified, the requested stream will start from that LSN. The default is None which passes the LSN 0/0 causing replay to begin at the last point for which the server got flush confirmation from the client, or the oldest available point for a new slot.

The server might produce an error if a WAL file for the given LSN has already been recycled or it may silently start streaming from a later position: the client can verify the actual position using information provided by the *ReplicationMessage* attributes. The exact server behavior depends on the type of replication and use of slots.

The *timeline* parameter can only be specified with physical replication and only starting with server version 9.3.

A dictionary of *options* may be passed to the logical decoding plugin on a logical replication slot. The set of supported options depends on the output plugin that was used to create the slot. Must be None for physical replication.

If decode is set to True the messages received from the server would be converted according to the connection encoding. This parameter should not be set with physical replication or with logical replication plugins that produce binary output.

Replication stream should periodically send feedback to the database to prevent disconnect via timeout. Feedback is automatically sent when <code>read\_message()</code> is called or during run of the <code>consume\_stream()</code>. To specify the feedback interval use <code>status\_interval</code> parameter. The value of this parameter must be set to at least 1 second, but it can have a fractional part.

This function constructs a START\_REPLICATION command and calls start\_replication\_expert() internally.

After starting the replication, to actually consume the incoming server messages use <code>consume\_stream()</code> or implement a loop around <code>read\_message()</code> in case of <code>asynchronous connection</code>.

Changed in version 2.8.3: added the *status\_interval* parameter.

**start\_replication\_expert**(command, decode=False, status\_interval=10)

Start replication on the connection using provided START\_REPLICATION command.

### **Parameters**

• **command** – The full replication command. It can be a string or a *Composable* instance for dynamic generation.

- decode a flag indicating that unicode conversion should be performed on messages received from the server.
- **status\_interval** time between feedback packets sent to the server

Changed in version 2.8.3: added the *status interval* parameter.

consume\_stream(consume, keepalive interval=None)

### **Parameters**

- **consume** a callable object with signature **consume** (*msg*)
- **keepalive\_interval** interval (in seconds) to send keepalive messages to the server

This method can only be used with synchronous connection. For asynchronous connections see read\_message().

Before using this method to consume the stream call start\_replication() first.

This method enters an endless loop reading messages from the server and passing them to consume() one at a time, then waiting for more messages from the server. In order to make this method break out of the loop and return, consume() can throw a *StopReplication* exception. Any unhandled exception will make it break out of the loop as well.

The *msg* object passed to consume() is an instance of *ReplicationMessage* class. See *read\_message()* for details about message decoding.

This method also sends feedback messages to the server every *keepalive\_interval* (in seconds). The value of this parameter must be set to at least 1 second, but it can have a fractional part. If the *keepalive\_interval* is not specified, the value of *status\_interval* specified in the *start\_replication()* or *start\_replication\_expert()* will be used.

The client must confirm every processed message by calling <code>send\_feedback()</code> method on the corresponding replication cursor. A reference to the cursor is provided in the <code>ReplicationMessage</code> as an attribute.

The following example is a sketch implementation of consume() callable for logical replication:

```
class LogicalStreamConsumer(object):

# ...

def __call__(self, msg):
    self.process_message(msg.payload)
    msg.cursor.send_feedback(flush_lsn=msg.data_start)

consumer = LogicalStreamConsumer()
cur.consume_stream(consumer)
```

### **A** Warning

When using replication with slots, failure to constantly consume *and* report success to the server appropriately can eventually lead to "disk full" condition on the server, because the server retains all the WAL segments that might be needed to stream the changes via all of the currently open replication slots.

Changed in version 2.8.3: changed the default value of the *keepalive\_interval* parameter to None.

**send\_feedback**(write\_lsn=0, flush\_lsn=0, apply\_lsn=0, reply=False, force=False)

### **Parameters**

- write\_lsn a LSN position up to which the client has written the data locally
- **flush\_lsn** a LSN position up to which the client has processed the data reliably (the server is allowed to discard all and every data that predates this LSN)
- apply\_lsn a LSN position up to which the warm standby server has applied the changes (physical replication master-slave protocol only)
- **reply** request the server to send back a keepalive message immediately
- force force sending a feedback message regardless of status\_interval timeout

Use this method to report to the server that all messages up to a certain LSN position have been processed on the client and may be discarded on the server.

If the *reply* or *force* parameters are not set, this method will just update internal structures without sending the feedback message to the server. The library sends feedback message automatically when *status\_interval* timeout is reached. For this to work, you must call <code>send\_feedback()</code> on the same Cursor that you called <code>start\_replication()</code> on (the one in <code>message.cursor</code>) or your feedback will be lost.

Changed in version 2.8.3: added the *force* parameter.

Low-level replication cursor methods for asynchronous connection operation.

With the synchronous connection a call to <code>consume\_stream()</code> handles all the complexity of handling the incoming messages and sending keepalive replies, but at times it might be beneficial to use low-level interface for better control, in particular to <code>select</code> on multiple sockets. The following methods are provided for asynchronous operation:

### read\_message()

Try to read the next message from the server without blocking and return an instance of *ReplicationMessage* or None, in case there are no more data messages from the server at the moment.

This method should be used in a loop with asynchronous connections (after calling *start\_replication()* once). For synchronous connections see *consume\_stream()*.

The returned message's *payload* is an instance of unicode decoded according to connection *encoding iff decode* was set to True in the initial call to *start\_replication()* on this connection, otherwise it is an instance of bytes with no decoding.

It is expected that the calling code will call this method repeatedly in order to consume all of the messages that might have been buffered until None is returned. After receiving None from this method the caller should use select() or poll() on the corresponding connection to block the process until there is more data from the server.

Last, but not least, this method sends feedback messages when *status\_interval* timeout is reached or when keepalive message with reply request arrived from the server.

### fileno()

Call the corresponding connection's fileno() method and return the result.

This is a convenience method which allows replication cursor to be used directly in select() or poll() calls.

### io\_timestamp

A datetime object representing the timestamp at the moment of last communication with the server (a data or keepalive message in either direction).

### feedback\_timestamp

A datetime object representing the timestamp at the moment when the last feedback message sent to the server.

Added in version 2.8.3.

### wal end

LSN position of the current end of WAL on the server at the moment of last data or keepalive message received from the server.

Added in version 2.8.

An actual example of asynchronous operation might look like this:

```
from select import select
from datetime import datetime
def consume(msg):
    msg.cursor.send_feedback(flush_lsn=msg.data_start)
status_interval = 10.0
while True:
    msg = cur.read_message()
   if msg:
        consume(msg)
    else:
        now = datetime.now()
        timeout = status_interval - (now - cur.feedback_timestamp).total_seconds()
        try:
            sel = select([cur], [], [], max(0, timeout))
        except InterruptedError:
            pass # recalculate timeout and continue
```

### class psycopg2.extras.StopReplication

Exception used to break out of the endless loop in consume\_stream().

Subclass of Exception. Intentionally *not* inherited from *Error* as occurrence of this exception does not indicate an error.

# 8.3 Additional data types

# 8.3.1 JSON adaptation

Added in version 2.5.

Changed in version 2.5.4: added jsonb support. In previous versions jsonb values are returned as strings. See *the FAQ* for a workaround.

Psycopg can adapt Python objects to and from the PostgreSQL json and jsonb types. With PostgreSQL 9.2 and following versions adaptation is available out-of-the-box. To use JSON data with previous database versions (either with the 9.1 json extension, but even if you want to convert text fields to JSON) you can use the  $register_json()$  function.

The Python json module is used by default to convert Python objects to JSON and to parse data from the database.

In order to pass a Python object to the database as query argument you can use the *Json* adapter:

```
curs.execute("insert into mytable (jsondata) values (%s)",
   [Json({'a': 100})])
```

Reading from the database, json and jsonb values will be automatically converted to Python objects.

### 1 Note

If you are using the PostgreSQL json data type but you want to read it as string in Python instead of having it parsed, your can either cast the column to text in the query (it is an efficient operation, that doesn't involve a copy):

```
cur.execute("select jsondata::text from mytable")
or you can register a no-op loads() function with register_default_json():
psycopg2.extras.register_default_json(loads=lambda x: x)
```

### 1 Note

You can use  $register\_adapter()$  to adapt any Python dictionary to JSON, either registering Json or any subclass or factory creating a compatible adapter:

```
psycopg2.extensions.register_adapter(dict, psycopg2.extras.Json)
```

This setting is global though, so it is not compatible with similar adapters such as the one registered by  $register_hstore()$ . Any other object supported by JSON can be registered the same way, but this will clobber the default adaptation rule, so be careful to unwanted side effects.

If you want to customize the adaptation from Python to PostgreSQL you can either provide a custom dumps() function to *Json*:

```
curs.execute("insert into mytable (jsondata) values (%s)",
   [Json({'a': 100}, dumps=simplejson.dumps)])
```

or you can subclass it overriding the dumps() method:

```
class MyJson(Json):
    def dumps(self, obj):
        return simplejson.dumps(obj)

curs.execute("insert into mytable (jsondata) values (%s)",
    [MyJson({'a': 100})])
```

Customizing the conversion from PostgreSQL to Python can be done passing a custom loads() function to  $register\_json()$ . For the builtin data types (json from PostgreSQL 9.2, jsonb from PostgreSQL 9.4) use  $register\_default\_json()$  and  $register\_default\_jsonb()$ . For example, if you want to convert the float values from json into Decimal you can use:

```
loads = lambda x: json.loads(x, parse_float=Decimal)
psycopg2.extras.register_json(conn, loads=loads)
```

Or, if you want to use an alternative JSON module implementation, such as the faster UltraJSON, you can use:

```
psycopg2.extras.register_default_json(loads=ujson.loads, globally=True)
psycopg2.extras.register_default_jsonb(loads=ujson.loads, globally=True)
```

class psycopg2.extras.Json(adapted, dumps=None)

An ISQLQuote wrapper to adapt a Python object to json data type.

Json can be used to wrap any object supported by the provided *dumps* function. If none is provided, the standard json.dumps() is used.

dumps(obj)

Serialize obj in JSON format.

The default is to call <code>json.dumps()</code> or the *dumps* function provided in the constructor. You can override this method to create a customized JSON wrapper.

```
psycopg2.extras.register_json(conn_or_curs=None, globally=False, loads=None, oid=None, array_oid=None, name='json')
```

Create and register typecasters converting json type to Python objects.

### **Parameters**

- **conn\_or\_curs** a connection or cursor used to find the json and json[] oids; the type-casters are registered in a scope limited to this object, unless *globally* is set to True. It can be None if the oids are provided
- **globally** if False register the typecasters only on *conn\_or\_curs*, otherwise register them globally
- **loads** the function used to parse the data into a Python object. If None use json.loads(), where json is the module chosen according to the Python version (see above)
- oid the OID of the json type if known; If not, it will be gueried on conn or curs
- array\_oid the OID of the json[] array type if known; if not, it will be queried on conn\_or\_curs
- name the name of the data type to look for in conn\_or\_curs

The connection or cursor passed to the function will be used to query the database and look for the OID of the json type (or an alternative type if *name* if provided). No query is performed if *oid* and *array\_oid* are provided. Raise *ProgrammingError* if the type is not found.

Changed in version 2.5.4: added the *name* parameter to enable jsonb support.

```
psycopg2.extras.register_default_json(conn_or_curs=None, globally=False, loads=None)
```

Create and register json typecasters for PostgreSQL 9.2 and following.

Since PostgreSQL 9.2 json is a builtin type, hence its oid is known and fixed. This function allows specifying a customized *loads* function for the default json type without querying the database. All the parameters have the same meaning of  $register_json()$ .

```
psycopq2.extras.register_default_jsonb(conn or curs=None, globally=False, loads=None)
```

Create and register jsonb typecasters for PostgreSQL 9.4 and following.

As in  $register\_default\_json()$ , the function allows to register a customized *loads* function for the jsonb type at its known oid for PostgreSQL 9.4 and following versions. All the parameters have the same meaning of  $register\_json()$ .

Added in version 2.5.4.

### 8.3.2 Hstore data type

Added in version 2.3.

The hstore data type is a key-value store embedded in PostgreSQL. It has been available for several server versions but with the release 9.0 it has been greatly improved in capacity and usefulness with the addition of many functions. It supports GiST or GIN indexes allowing search by keys or key/value pairs as well as regular BTree indexes for equality, uniqueness etc.

Psycopg can convert Python dict objects to and from hstore structures. Only dictionaries with string/unicode keys and values are supported. None is also allowed as value but not as a key. Psycopg uses a more efficient hstore representation when dealing with PostgreSQL 9.0 but previous server versions are supported as well. By default the adapter/typecaster are disabled: they can be enabled using the *register\_hstore()* function.

psycopg2.extras.register\_hstore(conn\_or\_curs, globally=False, unicode=False, oid=None, array\_oid=None)

Register adapter and typecaster for dict-hstore conversions.

### **Parameters**

- **conn\_or\_curs** a connection or cursor: the typecaster will be registered only on this object unless *globally* is set to True
- **globally** register the adapter globally, not only on *conn\_or\_curs*
- **unicode** if True, keys and values returned from the database will be unicode instead of str. The option is not available on Python 3
- oid the OID of the hstore type if known. If not, it will be queried on *conn or curs*.
- array\_oid the OID of the hstore array type if known. If not, it will be queried on conn\_or\_curs.

The connection or cursor passed to the function will be used to query the database and look for the OID of the hstore type (which may be different across databases). If querying is not desirable (e.g. with *asynchronous connections*) you may specify it in the *oid* parameter, which can be found using a query such as SELECT 'hstore'::regtype::oid. Analogously you can obtain a value for *array\_oid* using a query such as SELECT 'hstore[]'::regtype::oid.

Note that, when passing a dictionary from Python to the database, both strings and unicode keys and values are supported. Dictionaries returned from the database have keys/values according to the *unicode* parameter.

The hstore contrib module must be already installed in the database (executing the hstore.sql script in your contrib directory). Raise *ProgrammingError* if the type is not found.

Changed in version 2.4: added the *oid* parameter. If not specified, the typecaster is installed also if hstore is not installed in the public schema.

Changed in version 2.4.3: added support for hstore array.

# 8.3.3 Composite types casting

Added in version 2.4.

Using <code>register\_composite()</code> it is possible to cast a PostgreSQL composite type (either created with the CREATE TYPE command or implicitly defined after a table row type) into a Python named tuple, or into a regular tuple if <code>collections.namedtuple()</code> is not found.

```
>>> cur.execute("CREATE TYPE card AS (value int, suit text);")
>>> psycopg2.extras.register_composite('card', cur)
<psycopg2.extras.CompositeCaster object at 0x...>
>>> cur.execute("select (8, 'hearts')::card")
>>> cur.fetchone()[0]
card(value=8, suit='hearts')
```

Nested composite types are handled as expected, provided that the type of the composite components are registered as well.

```
>>> cur.execute("CREATE TYPE card_back AS (face card, back text);")
>>> psycopg2.extras.register_composite('card_back', cur)
<psycopg2.extras.CompositeCaster object at 0x...>
>>> cur.execute("select ((8, 'hearts'), 'blue')::card_back")
>>> cur.fetchone()[0]
card_back(face=card(value=8, suit='hearts'), back='blue')
```

Adaptation from Python tuples to composite types is automatic instead and requires no adapter registration.

### 1 Note

If you want to convert PostgreSQL composite types into something different than a namedtuple you can subclass the *CompositeCaster* overriding *make()*. For example, if you want to convert your type into a Python dictionary you can use:

```
>>> class DictComposite(psycopg2.extras.CompositeCaster):
...     def make(self, values):
...         return dict(zip(self.attnames, values))

>>> psycopg2.extras.register_composite('card', cur,
...         factory=DictComposite)

>>> cur.execute("select (8, 'hearts')::card")
>>> cur.fetchone()[0]
{'suit': 'hearts', 'value': 8}
```

psycopg2.extras.register\_composite(name, conn\_or\_curs, globally=False, factory=None)

Register a typecaster to convert a composite type into a tuple.

### **Parameters**

• name – the name of a PostgreSQL composite type, e.g. created using the CREATE TYPE command

- **conn\_or\_curs** a connection or cursor used to find the type oid and components; the type-caster is registered in a scope limited to this object, unless *globally* is set to True
- **globally** if False (default) register the typecaster only on *conn\_or\_curs*, otherwise register it globally
- factory if specified it should be a CompositeCaster subclass: use it to customize how
  to cast composite types

### Returns

the registered *CompositeCaster* or *factory* instance responsible for the conversion

Changed in version 2.4.3: added support for array of composite types

Changed in version 2.5: added the *factory* parameter

class psycopg2.extras.CompositeCaster(name, oid, attrs, array\_oid=None, schema=None)

Helps conversion of a PostgreSQL composite type into a Python object.

The class is usually created by the <code>register\_composite()</code> function. You may want to create and register manually instances of the class if querying the database at registration time is not desirable (such as when using an <code>asynchronous connections</code>).

### make(values)

Return a new Python object representing the data being casted.

values is the list of attributes, already casted into their Python representation.

You can subclass this method to customize the composite cast.

Added in version 2.5.

Object attributes:

### name

The name of the PostgreSQL type.

### schema

The schema where the type is defined.

Added in version 2.5.

### oid

The oid of the PostgreSQL type.

### array\_oid

The oid of the PostgreSQL array type, if available.

### type

The type of the Python objects returned. If collections.namedtuple() is available, it is a named tuple with attributes equal to the type components. Otherwise it is just the tuple object.

### attnames

List of component names of the type to be casted.

### atttypes

List of component type oids of the type to be casted.

### 8.3.4 Range data types

Added in version 2.5.

Psycopg offers a *Range* Python type and supports adaptation between them and PostgreSQL range types. Builtin range types are supported out-of-the-box; user-defined range types can be adapted using *register\_range()*.

**class** psycopg2.extras.**Range**(lower=None, upper=None, bounds='[)', empty=False)

Python representation for a PostgreSQL range type.

### **Parameters**

- lower lower bound for the range. None means unbound
- upper upper bound for the range. None means unbound
- **bounds** one of the literal strings (), [), (], [], representing whether the lower or upper bounds are included
- empty if True, the range is empty

This Python type is only used to pass and retrieve range values to and from PostgreSQL and doesn't attempt to replicate the PostgreSQL range features: it doesn't perform normalization and doesn't implement all the operators supported by the database.

Range objects are immutable, hashable, and support the in operator (checking if an element is within the range). They can be tested for equivalence. Empty ranges evaluate to False in boolean context, nonempty evaluate to True.

Changed in version 2.5.3: Range objects can be sorted although, as on the server-side, this ordering is not particularly meangingful. It is only meant to be used by programs assuming objects using Range as primary key can be sorted on them. In previous versions comparing Ranges raises TypeError.

Although it is possible to instantiate Range objects, the class doesn't have an adapter registered, so you cannot normally pass these instances as query arguments. To use range objects as query arguments you can either use one of the provided subclasses, such as <code>NumericRange</code> or create a custom subclass using <code>register\_range()</code>.

Object attributes:

### isempty

True if the range is empty.

### lower

The lower bound of the range. None if empty or unbound.

### upper

The upper bound of the range. None if empty or unbound.

### lower\_inc

True if the lower bound is included in the range.

### upper\_inc

True if the upper bound is included in the range.

### lower inf

True if the range doesn't have a lower bound.

### upper\_inf

True if the range doesn't have an upper bound.

The following *Range* subclasses map builtin PostgreSQL range types to Python objects: they have an adapter registered so their instances can be passed as query arguments. range values read from database queries are automatically casted into instances of these classes.

**class** psycopg2.extras.**NumericRange**(lower=None, upper=None, bounds='[]', empty=False)

A Range suitable to pass Python numeric types to a PostgreSQL range.

PostgreSQL types int4range, int8range, numrange are casted into NumericRange instances.

**class** psycopg2.extras.**DateRange**(lower=None, upper=None, bounds='[)', empty=False)
Represents daterange values.

class psycopg2.extras.DateTimeRange(lower=None, upper=None, bounds='[)', empty=False)
 Represents tsrange values.

**class** psycopg2.extras.**DateTimeTZRange**(lower=None, upper=None, bounds='[)', empty=False)
Represents tstzrange values.

### 1 Note

Python lacks a representation for infinity date so Psycopg converts the value to date.max and such. When written into the database these dates will assume their literal value (e.g. 9999-12-31 instead of infinity). Check *Infinite dates handling* for an example of an alternative adapter to map date.max to infinity. An alternative dates adapter will be used automatically by the *DateRange* adapter and so on.

Custom range types (created with CREATE TYPE ... AS RANGE) can be adapted to a custom Range subclass:

psycopg2.extras.register\_range(pgrange, pyrange, conn\_or\_curs, globally=False)

Create and register an adapter and the typecasters to convert between a PostgreSQL range type and a PostgreSQL *Range* subclass.

### **Parameters**

- pgrange the name of the PostgreSQL range type. Can be schema-qualified
- pyrange a Range strict subclass, or just a name to give to a new class
- **conn\_or\_curs** a connection or cursor used to find the oid of the range and its subtype; the typecaster is registered in a scope limited to this object, unless *globally* is set to True
- **globally** if False (default) register the typecaster only on *conn\_or\_curs*, otherwise register it globally

### Returns

RangeCaster instance responsible for the conversion

If a string is passed to *pyrange*, a new *Range* subclass is created with such name and will be available as the *range* attribute of the returned *RangeCaster* object.

The function queries the database on *conn\_or\_curs* to inspect the *pgrange* type and raises *ProgrammingError* if the type is not found. If querying the database is not advisable, use directly the *RangeCaster* class and register the adapter and typecasters using the provided functions.

class psycopg2.extras.RangeCaster(pgrange, pyrange, oid, subtype\_oid, array\_oid=None)

Helper class to convert between Range and PostgreSQL range types.

Objects of this class are usually created by *register\_range()*. Manual creation could be useful if querying the database is not advisable: in this case the oids must be provided.

Object attributes:

### range

The Range subclass adapted.

### adapter

The ISQLQuote responsible to adapt range.

### typecaster

The object responsible for casting.

### array\_typecaster

The object responsible to cast arrays, if available, else None.

# 8.3.5 UUID data type

Added in version 2.0.9.

Changed in version 2.0.13: added UUID array support.

```
>>> psycopg2.extras.register_uuid()
<psycopg2._psycopg.type object at 0x...>
>>> # Python UUID can be used in SQL queries
>>> import uuid
>>> my_uuid = uuid.UUID('{12345678-1234-5678-1234-567812345678}')
>>> psycopg2.extensions.adapt(my_uuid).getquoted()
"'12345678-1234-5678-1234-567812345678'::uuid"
>>> # PostgreSQL UUID are transformed into Python UUID objects.
>>> cur.execute("SELECT 'a0eebc99-9c0b-4ef8-bb6d-6bb9bd380a11'::uuid")
>>> cur.fetchone()[0]
UUID('a0eebc99-9c0b-4ef8-bb6d-6bb9bd380a11')
```

psycopg2.extras.register\_uuid(oids=None, conn\_or\_curs=None)

Create the UUID type and an uuid.UUID adapter.

### **Parameters**

- oids oid for the PostgreSQL unid type, or 2-items sequence with oids of the type and the array. If not specified, use PostgreSQL standard oids.
- **conn\_or\_curs** where to register the typecaster. If not specified, register it globally.

class psycopg2.extras.UUID\_adapter(uuid)

Adapt Python's uuid.UUID type to PostgreSQL's uuid.

# 8.3.6 Networking data types

By default Psycopg casts the PostgreSQL networking data types (inet, cidr, macaddr) into ordinary strings; array of such types are converted into lists of strings.

Changed in version 2.7: in previous version array of networking types were not treated as arrays.

```
psycopg2.extras.register_ipaddress(conn_or_curs=None)
```

Register conversion support between ipaddress objects and network types.

### **Parameters**

**conn\_or\_curs** – the scope where to register the type casters. If None register them globally.

After the function is called, PostgreSQL inet values will be converted into IPv4Interface or IPv6Interface objects, cidr values into IPv4Network or IPv6Network.

```
psycopg2.extras.register_inet(oid=None, conn_or_curs=None)
```

Create the INET type and an Inet adapter.

### **Parameters**

- **oid** oid for the PostgreSQL inet type, or 2-items sequence with oids of the type and the array. If not specified, use PostgreSQL standard oids.
- **conn\_or\_curs** where to register the typecaster. If not specified, register it globally.

Deprecated since version 2.7: this function will not receive further development and may disappear in future versions.

### class psycopg2.extras.Inet(addr)

Wrap a string to allow for correct SQL-quoting of inet values.

Note that this adapter does NOT check the passed value to make sure it really is an inet-compatible address but DOES call adapt() on it to make sure it is impossible to execute an SQL-injection by passing an evil value to the initializer.

Deprecated since version 2.7: this object will not receive further development and may disappear in future versions.

# 8.4 Fast execution helpers

The current implementation of *executemany()* is (using an extremely charitable understatement) not particularly performing. These functions can be used to speed up the repeated execution of a statement against a set of parameters. By reducing the number of server roundtrips the performance can be orders of magnitude better than using executemany().

```
psycopg2.extras.execute_batch(cur, sql, argslist, page_size=100)
```

Execute groups of statements in fewer server roundtrips.

Execute sql several times, against all parameters set (sequences or mappings) found in argslist.

```
The function is semantically similar to cur.executemany(sql, argslist)
```

but has a different implementation: Psycopg will join the statements into fewer multi-statement commands, each one containing at most *page\_size* statements, resulting in a reduced number of server roundtrips.

After the execution of the function the cursor.rowcount property will **not** contain a total result.

```
>>> nums = ((1,), (5,), (10,))
>>> execute_batch(cur, "INSERT INTO test (num) VALUES (%s)", nums)

>>> tuples = ((123, "foo"), (42, "bar"), (23, "baz"))
>>> execute_batch(cur, "INSERT INTO test (num, data) VALUES (%s, %s)", tuples)
```

Added in version 2.7.

### 1 Note

execute\_batch() can be also used in conjunction with PostgreSQL prepared statements using PREPARE, EXECUTE, DEALLOCATE. Instead of executing:

```
execute_batch(cur,
   "big and complex SQL with %s %s params",
   params_list)
```

it is possible to execute something like:

```
cur.execute("PREPARE stmt AS big and complex SQL with $1 $2 params")
execute_batch(cur, "EXECUTE stmt (%s, %s)", params_list)
cur.execute("DEALLOCATE stmt")
```

which may bring further performance benefits: if the operation to perform is complex, every single execution will be faster as the query plan is already cached; furthermore the amount of data to send on the server will be lesser (one EXECUTE per param set instead of the whole, likely longer, statement).

psycopg2.extras.execute\_values(cur, sql, argslist, template=None, page\_size=100, fetch=False)

Execute a statement using VALUES with a sequence of parameters.

### **Parameters**

- **cur** the cursor to use to execute the query.
- **sql** the query to execute. It must contain a single %s placeholder, which will be replaced by a VALUES list. Example: "INSERT INTO mytable (id, f1, f2) VALUES %s".
- **argslist** sequence of sequences or dictionaries with the arguments to send to the query. The type and content must be consistent with *template*.
- **template** the snippet to merge to every item in *argslist* to compose the query.
  - If the *argslist* items are sequences it should contain positional placeholders (e.g. "(%s, %s, %s)", or "(%s, %s, 42)" if there are constants value...).
  - If the argslist items are mappings it should contain named placeholders (e.g. "(%(id)s, %(f1)s, 42)").

If not specified, assume the arguments are sequence and use a simple positional template (i.e.  $(\%s, \%s, \ldots)$ ), with the number of placeholders sniffed by the first element in *argslist*.

- page\_size maximum number of *argslist* items to include in every statement. If there are more items the function will execute more than one statement.
- **fetch** if True return the query results into a list (like in a *fetchall()*). Useful for queries with RETURNING clause.

After the execution of the function the *cursor.rowcount* property will **not** contain a total result.

While INSERT is an obvious candidate for this function it is possible to use it with other statements, for example:

```
>>> cur.execute(
... "create table test (id int primary key, v1 int, v2 int)")
>>> execute_values(cur,
... "INSERT INTO test (id, v1, v2) VALUES %s",
... [(1, 2, 3), (4, 5, 6), (7, 8, 9)])
>>> execute_values(cur,
... """UPDATE test SET v1 = data.v1 FROM (VALUES %s) AS data (id, v1)
... WHERE test.id = data.id""",
... [(1, 20), (4, 50)])
>>> cur.execute("select * from test order by id")
>>> cur.fetchall()
[(1, 20, 3), (4, 50, 6), (7, 8, 9)])
```

Added in version 2.7.

Changed in version 2.8: added the fetch parameter.

# 8.5 Coroutine support

```
psycopg2.extras.wait_select(conn)
```

Wait until a connection or cursor has data available.

The function is an example of a wait callback to be registered with  $set\_wait\_callback()$ . This function uses select() to wait for data to become available, and therefore is able to handle/receive SIG-INT/KeyboardInterrupt.

Changed in version 2.6.2: allow to cancel a query using Ctrl-C, see *the FAQ* for an example.

**CHAPTER** 

NINE

# PSYCOPG2. ERRORS – EXCEPTION CLASSES MAPPING POSTGRESQL ERRORS

Added in version 2.8.

Changed in version 2.8.4: added errors introduced in PostgreSQL 12

Changed in version 2.8.6: added errors introduced in PostgreSQL 13

Changed in version 2.9.2: added errors introduced in PostgreSQL 14

Changed in version 2.9.4: added errors introduced in PostgreSQL 15

Changed in version 2.9.10: added errors introduced in PostgreSQL 17

This module exposes the classes psycopg raises upon receiving an error from the database with a SQLSTATE value attached (available in the *pgcode* attribute). The content of the module is generated from the PostgreSQL source code and includes classes for every error defined by PostgreSQL in versions between 9.1 and 15.

Every class in the module is named after what referred as "condition name" in the documentation, converted to Camel-Case: e.g. the error 22012, division\_by\_zero is exposed by this module as the class DivisionByZero.

Every exception class is a subclass of one of the *standard DB-API exception* and expose the *Error* interface. Each class' superclass is what used to be raised by psycopg in versions before the introduction of this module, so everything should be compatible with previously written code catching one the DB-API class: if your code used to catch IntegrityError to detect a duplicate entry, it will keep on working even if a more specialised subclass such as UniqueViolation is raised.

The new classes allow a more idiomatic way to check and process a specific error among the many the database may return. For instance, in order to check that a table is locked, the following code could have been used previously:

```
try:
    cur.execute("LOCK TABLE mytable IN ACCESS EXCLUSIVE MODE NOWAIT")
except psycopg2.OperationalError as e:
    if e.pgcode == psycopg2.errorcodes.LOCK_NOT_AVAILABLE:
        locked = True
    else:
        raise
```

While this method is still available, the specialised class allows for a more idiomatic error handler:

```
try:
    cur.execute("LOCK TABLE mytable IN ACCESS EXCLUSIVE MODE NOWAIT")
except psycopg2.errors.LockNotAvailable:
    locked = True
```

```
psycopg2.errors.lookup(code)
```

Lookup an error code and return its exception class.

Raise KeyError if the code is not found.

```
try:
    cur.execute("LOCK TABLE mytable IN ACCESS EXCLUSIVE MODE NOWAIT")
except psycopg2.errors.lookup("55P03"):
    locked = True
```

# 9.1 SQLSTATE exception classes

The following table contains the list of all the SQLSTATE classes exposed by the module.

Note that, for completeness, the module also exposes all the *DB-API-defined exceptions* and *a few psycopg-specific ones* exposed by the extensions module, which are not listed here.

| SQLSTATE | Exception   | Base exception    |
|----------|---|-------------------|
|          | Class 02: No Data (this is also a warning class per the SQL standard) |                   |
| 02000    | NoData  | DatabaseError     |
| 02001    | NoAdditionalDynamicResultSetsReturned                                 | DatabaseError     |
|          | Class 03: SQL Statement Not Yet Complete                              |                   |
| 03000    | SqlStatementNotYetComplete  | DatabaseError     |
|          | Class 08: Connection Exception  |                   |
| 08000    | ConnectionException   | OperationalError  |
| 08001    | SqlclientUnableToEstablishSqlconnection                               | OperationalError  |
| 08003    | ConnectionDoesNotExist  | OperationalError  |
| 08004    | SqlserverRejectedEstablishmentOfSqlconnection                         | OperationalError  |
| 08006    | ConnectionFailure   | OperationalError  |
| 08007    | TransactionResolutionUnknown  | OperationalError  |
| 08P01    | ProtocolViolation   | OperationalError  |
|          | Class 09: Triggered Action Exception                                  |                   |
| 09000    | TriggeredActionException  | DatabaseError     |
|          | Class 0A: Feature Not Supported                                       |                   |
| 0A000    | FeatureNotSupported   | NotSupportedError |
|          | Class 0B: Invalid Transaction Initiation                              |                   |
| 0B000    | InvalidTransactionInitiation  | DatabaseError     |
|          | Class 0F: Locator Exception   |                   |
| 0F000    | LocatorException  | DatabaseError     |
| 0F001    | InvalidLocatorSpecification   | DatabaseError     |
|          | Class 0L: Invalid Grantor   |                   |
| 0L000    | InvalidGrantor  | DatabaseError     |
| 0LP01    | InvalidGrantOperation   | DatabaseError     |
|          | Class 0P: Invalid Role Specification                                  |                   |
| 0P000    | InvalidRoleSpecification  | DatabaseError     |
|          | Class 0Z: Diagnostics Exception                                       |                   |
| 0Z000    | DiagnosticsException  | DatabaseError     |
| 0Z002    | StackedDiagnosticsAccessedWithoutActiveHandler                        | DatabaseError     |
|          | Class 20: Case Not Found  |                   |
| 20000    | CaseNotFound  | ProgrammingError  |
|          | Class 21: Cardinality Violation                                       |                   |

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| SQLSTATE | Exception                                 | Base exception   |
|----------|---|------------------|
| 21000    | CardinalityViolation                      | ProgrammingError |
|          | Class 22: Data Exception                  |                  |
| 22000    | DataException                             | DataError        |
| 22001    | StringDataRightTruncation                 | DataError        |
| 22002    | NullValueNoIndicatorParameter             | DataError        |
| 22003    | NumericValueOutOfRange                    | DataError        |
| 22004    | NullValueNotAllowed                       | DataError        |
| 22005    | ErrorInAssignment                         | DataError        |
| 22007    | InvalidDatetimeFormat                     | DataError        |
| 22008    | DatetimeFieldOverflow                     | DataError        |
| 22009    | InvalidTimeZoneDisplacementValue          | DataError        |
| 2200B    | EscapeCharacterConflict                   | DataError        |
| 2200C    | InvalidUseOfEscapeCharacter               | DataError        |
| 2200D    | InvalidEscapeOctet                        | DataError        |
| 2200F    | ZeroLengthCharacterString                 | DataError        |
| 2200G    | MostSpecificTypeMismatch                  | DataError        |
| 2200H    | SequenceGeneratorLimitExceeded            | DataError        |
| 2200L    | NotAnXmlDocument                          | DataError        |
| 2200M    | InvalidXmlDocument                        | DataError        |
| 2200N    | InvalidXmlContent                         | DataError        |
| 2200S    | InvalidXmlComment                         | DataError        |
| 2200T    | InvalidXmlProcessingInstruction           | DataError        |
| 22010    | InvalidIndicatorParameterValue            | DataError        |
| 22011    | SubstringError                            | DataError        |
| 22012    | DivisionByZero                            | DataError        |
| 22013    | InvalidPrecedingOrFollowingSize           | DataError        |
| 22014    | InvalidArgumentForNtileFunction           | DataError        |
| 22015    | IntervalFieldOverflow                     | DataError        |
| 22016    | InvalidArgumentForNthValueFunction        | DataError        |
| 22018    | InvalidCharacterValueForCast              | DataError        |
| 22019    | InvalidEscapeCharacter                    | DataError        |
| 2201B    | InvalidRegularExpression                  | DataError        |
| 2201E    | InvalidArgumentForLogarithm               | DataError        |
| 2201F    | InvalidArgumentForPowerFunction           | DataError        |
| 2201G    | InvalidArgumentForWidthBucketFunction     | DataError        |
| 2201W    | InvalidRowCountInLimitClause              | DataError        |
| 2201X    | InvalidRowCountInResultOffsetClause       | DataError        |
| 22021    | CharacterNotInRepertoire                  | DataError        |
| 22022    | IndicatorOverflow                         | DataError        |
| 22023    | InvalidParameterValue                     | DataError        |
| 22024    | UnterminatedCString                       | DataError        |
| 22025    | InvalidEscapeSequence                     | DataError        |
| 22026    | StringDataLengthMismatch                  | DataError        |
| 22027    | TrimError                                 | DataError        |
| 2202F    | ArraySubscriptError                       | DataError        |
| 2202G    | InvalidTablesampleRepeat                  | DataError        |
| 2202H    | InvalidTablesampleArgument                | DataError        |
| 22030    | DuplicateJsonObjectKeyValue               | DataError        |
| 22031    | InvalidArgumentForSqlJsonDatetimeFunction | DataError        |
| 22032    | InvalidJsonText                           | DataError        |
| 44WJ4    | THEATTAISONNEAT                           | pataerror        |

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| SQLSTATE       | Exception                                       | Base exception        |
|----------------|---|-----------------------|
| 22033          | InvalidSqlJsonSubscript                         | DataError             |
| 22034          | MoreThanOneSqlJsonItem                          | DataError             |
| 22035          | NoSqlJsonItem                                   | DataError             |
| 22036          | NonNumericSqlJsonItem                           | DataError             |
| 22037          | NonUniqueKeysInAJsonObject                      | DataError             |
| 22038          | SingletonSqlJsonItemRequired                    | DataError             |
| 22039          | SqlJsonArrayNotFound                            | DataError             |
| 2203A          | SqlJsonMemberNotFound                           | DataError             |
| 2203B          | SqlJsonNumberNotFound                           | DataError             |
| 2203C          | SqlJsonObjectNotFound                           | DataError             |
| 22 <b>0</b> 3D | TooManyJsonArrayElements                        | DataError             |
| 2203E          | TooManyJsonObjectMembers                        | DataError             |
| 2203F          | SqlJsonScalarRequired                           | DataError             |
| 2203G          | SqlJsonItemCannotBeCastToTargetType             | DataError             |
| 22P01          | FloatingPointException                          | DataError             |
| 22P02          | InvalidTextRepresentation                       | DataError             |
| 22P03          | InvalidBinaryRepresentation                     | DataError             |
| 22P04          | BadCopyFileFormat                               | DataError             |
| 22P05          | UntranslatableCharacter                         | DataError             |
| 22P06          | NonstandardUseOfEscapeCharacter                 | DataError             |
|                | Class 23: Integrity Constraint Violation        |                       |
| 23000          | IntegrityConstraintViolation                    | IntegrityError        |
| 23001          | RestrictViolation                               | IntegrityError        |
| 23502          | NotNullViolation                                | IntegrityError        |
| 23503          | ForeignKeyViolation                             | IntegrityError        |
| 23505          | UniqueViolation                                 | IntegrityError        |
| 23514          | CheckViolation                                  | IntegrityError        |
| 23P01          | ExclusionViolation                              | IntegrityError        |
|                | Class 24: Invalid Cursor State                  | 5                     |
| 24000          | InvalidCursorState                              | InternalError         |
|                | Class 25: Invalid Transaction State             |                       |
| 25000          | InvalidTransactionState                         | InternalError         |
| 25001          | ActiveSqlTransaction                            | InternalError         |
| 25002          | BranchTransactionAlreadyActive                  | InternalError         |
| 25003          | InappropriateAccessModeForBranchTransaction     | InternalError         |
| 25004          | InappropriateIsolationLevelForBranchTransaction | InternalError         |
| 25005          | NoActiveSqlTransactionForBranchTransaction      | InternalError         |
| 25006          | ReadOnlySqlTransaction                          | InternalError         |
| 25007          | SchemaAndDataStatementMixingNotSupported        | InternalError         |
| 25008          | HeldCursorRequiresSameIsolationLevel            | InternalError         |
| 25P01          | NoActiveSqlTransaction                          | InternalError         |
| 25P02          | InFailedSqlTransaction                          | InternalError         |
| 25P03          | IdleInTransactionSessionTimeout                 | InternalError         |
| 25P04          | TransactionTimeout                              | InternalError         |
|                | Class 26: Invalid SQL Statement Name            |                       |
| 26000          | InvalidSqlStatementName                         | OperationalError      |
|                | Class 27: Triggered Data Change Violation       | •                     |
| 27000          | TriggeredDataChangeViolation                    | OperationalError      |
|                | Class 28: Invalid Authorization Specification   | •                     |
| 28000          | InvalidAuthorizationSpecification               | OperationalError      |
|                |   | ontinues on next page |

Table 1 – continued from previous page

| SQLSTATE       | Exception   | Base exception     |
|----------------|---|--------------------|
| · · · ·        |   | <u>'</u>           |
| 28P01          | InvalidPassword                                       | OperationalError   |
|                | Class 2B: Dependent Privilege Descriptors Still Exist |                    |
| 2B000          | ${\tt DependentPrivilegeDescriptorsStillExist}$       | InternalError      |
| 2BP01          | DependentObjectsStillExist                            | InternalError      |
|                | Class 2D: Invalid Transaction Termination             |                    |
| 2D000          | InvalidTransactionTermination                         | InternalError      |
|                | Class 2F: SQL Routine Exception                       |                    |
| 2F000          | SqlRoutineException                                   | InternalError      |
| 2F002          | ${\tt ModifyingSqlDataNotPermitted}$                  | InternalError      |
| 2F003          | ${\tt ProhibitedSqlStatementAttempted}$               | InternalError      |
| 2F004          | ReadingSqlDataNotPermitted                            | InternalError      |
| 2F005          | FunctionExecutedNoReturnStatement                     | InternalError      |
|                | Class 34: Invalid Cursor Name                         |                    |
| 34000          | InvalidCursorName                                     | OperationalError   |
|                | Class 38: External Routine Exception                  |                    |
| 38000          | ExternalRoutineException                              | InternalError      |
| 38001          | ContainingSqlNotPermitted                             | InternalError      |
| 38002          | ModifyingSqlDataNotPermittedExt                       | InternalError      |
| 38003          | ProhibitedSqlStatementAttemptedExt                    | InternalError      |
| 38004          | ReadingSqlDataNotPermittedExt                         | InternalError      |
|                | Class 39: External Routine Invocation Exception       |                    |
| 39000          | ExternalRoutineInvocationException                    | InternalError      |
| 39001          | InvalidSqlstateReturned                               | InternalError      |
| 39004          | NullValueNotAllowedExt                                | InternalError      |
| 39P <b>0</b> 1 | TriggerProtocolViolated                               | InternalError      |
| 39P02          | SrfProtocolViolated                                   | InternalError      |
| 39P03          | EventTriggerProtocolViolated                          | InternalError      |
|                | Class 3B: Savepoint Exception                         |                    |
| 3B000          | SavepointException                                    | InternalError      |
| 3B001          | InvalidSavepointSpecification                         | InternalError      |
|                | Class 3D: Invalid Catalog Name                        |                    |
| 3D000          | InvalidCatalogName                                    | ProgrammingError   |
|                | Class 3F: Invalid Schema Name                         | 5 5                |
| 3F000          | InvalidSchemaName                                     | ProgrammingError   |
|                | Class 40: Transaction Rollback                        | 99                 |
| 40000          | TransactionRollback                                   | OperationalError   |
| 40001          | SerializationFailure                                  | OperationalError   |
| 40002          | TransactionIntegrityConstraintViolation               | OperationalError   |
| 40003          | StatementCompletionUnknown                            | OperationalError   |
| 40P01          | DeadlockDetected                                      | OperationalError   |
| 101 01         | Class 42: Syntax Error or Access Rule Violation       | operacionalization |
| 42000          | SyntaxErrorOrAccessRuleViolation                      | ProgrammingError   |
| 42501          | InsufficientPrivilege                                 | ProgrammingError   |
| 42601          | SyntaxError   | ProgrammingError   |
| 42602          | InvalidName   | ProgrammingError   |
| 42602          | InvalidColumnDefinition                               | ProgrammingError   |
| 42611          |   | ProgrammingError   |
|                | NameTooLong   |                    |
| 42701          | DuplicateColumn                                       | ProgrammingError   |
| 42702          | AmbiguousColumn<br>UndefinedColumn                    | ProgrammingError   |
| 42703          | OnderineaCorumn                                       | ProgrammingError   |

Table 1 – continued from previous page

| SQLSTATE  | Exception                                  | Base exception           |
|-----------|--|--------------------------|
| 42704     | UndefinedObject                            | ProgrammingError         |
| 42710     | DuplicateObject                            | ProgrammingError         |
| 42712     | DuplicateAlias                             | ProgrammingError         |
| 42723     | DuplicateFunction                          | ProgrammingError         |
| 42725     | AmbiguousFunction                          | ProgrammingError         |
| 42803     | GroupingError                              | ProgrammingError         |
| 42804     | DatatypeMismatch                           | ProgrammingError         |
| 42809     | WrongObjectType                            | ProgrammingError         |
| 42830     | InvalidForeignKey                          | ProgrammingError         |
| 42846     | CannotCoerce                               | ProgrammingError         |
| 42883     | UndefinedFunction                          | ProgrammingError         |
| 428C9     | GeneratedAlways                            | ProgrammingError         |
| 42939     | ReservedName                               | ProgrammingError         |
| 42P01     | UndefinedTable                             | ProgrammingError         |
| 42P02     | UndefinedParameter                         | ProgrammingError         |
| 42P03     | DuplicateCursor                            | ProgrammingError         |
| 42P04     | DuplicateDatabase                          | ProgrammingError         |
| 42P05     | DuplicatePreparedStatement                 | ProgrammingError         |
| 42P06     | DuplicateSchema                            | ProgrammingError         |
| 42P07     | DuplicateTable                             | ProgrammingError         |
| 42P08     | AmbiguousParameter                         | ProgrammingError         |
| 42P09     | AmbiguousAlias                             | ProgrammingError         |
| 42P10     | InvalidColumnReference                     | ProgrammingError         |
| 42P11     | InvalidCursorDefinition                    | ProgrammingError         |
| 42P12     | InvalidDatabaseDefinition                  | ProgrammingError         |
| 42P13     | InvalidFunctionDefinition                  | ProgrammingError         |
| 42P14     | InvalidPreparedStatementDefinition         | ProgrammingError         |
| 42P15     | InvalidSchemaDefinition                    | ProgrammingError         |
| 42P16     | InvalidTableDefinition                     | ProgrammingError         |
| 42P17     | InvalidObjectDefinition                    | ProgrammingError         |
| 42P18     | IndeterminateDatatype                      | ProgrammingError         |
| 42P19     | InvalidRecursion                           | ProgrammingError         |
| 42P20     | WindowingError                             | ProgrammingError         |
| 42P21     | CollationMismatch                          | ProgrammingError         |
| 42P22     | IndeterminateCollation                     | ProgrammingError         |
| 101 00    | Class 44: WITH CHECK OPTION Violation      | 110g1 animi11g21101      |
| 44000     | WithCheckOptionViolation                   | ProgrammingError         |
| 11000     | Class 53: Insufficient Resources           | 110g1ammingE1101         |
| 53000     | InsufficientResources                      | OperationalError         |
| 53100     | DiskFull                                   | OperationalError         |
| 53200     | OutOfMemory                                | OperationalError         |
| 53300     | TooManyConnections                         | OperationalError         |
| 53400     | ConfigurationLimitExceeded                 | OperationalError         |
| 33100     | Class 54: Program Limit Exceeded           | operationalition         |
| 54000     | ProgramLimitExceeded                       | OperationalError         |
| 54001     | StatementTooComplex                        | OperationalError         |
| 54011     | TooManyColumns                             | OperationalError         |
| 54023     | TooManyArguments                           | OperationalError         |
| J 1023    | Class 55: Object Not In Prerequisite State | operationalLifor         |
| 55000     | ObjectNotInPrerequisiteState               | OperationalError         |
| J J G G G | onjectnotin rerequisitestate               | operational on post page |

Table 1 – continued from previous page

| SQLSTATE | Exception   | Base exception   |
|----------|---|------------------|
| 55006    | ObjectInUse   | OperationalError |
| 55P02    | CantChangeRuntimeParam  | OperationalError |
| 55P03    | LockNotAvailable  | OperationalError |
| 55P04    | UnsafeNewEnumValueUsage                                       | OperationalError |
|          | Class 57: Operator Intervention                               |                  |
| 57000    | OperatorIntervention  | OperationalError |
| 57014    | QueryCanceled   | OperationalError |
| 57P01    | AdminShutdown   | OperationalError |
| 57P02    | CrashShutdown   | OperationalError |
| 57P03    | CannotConnectNow  | OperationalError |
| 57P04    | DatabaseDropped   | OperationalError |
| 57P05    | IdleSessionTimeout  | OperationalError |
|          | Class 58: System Error (errors external to PostgreSQL itself) | •                |
| 58000    | SystemError   | OperationalError |
| 58030    | IoError   | OperationalError |
| 58P01    | UndefinedFile   | OperationalError |
| 58P02    | DuplicateFile   | OperationalError |
|          | Class 72: Snapshot Failure                                    |                  |
| 72000    | SnapshotTooOld  | DatabaseError    |
|          | Class F0: Configuration File Error                            |                  |
| F0000    | ConfigFileError   | InternalError    |
| F0001    | LockFileExists  | InternalError    |
|          | Class HV: Foreign Data Wrapper Error (SQL/MED)                |                  |
| HV000    | FdwError  | OperationalError |
| HV001    | FdwOutOfMemory  | OperationalError |
| HV002    | FdwDynamicParameterValueNeeded                                | OperationalError |
| HV004    | FdwInvalidDataType  | OperationalError |
| HV005    | FdwColumnNameNotFound   | OperationalError |
| HV006    | FdwInvalidDataTypeDescriptors                                 | OperationalError |
| HV007    | FdwInvalidColumnName  | OperationalError |
| HV008    | FdwInvalidColumnNumber  | OperationalError |
| HV009    | FdwInvalidUseOfNullPointer                                    | OperationalError |
| HV00A    | FdwInvalidStringFormat  | OperationalError |
| HV00B    | FdwInvalidHandle  | OperationalError |
| HV00C    | FdwInvalidOptionIndex   | OperationalError |
| HV00D    | FdwInvalidOptionName  | OperationalError |
| HV00J    | FdwOptionNameNotFound   | OperationalError |
| HV00K    | FdwReplyHandle  | OperationalError |
| HV00L    | FdwUnableToCreateExecution                                    | OperationalError |
| HV00M    | FdwUnableToCreateReply  | OperationalError |
| HV00N    | FdwUnableToEstablishConnection                                | OperationalError |
|          | FdwOnableToEstablIshConnectIon<br>FdwNoSchemas                | -                |
| HV00P    |   | OperationalError |
| HV00Q    | FdwSchemaNotFound<br>FdwTableNotFound                         | OperationalError |
| HV00R    |   | OperationalError |
| HV010    | FdwFunctionSequenceError                                      | OperationalError |
| HV014    | FdwTooManyHandles   | OperationalError |
| HV021    | FdwInconsistentDescriptorInformation                          | OperationalError |
| HV024    | FdwInvalidAttributeValue                                      | OperationalError |
| HV090    | FdwInvalidStringLengthOrBufferLength                          | OperationalError |
| HV091    | FdwInvalidDescriptorFieldIdentifier                           | OperationalError |

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Table 1 – continued from previous page

| SQLSTATE                 | Exception      | Base exception |
|--------------------------|----------------|----------------|
| Class P0: PL/pgSQL Error |                |                |
| P0000                    | PlpgsqlError   | InternalError  |
| P0001                    | RaiseException | InternalError  |
| P0002                    | NoDataFound    | InternalError  |
| P0003                    | TooManyRows    | InternalError  |
| P0004                    | AssertFailure  | InternalError  |
| Class XX: Internal Error |                |                |
| XX000                    | InternalError_ | InternalError  |
| XX001                    | DataCorrupted  | InternalError  |
| XX002                    | IndexCorrupted | InternalError  |

**CHAPTER** 

TEN

# PSYCOPG2.SQL - SQL STRING COMPOSITION

Added in version 2.7.

The module contains objects and functions useful to generate SQL dynamically, in a convenient and safe way. SQL identifiers (e.g. names of tables and fields) cannot be passed to the *execute()* method like query arguments:

```
# This will not work
table_name = 'my_table'
cur.execute("insert into %s values (%s, %s)", [table_name, 10, 20])
```

The SQL query should be composed before the arguments are merged, for instance:

```
# This works, but it is not optimal
table_name = 'my_table'
cur.execute(
    "insert into %s values (%%s, %%s)" % table_name,
    [10, 20])
```

This sort of works, but it is an accident waiting to happen: the table name may be an invalid SQL literal and need quoting; even more serious is the security problem in case the table name comes from an untrusted source. The name should be escaped using <code>quote\_ident()</code>:

```
# This works, but it is not optimal
table_name = 'my_table'
cur.execute(
    "insert into %s values (%%s, %%s)" % ext.quote_ident(table_name, cur),
    [10, 20])
```

This is now safe, but it somewhat ad-hoc. In case, for some reason, it is necessary to include a value in the query string (as opposite as in a value) the merging rule is still different (adapt() should be used...). It is also still relatively dangerous: if quote\_ident() is forgotten somewhere, the program will usually work, but will eventually crash in the presence of a table or field name with containing characters to escape, or will present a potentially exploitable weakness.

The objects exposed by the psycopg2.sql module allow generating SQL statements on the fly, separating clearly the variable parts of the statement from the query parameters:

```
from psycopg2 import sql

cur.execute(
    sql.SQL("insert into {} values (%s, %s)")
        .format(sql.Identifier('my_table')),
        [10, 20])
```

# 10.1 Module usage

Usually you should express the template of your query as an *SQL* instance with {}-style placeholders and use *format()* to merge the variable parts into them, all of which must be *Composable* subclasses. You can still have %s-style placeholders in your query and pass values to *execute()*: such value placeholders will be untouched by format():

```
query = sql.SQL("select {field} from {table} where {pkey} = %s").format(
    field=sql.Identifier('my_name'),
    table=sql.Identifier('some_table'),
    pkey=sql.Identifier('id'))
```

The resulting object is meant to be passed directly to cursor methods such as execute(), executemany(), copy\_expert(), but can also be used to compose a query as a Python string, using the as\_string() method:

```
cur.execute(query, (42,))
```

If part of your query is a variable sequence of arguments, such as a comma-separated list of field names, you can use the *SQL.join()* method to pass them to the query:

```
query = sql.SQL("select {fields} from {table}").format(
    fields=sql.SQL(',').join([
        sql.Identifier('field1'),
        sql.Identifier('field2'),
        sql.Identifier('field3'),
    ]),
    table=sql.Identifier('some_table'))
```

# 10.2 sql objects

The sql objects are in the following inheritance hierarchy:

```
Composable: the base class exposing the common interface

|__ SQL: a literal snippet of an SQL query

|__ Identifier: a PostgreSQL identifier or dot-separated sequence of identifiers

|__ Literal: a value hardcoded into a query

|__ Placeholder: a %s-style placeholder whose value will be added later e.g. by execute()
```

class psycopg2.sql.Composable(wrapped)

\_\_ Composed: a sequence of Composable instances.

Abstract base class for objects that can be used to compose an SQL string.

Composable objects can be passed directly to <code>execute()</code>, <code>executemany()</code>, <code>copy\_expert()</code> in place of the query string.

Composable objects can be joined using the + operator: the result will be a *Composed* instance containing the objects joined. The operator \* is also supported with an integer argument: the result is a Composed instance containing the left argument repeated as many times as requested.

```
as_string(context)
```

Return the string value of the object.

#### **Parameters**

**context** (connection or cursor) – the context to evaluate the string into.

The method is automatically invoked by <code>execute()</code>, <code>executemany()</code>, <code>copy\_expert()</code> if a Composable is passed instead of the query string.

```
class psycopg2.sql.SQL(string)
```

A Composable representing a snippet of SQL statement.

SQL exposes *join()* and *format()* methods useful to create a template where to merge variable parts of a query (for instance field or table names).

The *string* doesn't undergo any form of escaping, so it is not suitable to represent variable identifiers or values: you should only use it to pass constant strings representing templates or snippets of SQL statements; use other objects such as *Identifier* or *Literal* to represent variable parts.

#### Example:

```
>>> query = sql.SQL("select {0} from {1}").format(
... sql.SQL(', ').join([sql.Identifier('foo'), sql.Identifier('bar')]),
... sql.Identifier('table'))
>>> print(query.as_string(conn))
select "foo", "bar" from "table"
```

#### string

The string wrapped by the SQL object.

```
format(*args, **kwargs)
```

Merge Composable objects into a template.

#### **Parameters**

- args (Composable) parameters to replace to numbered ({0}, {1}) or auto-numbered ({}) placeholders
- **kwargs** (Composable) parameters to replace to named ({name}) placeholders

#### Returns

the union of the SQL string with placeholders replaced

#### **Return type**

Composed

The method is similar to the Python str.format() method: the string template supports auto-numbered ( $\{\}$ ), numbered ( $\{0\}$ ,  $\{1\}$ ...), and named placeholders ( $\{$ name $\}$ ), with positional arguments replacing the numbered placeholders and keywords replacing the named ones. However placeholder modifiers ( $\{0!r\}$ ,  $\{0:<10\}$ ) are not supported. Only Composable objects can be passed to the template.

#### Example:

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```
join(seq)
```

Join a sequence of Composable.

#### **Parameters**

**seq** (iterable of Composable) – the elements to join.

Use the SQL object's *string* to separate the elements in *seq*. Note that *Composed* objects are iterable too, so they can be used as argument for this method.

#### Example:

```
>>> snip = sql.SQL(', ').join(
... sql.Identifier(n) for n in ['foo', 'bar', 'baz'])
>>> print(snip.as_string(conn))
"foo", "bar", "baz"
```

#### class psycopg2.sql.Identifier(\*strings)

A Composable representing an SQL identifier or a dot-separated sequence.

Identifiers usually represent names of database objects, such as tables or fields. PostgreSQL identifiers follow different rules than SQL string literals for escaping (e.g. they use double quotes instead of single).

#### Example:

```
>>> t1 = sql.Identifier("foo")
>>> t2 = sql.Identifier("ba'r")
>>> t3 = sql.Identifier('ba"z')
>>> print(sql.SQL(', ').join([t1, t2, t3]).as_string(conn))
"foo", "ba'r", "ba""z"
```

Multiple strings can be passed to the object to represent a qualified name, i.e. a dot-separated sequence of identifiers.

#### Example:

```
>>> query = sql.SQL("select {} from {}").format(
... sql.Identifier("table", "field"),
... sql.Identifier("schema", "table"))
>>> print(query.as_string(conn))
select "table"."field" from "schema"."table"
```

Changed in version 2.8: added support for multiple strings.

#### strings

A tuple with the strings wrapped by the *Identifier*.

Added in version 2.8: previous verions only had a string attribute. The attribute still exists but is deprecate and will only work if the Identifier wraps a single string.

#### class psycopg2.sql.Literal(wrapped)

A *Composable* representing an SQL value to include in a query.

Usually you will want to include placeholders in the query and pass values as **execute()** arguments. If however you really need to include a literal value in the query you can use this object.

The string returned by as\_string() follows the normal *adaptation rules* for Python objects.

Example:

```
>>> s1 = sql.Literal("foo")
>>> s2 = sql.Literal("ba'r")
>>> s3 = sql.Literal(42)
>>> print(sql.SQL(', ').join([s1, s2, s3]).as_string(conn))
'foo', 'ba''r', 42
```

#### wrapped

The object wrapped by the Literal.

#### class psycopg2.sq1.Placeholder(name=None)

A Composable representing a placeholder for query parameters.

If the name is specified, generate a named placeholder (e.g. %(name)s), otherwise generate a positional placeholder (e.g. %s).

The object is useful to generate SQL queries with a variable number of arguments.

#### **Examples:**

```
>>> names = ['foo', 'bar', 'baz']
>>> q1 = sql.SQL("insert into table ({}) values ({})").format(
... sql.SQL(', ').join(map(sql.Identifier, names)),
... sql.SQL(', ').join(sql.Placeholder() * len(names)))
>>> print(q1.as_string(conn))
insert into table ("foo", "bar", "baz") values (%s, %s, %s)
>>> q2 = sql.SQL("insert into table ({}) values ({})").format(
... sql.SQL(', ').join(map(sql.Identifier, names)),
... sql.SQL(', ').join(map(sql.Placeholder, names)))
>>> print(q2.as_string(conn))
insert into table ("foo", "bar", "baz") values (%(foo)s, %(bar)s, %(baz)s)
```

#### name

The name of the Placeholder.

#### class psycopg2.sql.Composed(seq)

A *Composable* object made of a sequence of Composable.

The object is usually created using Composable operators and methods. However it is possible to create a Composed directly specifying a sequence of Composable as arguments.

Example:

```
>>> comp = sql.Composed(
... [sql.SQL("insert into "), sql.Identifier("table")])
>>> print(comp.as_string(conn))
insert into "table"
```

Composed objects are iterable (so they can be used in SQL. join for instance).

#### seq

The list of the content of the Composed.

#### join(joiner)

Return a new Composed interposing the *joiner* with the Composed items.

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The *joiner* must be a *SQL* or a string which will be interpreted as an *SQL*.

# Example:

```
>>> fields = sql.Identifier('foo') + sql.Identifier('bar') # a Composed
>>> print(fields.join(', ').as_string(conn))
"foo", "bar"
```

# PSYCOPG2.TZ - TZINFO IMPLEMENTATIONS FOR PSYCOPG 2

Deprecated since version 2.9: The module will be dropped in psycopg 2.10. Use datetime.timezone instead.

This module holds two different tzinfo implementations that can be used as the tzinfo argument to datetime constructors, directly passed to Psycopg functions or used to set the *cursor.tzinfo\_factory* attribute in cursors.

#### class psycopg2.tz.FixedOffsetTimezone(offset=None, name=None)

Fixed offset in minutes east from UTC.

This is exactly the implementation found in Python 2.3.x documentation, with a small change to the \_\_init\_\_() method to allow for pickling and a default name in the form shift: MM (s is the sign.).

The implementation also caches instances. During creation, if a FixedOffsetTimezone instance has previously been created with the same offset and name that instance will be returned. This saves memory and improves comparability.

Changed in version 2.9: The constructor can take either a timedelta or a number of minutes of offset. Previously only minutes were supported.

#### class psycopg2.tz.LocalTimezone

Platform idea of local timezone.

This is the exact implementation from the Python 2.3 documentation.

| Psycopg Documentation, Release 2.9.10 |  |  |  |  |  |  |
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# PSYCOPG2.POOL - CONNECTIONS POOLING

Creating new PostgreSQL connections can be an expensive operation. This module offers a few pure Python classes implementing simple connection pooling directly in the client application.

class psycopg2.pool.AbstractConnectionPool(minconn, maxconn, \\*args, \\*\\*kwargs)

Base class implementing generic key-based pooling code.

New *minconn* connections are created automatically. The pool will support a maximum of about *maxconn* connections. \*args and \*\*kwargs are passed to the *connect()* function.

The following methods are expected to be implemented by subclasses:

#### getconn(key=None)

Get a free connection from the pool.

The *key* parameter is optional: if used, the connection will be associated to the key and calling getconn() with the same key again will return the same connection.

putconn(conn, key=None, close=False)

Put away a connection.

If *close* is True, discard the connection from the pool. *key* should be used consistently with *getconn()*.

#### closeall()

Close all the connections handled by the pool.

Note that all the connections are closed, including ones eventually in use by the application.

The following classes are AbstractConnectionPool subclasses ready to be used.

class psycopg2.pool.SimpleConnectionPool(minconn, maxconn, \*args, \*\*kwargs)

A connection pool that can't be shared across different threads.

#### 1 Note

This pool class is useful only for single-threaded applications.

class psycopg2.pool.ThreadedConnectionPool(minconn, maxconn, \*args, \*\*kwargs)

A connection pool that works with the threading module.

#### 1 Note

This pool class can be safely used in multi-threaded applications.

**CHAPTER** 

**THIRTEEN** 

# PSYCOPG2. ERRORCODES - ERROR CODES DEFINED BY POSTGRESQL

Added in version 2.0.6.

This module contains symbolic names for all PostgreSQL error codes and error classes codes. Subclasses of Error make the PostgreSQL error code available in the pgcode attribute.

From PostgreSQL documentation:

All messages emitted by the PostgreSQL server are assigned five-character error codes that follow the SQL standard's conventions for SQLSTATE codes. Applications that need to know which error condition has occurred should usually test the error code, rather than looking at the textual error message. The error codes are less likely to change across PostgreSQL releases, and also are not subject to change due to localization of error messages. Note that some, but not all, of the error codes produced by PostgreSQL are defined by the SQL standard; some additional error codes for conditions not defined by the standard have been invented or borrowed from other databases.

According to the standard, the first two characters of an error code denote a class of errors, while the last three characters indicate a specific condition within that class. Thus, an application that does not recognize the specific error code can still be able to infer what to do from the error class.

```
See also
PostgreSQL Error Codes table
```

An example of the available constants defined in the module:

```
>>> errorcodes.CLASS_SYNTAX_ERROR_OR_ACCESS_RULE_VIOLATION
'42'
>>> errorcodes.UNDEFINED_TABLE
'42P01'
```

Constants representing all the error values defined by PostgreSQL versions between 8.1 and 15 are included in the module.

```
psycopg2.errorcodes.lookup(code)
```

Lookup an error code or class code and return its symbolic name.

Raise KeyError if the code is not found.

```
>>> try:
        cur.execute("SELECT ouch FROM aargh;")
   except Exception as e:
        pass
```

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```
...
>>> errorcodes.lookup(e.pgcode[:2])
'CLASS_SYNTAX_ERROR_OR_ACCESS_RULE_VIOLATION'
>>> errorcodes.lookup(e.pgcode)
'UNDEFINED_TABLE'
```

Added in version 2.0.14.

# FREQUENTLY ASKED QUESTIONS

Here are a few gotchas you may encounter using *psycopg2*. Feel free to suggest new entries!

# 14.1 Meta

#### How do I ask a question?

- Have you first checked if your question is answered already in the documentation?
- If your question is about installing psycopg, have you checked the install FAQ and the install docs?
- · Have you googled for your error message?
- If you haven't found an answer yet, please write to the Mailing List.
- If you haven't found a bug, DO NOT write to the bug tracker to ask questions. You will only get piro grumpy.

# 14.2 Problems with transactions handling

#### Why does psycopg2 leave database sessions "idle in transaction"?

Psycopg normally starts a new transaction the first time a query is executed, e.g. calling *cursor.execute()*, even if the command is a SELECT. The transaction is not closed until an explicit *commit()* or *rollback()*.

If you are writing a long-living program, you should probably make sure to call one of the transaction closing methods before leaving the connection unused for a long time (which may also be a few seconds, depending on the concurrency level in your database). Alternatively you can use a connection in *autocommit* mode to avoid a new transaction to be started at the first command.

# I receive the error current transaction is aborted, commands ignored until end of transaction block and can't do anything else!

There was a problem *in the previous* command to the database, which resulted in an error. The database will not recover automatically from this condition: you must run a *rollback()* before sending new commands to the session (if this seems too harsh, remember that PostgreSQL supports nested transactions using the SAVEPOINT command).

# Why do I get the error current transaction is aborted, commands ignored until end of transaction block when I use multiprocessing (or any other forking system) and not when use threading?

Psycopg's connections can't be shared across processes (but are thread safe). If you are forking the Python process make sure to create a new connection in each forked child. See *Thread and process safety* for further informations.

# 14.3 Problems with type conversions

#### Why does cursor.execute() raise the exception can't adapt?

Psycopg converts Python objects in a SQL string representation by looking at the object class. The exception is raised when you are trying to pass as query parameter an object for which there is no adapter registered for its class. See *Adapting new Python types to SQL syntax* for informations.

#### I can't pass an integer or a float parameter to my query: it says a number is required, but it is a number!

In your query string, you always have to use %s placeholders, even when passing a number. All Python objects are converted by Psycopg in their SQL representation, so they get passed to the query as strings. See *Passing parameters to SQL queries*.

```
>>> cur.execute("INSERT INTO numbers VALUES (%d)", (42,)) # WRONG
>>> cur.execute("INSERT INTO numbers VALUES (%s)", (42,)) # correct
```

I try to execute a query but it fails with the error not all arguments converted during string formatting (or object does not support indexing). Why?

Psycopg always require positional arguments to be passed as a sequence, even when the query takes a single parameter. And remember that to make a single item tuple in Python you need a comma! See *Passing parameters to SQL queries*.

```
>>> cur.execute("INSERT INTO foo VALUES (%s)", "bar") # WRONG
>>> cur.execute("INSERT INTO foo VALUES (%s)", ("bar")) # WRONG
>>> cur.execute("INSERT INTO foo VALUES (%s)", ("bar",)) # correct
>>> cur.execute("INSERT INTO foo VALUES (%s)", ["bar"]) # correct
```

My database is Unicode, but I receive all the strings as UTF-8 str. Can I receive unicode objects instead?

The following magic formula will do the trick:

```
psycopg2.extensions.register_type(psycopg2.extensions.UNICODE)
psycopg2.extensions.register_type(psycopg2.extensions.UNICODEARRAY)
```

See *Unicode handling* for the gory details.

My database is in mixed encoding. My program was working on Python 2 but Python 3 fails decoding the strings. How do I avoid decoding?

From psycopg 2.8 you can use the following adapters to always return bytes from strings:

```
psycopg2.extensions.register_type(psycopg2.extensions.BYTES)
psycopg2.extensions.register_type(psycopg2.extensions.BYTESARRAY)
```

See *Unicode handling* for an example.

Psycopg converts decimal/numeric database types into Python Decimal objects. Can I have float instead? You can register a customized adapter for PostgreSQL decimal type:

```
DEC2FLOAT = psycopg2.extensions.new_type(
    psycopg2.extensions.DECIMAL.values,
    'DEC2FLOAT',
    lambda value, curs: float(value) if value is not None else None)
psycopg2.extensions.register_type(DEC2FLOAT)
```

See *Type casting of SQL types into Python objects* to read the relevant documentation. If you find psycopg2. extensions.DECIMAL not available, use psycopg2.\_psycopg.DECIMAL instead.

Psycopg automatically converts PostgreSQL json data into Python objects. How can I receive strings instead? The easiest way to avoid JSON parsing is to register a no-op function with register\_default\_json():

```
psycopg2.extras.register_default_json(loads=lambda x: x)
```

See JSON adaptation for further details.

# Psycopg converts json values into Python objects but jsonb values are returned as strings. Can jsonb be converted automatically?

Automatic conversion of jsonb values is supported from Psycopg release 2.5.4. For previous versions you can register the json typecaster on the jsonb oids (which are known and not supposed to change in future PostgreSQL versions):

```
psycopg2.extras.register_json(oid=3802, array_oid=3807, globally=True)
```

See JSON adaptation for further details.

#### How can I pass field/table names to a query?

The arguments in the *execute()* methods can only represent data to pass to the query: they cannot represent a table or field name:

```
# This doesn't work
cur.execute("insert into %s values (%s)", ["my_table", 42])
```

If you want to build a query dynamically you can use the objects exposed by the psycopg2.sql module:

```
cur.execute(
    sql.SQL("insert into %s values (%%s)") % [sql.Identifier("my_table")],
    [42])
```

#### Transferring binary data from PostgreSQL 9.0 doesn't work.

PostgreSQL 9.0 uses by default the "hex" format to transfer bytea data: the format can't be parsed by the libpq 8.4 and earlier. The problem is solved in Psycopg 2.4.1, that uses its own parser for the bytea format. For previous Psycopg releases, three options to solve the problem are:

- set the bytea output parameter to escape in the server;
- execute the database command SET bytea\_output TO escape; in the session before reading binary data;
- upgrade the libpq library on the client to at least 9.0.

#### Arrays of TYPE are not casted to list.

Arrays are only casted to list when their oid is known, and an array typecaster is registered for them. If there is no typecaster, the array is returned unparsed from PostgreSQL (e.g. {a,b,c}). It is easy to create a generic arrays typecaster, returning a list of array: an example is provided in the new\_array\_type() documentation.

# 14.4 Best practices

#### When should I save and re-use a cursor as opposed to creating a new one as needed?

Cursors are lightweight objects and creating lots of them should not pose any kind of problem. But note that cursors used to fetch result sets will cache the data and use memory in proportion to the result set size. Our suggestion is to almost always create a new cursor and dispose old ones as soon as the data is not required anymore (call <code>close()</code> on them.) The only exception are tight loops where one usually use the same cursor for a whole bunch of INSERTs or UPDATEs.

#### When should I save and re-use a connection as opposed to creating a new one as needed?

Creating a connection can be slow (think of SSL over TCP) so the best practice is to create a single connection and keep it open as long as required. It is also good practice to rollback or commit frequently (even after a single

SELECT statement) to make sure the backend is never left "idle in transaction". See also *psycopg2.pool* for lightweight connection pooling.

#### What are the advantages or disadvantages of using named cursors?

The only disadvantages is that they use up resources on the server and that there is a little overhead because at least two queries (one to create the cursor and one to fetch the initial result set) are issued to the backend. The advantage is that data is fetched one chunk at a time: using small <code>fetchmany()</code> values it is possible to use very little memory on the client and to skip or discard parts of the result set.

#### How do I interrupt a long-running query in an interactive shell?

Normally the interactive shell becomes unresponsive to Ctrl-C when running a query. Using a connection in green mode allows Python to receive and handle the interrupt, although it may leave the connection broken, if the async callback doesn't handle the KeyboardInterrupt correctly.

Starting from psycopg 2.6.2, the *wait\_select* callback can handle a Ctrl-C correctly. For previous versions, you can use this implementation.

```
>>> psycopg2.extensions.set_wait_callback(psycopg2.extras.wait_select)
>>> cnn = psycopg2.connect('')
>>> cur = cnn.cursor()
>>> cur.execute("select pg_sleep(10)")
^C
Traceback (most recent call last):
   File "<stdin>", line 1, in <module>
    QueryCanceledError: canceling statement due to user request
>>> cnn.rollback()
>>> # You can use the connection and cursor again from here
```

# 14.5 Problems compiling and installing psycopg2

# Psycopg 2.8 fails to install, Psycopg 2.7 was working fine.

With Psycopg 2.7 you were installing binary packages, but they have proven unreliable so now you have to install them explicitly using the psycopg2-binary package. See *Quick Install* for all the details.

# I can't compile psycopg2: the compiler says *error: Python.h: No such file or directory.* What am I missing? You need to install a Python development package: it is usually called python-dev or python3-dev according to your Python version.

I can't compile psycopg2: the compiler says *error*: *libpq-fe.h*: *No such file or directory*. What am I missing? You need to install the development version of the libpq: the package is usually called libpq-dev.

#### psycopg2 raises ImportError with message psycopg.so: undefined symbol: lo truncate when imported.

This means that Psycopg was compiled with lo\_truncate() support (*i.e.* the libpq used at compile time was version >= 8.3) but at runtime an older libpq dynamic library is found.

Fast-forward several years, if the message reports *undefined symbol: lo\_truncate64* it means that Psycopg was built with large objects 64 bits API support (*i.e.* the libpq used at compile time was at least 9.3) but at runtime an older libpq dynamic library is found.

You can use:

```
$ ldd /path/to/packages/psycopg2/_psycopg.so | grep libpq
```

to find what is the libpq dynamic library used at runtime.

You can avoid the problem by using the same version of the **pg\_config** at install time and the libpq at runtime.

Psycopg raises ImportError: cannot import name tz on import in mod\_wsgi / ASP, but it works fine otherwise. If psycopg2 is installed in an egg (e.g. because installed by easy\_install), the user running the program may be unable to write in the eggs cache. Set the env variable PYTHON\_EGG\_CACHE to a writable directory. With modwsgi you can use the WSGIPythonEggs directive.

**CHAPTER** 

# **FIFTEEN**

# **RELEASE NOTES**

# 15.1 Current release

# 15.1.1 What's new in psycopg 2.9.10

- Add support for Python 3.13.
- Receive notifications on commit (ticket #1728).
- errorcodes map and errors classes updated to PostgreSQL 17.
- Drop support for Python 3.7.

# 15.1.2 What's new in psycopg 2.9.9

- Add support for Python 3.12.
- Drop support for Python 3.6.

# 15.1.3 What's new in psycopg 2.9.8

• Wheel package bundled with PostgreSQL 16 libpq in order to add support for recent features, such as sslcertmode.

# 15.1.4 What's new in psycopg 2.9.7

- Fix propagation of exceptions raised during module initialization (ticket #1598).
- Fix building when pg\_config returns an empty string (ticket #1599).
- Wheel package bundled with OpenSSL 1.1.1v.

# 15.1.5 What's new in psycopg 2.9.6

- Package manylinux 2014 for aarch64 and ppc64le platforms, in order to include libpq 15 in the binary package (ticket #1396).
- Wheel package bundled with OpenSSL 1.1.1t.

# 15.1.6 What's new in psycopg 2.9.5

- Add support for Python 3.11.
- Add support for rowcount in MERGE statements in binary packages (ticket #1497).
- Wheel package bundled with OpenSSL 1.1.1r and PostgreSQL 15 libpq.

# 15.1.7 What's new in psycopg 2.9.4

- Fix register\_composite(), register\_range() with customized search\_path (ticket #1487).
- Handle correctly composite types with names or in schemas requiring escape.
- Find pg\_service.conf file in the /etc/postgresql-common directory in binary packages (ticket #1365).
- errorcodes map and errors classes updated to PostgreSQL 15.
- Wheel package bundled with OpenSSL 1.1.1q and PostgreSQL 14.4 libpq.

# 15.1.8 What's new in psycopg 2.9.3

- Alpine (musl) wheels now available (ticket #1392).
- macOS arm64 (Apple M1) wheels now available (ticket 1482).

# 15.1.9 What's new in psycopg 2.9.2

- Raise ValueError for dates >= Y10k (ticket #1307).
- errorcodes map and errors classes updated to PostgreSQL 14.
- Add preliminary support for Python 3.11 (tickets #1376, #1386).
- Wheel package bundled with OpenSSL 1.1.11 and PostgreSQL 14.1 libpq (ticket #1388).

# 15.1.10 What's new in psycopg 2.9.1

• Fix regression with named *Placeholder* (ticket #1291).

# 15.2 What's new in psycopg 2.9

- with connection starts a transaction on autocommit transactions too (ticket #941).
- Timezones with fractional minutes are supported on Python 3.7 and following (ticket #1272).
- Escape table and column names in copy\_from() and copy\_to().
- Connection exceptions with sqlstate **08XXX** reclassified as *OperationalError* (a subclass of the previously used *DatabaseError*) (ticket #1148).
- Include library dirs required from libpq to work around MacOS build problems (ticket #1200).

#### Other changes:

- Dropped support for Python 2.7, 3.4, 3.5 (tickets #1198, #1000, #1197).
- Dropped support for mx.DateTime.
- Use datetime.timezone objects by default in datetime objects instead of FixedOffsetTimezone.
- The *psycopg2*. tz module is deprecated and scheduled to be dropped in the next major release.
- Provide PEP 599 wheels packages (manylinux2014 tag) for i686 and x86\_64 platforms.
- Provide PEP 600 wheels packages (manylinux\_2\_24 tag) for aarch64 and ppc64le platforms.
- Wheel package bundled with OpenSSL 1.1.1k and PostgreSQL 13.3 libpq.
- Build system for Linux/MacOS binary packages moved to GitHub Actions.

# 15.2.1 What's new in psycopg 2.8.7

- Accept empty params as connect() (ticket #1250).
- Fix attributes refcount in Column initialisation (ticket #1252).
- Allow re-initialisation of static variables in the C module (ticket #1267).

#### 15.2.2 What's new in psycopg 2.8.6

- Fixed memory leak changing connection encoding to the current one (ticket #1101).
- Fixed search of mxDateTime headers in virtualenvs (ticket #996).
- Added missing values from errorcodes (ticket #1133).
- cursor.query reports the query of the last COPY operation too (ticket #1141).
- errorcodes map and errors classes updated to PostgreSQL 13.
- Added wheel packages for ARM architecture (ticket #1125).
- Wheel package bundled with OpenSSL 1.1.1g.

# 15.2.3 What's new in psycopg 2.8.5

- Fixed use of connection\_factory and cursor\_factory together (ticket #1019).
- Added support for LoggerAdapter in LoggingConnection (ticket #1026).
- Column objects in cursor.description can be sliced (ticket #1034).
- Added AIX support (ticket #1061).
- Fixed copy() of *DictCursor* rows (ticket #1073).

# 15.2.4 What's new in psycopg 2.8.4

- Fixed building with Python 3.8 (ticket #854).
- Don't swallow keyboard interrupts on connect when a password is specified in the connection string (ticket #898).
- Don't advance replication cursor when the message wasn't confirmed (ticket #940).
- Fixed inclusion of time.h on linux (ticket #951).
- Fixed int overflow for large values in table\_oid and type\_code (ticket #961).
- errorcodes map and errors classes updated to PostgreSQL 12.
- Wheel package bundled with OpenSSL 1.1.1d and PostgreSQL at least 11.4.

# 15.2.5 What's new in psycopg 2.8.3

- Added *interval\_status* parameter to *start\_replication()* method and other facilities to send automatic replication keepalives at periodic intervals (ticket #913).
- Fixed namedtuples caching introduced in 2.8 (ticket #928).

# 15.2.6 What's new in psycopg 2.8.2

- Fixed RealDictCursor when there are repeated columns (ticket #884).
- Binary packages built with openssl 1.1.1b. Should fix concurrency problems (tickets #543, #836).

#### 15.2.7 What's new in psycopg 2.8.1

- Fixed RealDictRow modifiability (ticket #886).
- Fixed "there's no async cursor" error polling a connection with no cursor (ticket #887).

# 15.3 What's new in psycopg 2.8

#### New features:

- Added errors module. Every PostgreSQL error is converted into a specific exception class (ticket #682).
- Added encrypt\_password() function (ticket #576).
- Added BYTES adapter to manage databases with mixed encodings on Python 3 (ticket #835).
- Added table\_oid and table\_column attributes on cursor.description items (ticket #661).
- Added *connection*. info object to retrieve various PostgreSQL connection information (ticket #726).
- Added *get\_native\_connection()* to expose the raw PGconn structure to C extensions via Capsule (ticket #782).
- Added *pgconn\_ptr* and *pgresult\_ptr* to expose raw C structures to Python and interact with libpq via ctypes (ticket #782).
- Identifier can represent qualified names in SQL composition (ticket #732).
- Added ReplicationCursor.wal\_end attribute (ticket #800).
- Added *fetch* parameter to execute\_values() function (ticket #813).
- str() on Range produces a human-readable representation (ticket #773).
- DictCursor and RealDictCursor rows maintain columns order (ticket #177).
- Added severity\_nonlocalized attribute on the Diagnostics object (ticket #783).
- More efficient NamedTupleCursor (ticket #838).

#### Bug fixes:

- Fixed connections occasionally broken by the unrelated use of the multiprocessing module (ticket #829).
- Fixed async communication blocking if results are returned in different chunks, e.g. with notices interspersed to the results (ticket #856).
- Fixed adaptation of numeric subclasses such as IntEnum (ticket #591).

#### Other changes:

- Dropped support for Python 2.6, 3.2, 3.3.
- Dropped psycopg1 module.
- Dropped deprecated register\_tstz\_w\_secs() (was previously a no-op).
- Dropped deprecated PersistentConnectionPool. This pool class was mostly designed to interact with Zope. Use ZPsycopgDA.pool instead.
- Binary packages no longer installed by default. The 'psycopg2-binary' package must be used explicitly.
- Dropped PSYCOPG\_DISPLAY\_SIZE build parameter.
- Dropped support for mxDateTime as the default date and time adapter. mxDatetime support continues to be available as an alternative to Python's builtin datetime.
- No longer use 2to3 during installation for Python 2 & 3 compatibility. All source files are now compatible with Python 2 & 3 as is.
- The psycopg2.test package is no longer installed by python setup.py install.
- Wheel package bundled with OpenSSL 1.0.2r and PostgreSQL 11.2 libpq.

# 15.3.1 What's new in psycopg 2.7.7

- Cleanup of the cursor results assignment code, which might have solved double free and inconsistencies in concurrent usage (tickets #346, #384).
- Wheel package bundled with OpenSSL 1.0.2q.

#### 15.3.2 What's new in psycopg 2.7.6.1

- Fixed binary package broken on OS X 10.12 (ticket #807).
- Wheel package bundled with PostgreSQL 11.1 libpq.

# 15.3.3 What's new in psycopg 2.7.6

- Close named cursors if exist, even if execute() wasn't called (ticket #746).
- Fixed building on modern FreeBSD versions with Python 3.7 (ticket #755).
- Fixed hang trying to COPY via execute() in asynchronous connections (ticket #781).
- Fixed adaptation of arrays of empty arrays (ticket #788).
- Fixed segfault accessing the connection's readonly and deferrable attributes repeatedly (ticket #790).
- execute\_values() accepts Composable objects (ticket #794).
- errorcodes map updated to PostgreSQL 11.
- Wheel package bundled with PostgreSQL 10.5 libpq and OpenSSL 1.0.2p.

#### 15.3.4 What's new in psycopg 2.7.5

- Allow non-ascii chars in namedtuple fields (regression introduced fixing ticket #211).
- Fixed adaptation of arrays of arrays of nulls (ticket #325).
- Fixed building on Solaris 11 and derivatives such as SmartOS and illumos (ticket #677).
- Maybe fixed building on MSYS2 (as reported in ticket #658).
- Allow string subclasses in connection and other places (ticket #679).
- Don't raise an exception closing an unused named cursor (ticket #716).
- Wheel package bundled with PostgreSQL 10.4 libpq and OpenSSL 1.0.2o.

#### 15.3.5 What's new in psycopg 2.7.4

- Moving away from installing the wheel package by default. Packages installed from wheel raise a warning on import. Added package psycopg2-binary to install from wheel instead (ticket #543).
- Convert fields names into valid Python identifiers in NamedTupleCursor (ticket #211).
- Fixed Solaris 10 support (ticket #532).
- cursor.mogrify() can be called on closed cursors (ticket #579).
- Fixed setting session characteristics in corner cases on autocommit connections (ticket #580).

- Fixed MinTimeLoggingCursor on Python 3 (ticket #609).
- Fixed parsing of array of points as floats (ticket #613).
- Fixed \_\_libpq\_version\_ building with libpq >= 10.1 (ticket #632).
- Fixed rowcount after executemany() with RETURNING statements (ticket #633).
- Fixed compatibility problem with pypy3 (ticket #649).
- Wheel packages bundled with PostgreSQL 10.1 libpq and OpenSSL 1.0.2n.
- Wheel packages for Python 2.6 no more available (support dropped from wheel building infrastructure).

# 15.3.6 What's new in psycopg 2.7.3.2

• Wheel package bundled with PostgreSQL 10.0 libpq and OpenSSL 1.0.2l (tickets #601, #602).

# 15.3.7 What's new in psycopg 2.7.3.1

• Dropped libresolv from wheel package to avoid incompatibility with glibc 2.26 (wheels ticket #2).

#### 15.3.8 What's new in psycopg 2.7.3

• Restored default timestamptz[] typecasting to Python datetime. Regression introduced in Psycopg 2.7.2 (ticket #578).

#### 15.3.9 What's new in psycopg 2.7.2

- Fixed inconsistent state in externally closed connections (tickets #263, #311, #443). Was fixed in 2.6.2 but not included in 2.7 by mistake.
- Fixed Python exceptions propagation in green callback (ticket #410).
- Don't display the password in *connection.dsn* when the connection string is specified as an URI (ticket #528).
- Return objects with timezone parsing "infinity" timestamptz (ticket #536).
- Dropped dependency on VC9 runtime on Windows binary packages (ticket #541).
- Fixed segfault in *lobject()* when *mode*=None (ticket #544).
- Fixed *lobject()* keyword argument *lobject\_factory* (ticket #545).
- Fixed consume\_stream() keepalive\_interval argument (ticket #547).
- Maybe fixed random import error on Python 3.6 in multiprocess environment (ticket #550).
- Fixed random SystemError upon receiving abort signal (ticket #551).
- Accept Composable objects in start\_replication\_expert() (ticket #554).
- Parse intervals returned as microseconds from Redshift (ticket #558).
- Added Json prepare() method to consider connection params when adapting (ticket #562).
- errorcodes map updated to PostgreSQL 10 beta 1.

# 15.3.10 What's new in psycopg 2.7.1

- Ignore None arguments passed to *connect()* and *make\_dsn()* (ticket #517).
- OpenSSL upgraded from major version 0.9.8 to 1.0.2 in the Linux wheel packages (ticket #518).
- Fixed build with libpq versions < 9.3 (ticket #520).

# 15.4 What's new in psycopg 2.7

#### New features:

- Added *sq1* module to generate SQL dynamically (ticket #308).
- Added *Replication protocol support* (ticket #322). Main authors are Oleksandr Shulgin and Craig Ringer, who deserve a huge thank you.
- Added parse\_dsn() and make\_dsn() functions (tickets #321, #363). connect() now can take both dsn and keyword arguments, merging them together.
- Added \_\_libpq\_version\_\_ and libpq\_version() to inspect the version of the libpq library the module was bundled with (tickets #35, #323).
- The attributes *notices* and *notifies* can be customized replacing them with any object exposing an append() method (ticket #326).
- Adapt network types to ipaddress objects when available. When not enabled, convert arrays of network types to lists by default. The old Inet adapter is deprecated (tickets #317, #343, #387).
- Added quote\_ident() function (ticket #359).
- Added get\_dsn\_parameters() connection method (ticket #364).
- callproc() now accepts a dictionary of parameters (ticket #381).
- Give precedence to \_\_conform\_\_() over superclasses to choose an object adapter (ticket #456).
- Using Python C API decoding functions and codecs caching for faster unicode encoding/decoding (ticket #473).
- executemany() slowness addressed by execute\_batch() and execute\_values() (ticket #491).
- Added async\_ as an alias for async to support Python 3.7 where async will become a keyword (ticket #495).
- Unless in autocommit, do not use default\_transaction\_\* settings to control the session characteristics as it may create problems with external connection pools such as pgbouncer; use BEGIN options instead (ticket #503).
- isolation\_level is now writable and entirely separated from autocommit; added readonly, deferrable writable attributes.

#### Bug fixes:

- Throw an exception trying to pass NULL chars as parameters (ticket #420).
- Fixed error caused by missing decoding *LoggingConnection* (ticket #483).
- Fixed integer overflow in interval seconds (ticket #512).
- Make Range objects picklable (ticket #462).
- Fixed version parsing and building with PostgreSQL 10 (ticket #489).

#### Other changes:

• Dropped support for Python 2.5 and 3.1.

- Dropped support for client library older than PostgreSQL 9.1 (but older server versions are still supported).
- isolation\_level doesn't read from the database but will return ISOLATION\_LEVEL\_DEFAULT if no value was
  set on the connection.
- Empty arrays no more converted into lists if they don't have a type attached (ticket #506)

# 15.4.1 What's new in psycopg 2.6.2

- Fixed inconsistent state in externally closed connections (tickets #263, #311, #443).
- Report the server response status on errors (such as ticket #281).
- Raise NotSupportedError on unhandled server response status (ticket #352).
- Allow overriding string adapter encoding with no connection (ticket #331).
- The wait\_select callback allows interrupting a long-running query in an interactive shell using Ctrl-C (ticket #333).
- Fixed PersistentConnectionPool on Python 3 (ticket #348).
- Fixed segfault on repr() of an unitialized connection (ticket #361).
- Allow adapting bytes using QuotedString on Python 3 (ticket #365).
- Added support for setuptools/wheel (ticket #370).
- Fix build on Windows with Python 3.5, VS 2015 (ticket #380).
- Fixed errorcodes.lookup initialization thread-safety (ticket #382).
- Fixed read() exception propagation in copy\_from (ticket #412).
- Fixed possible NULL TZ decref (ticket #424).
- errorcodes map updated to PostgreSQL 9.5.

# 15.4.2 What's new in psycopg 2.6.1

- Lists consisting of only None are escaped correctly (ticket #285).
- Fixed deadlock in multithread programs using OpenSSL (ticket #290).
- Correctly unlock the connection after error in flush (ticket #294).
- Fixed MinTimeLoggingCursor.callproc() (ticket #309).
- Added support for MSVC 2015 compiler (ticket #350).

# 15.5 What's new in psycopg 2.6

#### New features:

- Added support for large objects larger than 2GB. Many thanks to Blake Rouse and the MAAS Team for the feature development.
- Python time objects with a tzinfo specified and PostgreSQL timetz data are converted into each other (ticket #272).

#### Bug fixes:

• Json adapter's str() returns the adapted content instead of the repr() (ticket #191).

# 15.5.1 What's new in psycopg 2.5.5

- Named cursors used as context manager don't swallow the exception on exit (ticket #262).
- *cursor.description* can be pickled (ticket #265).
- Propagate read error messages in COPY FROM (ticket #270).
- PostgreSQL time 24:00 is converted to Python 00:00 (ticket #278).

# 15.5.2 What's new in psycopg 2.5.4

- Added jsonb support for PostgreSQL 9.4 (ticket #226).
- Fixed segfault if COPY statements are passed to execute() instead of using the proper methods (ticket #219).
- Force conversion of pool arguments to integer to avoid potentially unbounded pools (ticket #220).
- Cursors WITH HOLD don't begin a new transaction upon move/fetch/close (ticket #228).
- Cursors WITH HOLD can be used in autocommit (ticket #229).
- callproc() doesn't silently ignore an argument without a length.
- Fixed memory leak with large objects (ticket #256).
- Make sure the internal \_psycopg.so module can be imported stand-alone (to allow modules juggling such as the one described in ticket #201).

# 15.5.3 What's new in psycopg 2.5.3

- Work around pip issue #1630 making installation via pip -e git+url impossible (ticket #18).
- Copy operations correctly set the *cursor.rowcount* attribute (ticket #180).
- It is now possible to call get\_transaction\_status() on closed connections.
- Fixed unsafe access to object names causing assertion failures in Python 3 debug builds (ticket #188).
- Mark the connection closed if found broken on poll() (from ticket #192 discussion)
- Fixed handling of dsn and closed attributes in connection subclasses failing to connect (from ticket #192 discussion).
- Added arbitrary but stable order to Range objects, thanks to Chris Withers (ticket #193).
- Avoid blocking async connections on connect (ticket #194). Thanks to Adam Petrovich for the bug report and diagnosis.
- Don't segfault using poorly defined cursor subclasses which forgot to call the superclass init (ticket #195).
- Mark the connection closed when a Socket connection is broken, as it happens for TCP connections instead (ticket #196).
- Fixed overflow opening a lobject with an oid not fitting in a signed int (ticket #203).
- Fixed handling of explicit default cursor\_factory=None in connection.cursor() (ticket #210).
- Fixed possible segfault in named cursors creation.
- Fixed debug build on Windows, thanks to James Emerton.

# 15.5.4 What's new in psycopg 2.5.2

- Fixed segfault pickling the exception raised on connection error (ticket #170).
- Meaningful connection errors report a meaningful message, thanks to Alexey Borzenkov (ticket #173).
- Manually creating lobject with the wrong parameter doesn't segfault (ticket #187).

# 15.5.5 What's new in psycopg 2.5.1

- Fixed build on Solaris 10 and 11 where the round() function is already declared (ticket #146).
- Fixed comparison of Range with non-range objects (ticket #164). Thanks to Chris Withers for the patch.
- Fixed double-free on connection dealloc (ticket #166). Thanks to Gangadharan S.A. for the report and fix suggestion.

# 15.6 What's new in psycopg 2.5

# New features:

- Added JSON adaptation.
- Added support for PostgreSQL 9.2 range types.
- connection and cursor objects can be used in with statements as context managers as specified by recent DB API 2.0 extension.
- Added *Diagnostics* object to get extended info from a database error. Many thanks to Matthew Woodcraft for the implementation (ticket #149).
- Added connection.cursor\_factory attribute to customize the default object returned by cursor().
- Added support for backward scrollable cursors. Thanks to Jon Nelson for the initial patch (ticket #108).
- Added a simple way to *customize casting of composite types* into Python objects other than namedtuples. Many thanks to Ronan Dunklau and Tobias Oberstein for the feature development.
- connection.reset() implemented using DISCARD ALL on server versions supporting it.

#### Bug fixes:

- Properly cleanup memory of broken connections (ticket #148).
- Fixed bad interaction of setup.py with other dependencies in Distribute projects on Python 3 (ticket #153).

#### Other changes:

- Added support for Python 3.3.
- Dropped support for Python 2.4. Please use Psycopg 2.4.x if you need it.
- errorcodes map updated to PostgreSQL 9.2.
- Dropped Zope adapter from source repository. ZPsycopgDA now has its own project at <a href="https://github.com/psycopg/ZPsycopgDA">https://github.com/psycopg/ZPsycopgDA</a>.

# 15.6.1 What's new in psycopg 2.4.6

- Fixed 'cursor()' arguments propagation in connection subclasses and overriding of the 'cursor\_factory' argument. Thanks to Corry Haines for the report and the initial patch (ticket #105).
- Dropped GIL release during string adaptation around a function call invoking a Python API function, which could cause interpreter crash. Thanks to Manu Cupcic for the report (ticket #110).
- Close a green connection if there is an error in the callback. Maybe a harsh solution but it leaves the program responsive (ticket #113).
- 'register\_hstore()', 'register\_composite()', 'tpc\_recover()' work with RealDictConnection and Cursor (ticket #114).
- Fixed broken pool for Zope and connections re-init across ZSQL methods in the same request (tickets #123, #125, #142).
- connect() raises an exception instead of swallowing keyword arguments when a connection string is specified as well (ticket #131).
- Discard any result produced by 'executemany()' (ticket #133).
- Fixed pickling of FixedOffsetTimezone objects (ticket #135).
- Release the GIL around PQgetResult calls after COPY (ticket #140).
- Fixed empty strings handling in composite caster (ticket #141).
- Fixed pickling of DictRow and RealDictRow objects.

# 15.6.2 What's new in psycopg 2.4.5

- The close() methods on connections and cursors don't raise exceptions if called on already closed objects.
- Fixed fetchmany() with no argument in cursor subclasses (ticket #84).
- Use lo\_creat() instead of lo\_create() when possible for better interaction with pgpool-II (ticket #88).
- Error and its subclasses are picklable, useful for multiprocessing interaction (ticket #90).
- Better efficiency and formatting of timezone offset objects thanks to Menno Smits (tickets #94, #95).
- Fixed 'rownumber' during iteration on cursor subclasses. Regression introduced in 2.4.4 (ticket #100).
- Added support for 'inet' arrays.
- Fixed 'commit()' concurrency problem (ticket #103).
- Codebase cleaned up using the GCC Python plugin's static analysis tool, which has revealed several unchecked return values, possible NULL dereferences, reference counting problems. Many thanks to David Malcolm for the useful tool and the assistance provided using it.

# 15.6.3 What's new in psycopg 2.4.4

- 'register\_composite()' also works with the types implicitly defined after a table row, not only with the ones created by 'CREATE TYPE'.
- Values for the isolation level symbolic constants restored to what they were before release 2.4.2 to avoid breaking apps using the values instead of the constants.
- Named DictCursor/RealDictCursor honour itersize (ticket #80).
- Fixed rollback on error on Zope (ticket #73).
- Raise 'DatabaseError' instead of 'Error' with empty libpq errors, consistently with other disconnection-related errors: regression introduced in release 2.4.1 (ticket #82).

# 15.6.4 What's new in psycopg 2.4.3

- connect() supports all the keyword arguments supported by the database
- Added 'new array type()' function for easy creation of array typecasters.
- Added support for arrays of hstores and composite types (ticket #66).
- Fixed segfault in case of transaction started with connection lost (and possibly other events).
- Fixed adaptation of Decimal type in sub-interpreters, such as in certain mod\_wsgi configurations (ticket #52).
- Rollback connections in transaction or in error before putting them back into a pool. Also discard broken connections (ticket #62).
- Lazy import of the slow uuid module, thanks to Marko Kreen.
- Fixed NamedTupleCursor.executemany() (ticket #65).
- Fixed –static-libpq setup option (ticket #64).
- Fixed interaction between RealDictCursor and named cursors (ticket #67).
- Dropped limit on the columns length in COPY operations (ticket #68).
- Fixed reference leak with arguments referenced more than once in queries (ticket #81).
- Fixed typecasting of arrays containing consecutive backslashes.
- 'errorcodes' map updated to PostgreSQL 9.1.

# 15.6.5 What's new in psycopg 2.4.2

- Added 'set\_session()' method and 'autocommit' property to the connection. Added support for read-only sessions and, for PostgreSQL 9.1, for the "repeatable read" isolation level and the "deferrable" transaction property.
- Psycopg doesn't execute queries at connection time to find the default isolation level.
- Fixed bug with multithread code potentially causing loss of sync with the server communication or lock of the client (ticket #55).
- Don't fail import if mx.DateTime module can't be found, even if its support was built (ticket #53).
- Fixed escape for negative numbers prefixed by minus operator (ticket #57).
- Fixed refcount issue during copy. Reported and fixed by Dave Malcolm (ticket #58, Red Hat Bug 711095).
- Trying to execute concurrent operations on the same connection through concurrent green thread results in an
  error instead of a deadlock.

 Fixed detection of pg\_config on Window. Report and fix, plus some long needed setup.py cleanup by Steve Lacy: thanks!

# 15.6.6 What's new in psycopg 2.4.1

- Use own parser for bytea output, not requiring anymore the libpq 9.0 to parse the hex format.
- Don't fail connection if the client encoding is a non-normalized variant. Issue reported by Peter Eisentraut.
- Correctly detect an empty query sent to the backend (ticket #46).
- Fixed a SystemError clobbering libpq errors raised without SQLSTATE. Bug vivisectioned by Eric Snow.
- Fixed interaction between NamedTuple and server-side cursors.
- Allow to specify –static-libpq on setup.py command line instead of just in 'setup.cfg'. Patch provided by Matthew Ryan (ticket #48).

# 15.7 What's new in psycopg 2.4

New features and changes:

- Added support for Python 3.1 and 3.2. The conversion has also brought several improvements:
  - Added 'b' and 't' mode to large objects: write can deal with both bytes strings and unicode; read can return
    either bytes strings or decoded unicode.
  - COPY sends Unicode data to files implementing 'io.TextIOBase'.
  - Improved PostgreSQL-Python encodings mapping.
  - Added a few missing encodings: EUC\_CN, EUC\_JIS\_2004, ISO885910, ISO885916, LATIN10, SHIFT\_JIS\_2004.
  - Dropped repeated dictionary lookups with unicode query/parameters.
- Improvements to the named cursors:
  - More efficient iteration on named cursors, fetching 'itersize' records at time from the backend.
  - The named cursors name can be an invalid identifier.
- Improvements in data handling:
  - Added 'register\_composite()' function to cast PostgreSQL composite types into Python tuples/namedtuples.
  - Adapt types 'bytearray' (from Python 2.6), 'memoryview' (from Python 2.7) and other objects implementing the "Revised Buffer Protocol" to 'bytea' data type.
  - The 'hstore' adapter can work even when the data type is not installed in the 'public' namespace.
  - Raise a clean exception instead of returning bad data when receiving bytea in 'hex' format and the client libpq can't parse them.
  - Empty lists correctly roundtrip Python -> PostgreSQL -> Python.
- · Other changes:
  - 'cursor.description' is provided as named tuples if available.
  - The build script refuses to guess values if 'pg\_config' is not found.

- Connections and cursors are weakly referenceable.

#### Bug fixes:

- Fixed adaptation of None in composite types (ticket #26). Bug report by Karsten Hilbert.
- Fixed several reference leaks in less common code paths.
- Fixed segfault when a large object is closed and its connection no more available.
- Added missing icon to ZPsycopgDA package, not available in Zope 2.12.9 (ticket #30). Bug report and patch by Pumukel.
- Fixed conversion of negative infinity (ticket #40). Bug report and patch by Marti Raudsepp.

# 15.7.1 What's new in psycopg 2.3.2

• Fixed segfault with middleware not passing DateStyle to the client (ticket #24). Bug report and patch by Marti Raudsepp.

# 15.7.2 What's new in psycopg 2.3.1

• Fixed build problem on CentOS 5.5 x86 64 (ticket #23).

# 15.8 What's new in psycopg 2.3

psycopg 2.3 aims to expose some new features introduced in PostgreSQL 9.0.

#### Main new features:

- dict to hstore adapter and hstore to dict typecaster, using both 9.0 and pre-9.0 syntax.
- Two-phase commit protocol support as per DBAPI specification.
- Support for payload in notifications received from the backend.
- namedtuple-returning cursor.
- · Query execution cancel.

#### Other features and changes:

- Dropped support for protocol 2: Psycopg 2.3 can only connect to PostgreSQL servers with version at least 7.4.
- Don't issue a query at every connection to detect the client encoding and to set the datestyle to ISO if it is already compatible with what expected.
- mogrify() now supports unicode queries.
- Subclasses of a type that can be adapted are adapted as the superclass.
- errorcodes knows a couple of new codes introduced in PostgreSQL 9.0.
- Dropped deprecated Psycopg "own quoting".
- Never issue a ROLLBACK on close/GC. This behaviour was introduced as a bug in release 2.2, but trying to send a command while being destroyed has been considered not safe.

#### Bug fixes:

• Fixed use of PQfreemem instead of free in binary typecaster.

- Fixed access to freed memory in conn\_get\_isolation\_level().
- Fixed crash during Decimal adaptation with a few 2.5.x Python versions (ticket #7).
- Fixed notices order (ticket #9).

# 15.8.1 What's new in psycopg 2.2.2

#### Bux fixes:

- the call to logging.basicConfig() in pool.py has been dropped: it was messing with some projects using logging (and a library should not initialize the logging system anyway.)
- psycopg now correctly handles time zones with seconds in the UTC offset. The old register\_tstz\_w\_secs() function is deprecated and will raise a warning if called.
- Exceptions raised by the column iterator are propagated.
- Exceptions raised by executemany() iterators are propagated.

# 15.8.2 What's new in psycopg 2.2.1

#### Bux fixes:

• psycopg now builds again on MS Windows.

# 15.9 What's new in psycopg 2.2

This is the first release of the new 2.2 series, supporting not just one but two different ways of executing asynchronous queries, thanks to Jan and Daniele (with a little help from me and others, but they did 99% of the work so they deserve their names here in the news.)

psycopg now supports both classic select() loops and "green" coroutine libraries. It is all in the documentation, so just point your browser to doc/html/advanced.html.

#### Other new features:

- truncate() method for lobjects.
- · COPY functions are now a little bit faster.
- All builtin PostgreSQL to Python typecasters are now available from the psycopg2.extensions module.
- Notifications from the backend are now available right after the execute() call (before client code needed to call isbusy() to ensure NOTIFY reception.)
- Better timezone support.
- · Lots of documentation updates.

#### Bug fixes:

- Fixed some gc/refcounting problems.
- Fixed reference leak in NOTIFY reception.
- Fixed problem with PostgreSQL not casting string literals to the correct types in some situations: psycopg now add an explicit cast to dates, times and bytea representations.
- Fixed TimestampFromTicks() and TimeFromTicks() for seconds >= 59.5.

• Fixed spurious exception raised when calling C typecasters from Python ones.

## 15.9.1 What's new in psycopg 2.0.14

#### New features:

- Support for adapting tuples to PostgreSQL arrays is now enabled by default and does not require importing psycopg2.extensions anymore.
- "can't adapt" error message now includes full type information.
- Thank to Daniele Varrazzo (piro) psycopg2's source package now includes full documentation in HTML and plain text format.

#### Bug fixes:

- No loss of precision when using floats anymore.
- decimal.Decimal "nan" and "infinity" correctly converted to PostgreSQL numeric NaN values (note that PostgreSQL numeric type does not support infinity but just NaNs.)
- psycopg2.extensions now includes Binary.

It seems we're good citizens of the free software ecosystem and that big big companies and people ranting on the pgsql-hackers mailing list we'll now not dislike us. g (See LICENSE file for the details.)

# 15.9.2 What's new in psycopg 2.0.13

#### New features:

- Support for UUID arrays.
- It is now possible to build psycopg linking to a static libpq library.

#### Bug fixes:

- Fixed a deadlock related to using the same connection with multiple cursors from different threads.
- Builds again with MSVC.

# 15.9.3 What's new in psycopg 2.0.12

#### New features:

• The connection object now has a reset() method that can be used to reset the connection to its default state.

#### Bug fixes:

- copy\_to() and copy\_from() now accept a much larger number of columns.
- Fixed PostgreSQL version detection.
- Fixed ZPsycopgDA version check.
- Fixed regression in ZPsycopgDA that made it behave wrongly when receiving serialization errors: now the query is re-issued as it should be by propagating the correct exception to Zope.
- Writing "large" large objects should now work.

### 15.9.4 What's new in psycopg 2.0.11

#### New features:

• DictRow and RealDictRow now use less memory. If you inherit on them remember to set <u>\_\_slots\_\_</u> for your new attributes or be prepare to go back to old memory usage.

#### Bug fixes:

- Fixed exception in setup.py.
- More robust detection of PostgreSQL development versions.
- Fixed exception in RealDictCursor, introduced in 2.0.10.

### 15.9.5 What's new in psycopg 2.0.10

#### New features:

- A specialized type-caster that can parse time zones with seconds is now available. Note that after enabling it (see extras.py) "wrong" time zones will be parsed without raising an exception but the result will be rounded.
- DictCursor can be used as a named cursor.
- · DictRow now implements more dict methods.
- The connection object now expose PostgreSQL server version as the .server\_version attribute and the protocol version used as .protocol\_version.
- The connection object has a .get\_parameter\_status() methods that can be used to obtain useful information from the server.

#### Bug fixes:

- None is now correctly always adapted to NULL.
- · Two double memory free errors provoked by multithreading and garbage collection are now fixed.
- Fixed usage of internal Python code in the notice processor; this should fix segfaults when receiving a lot of notices in multithreaded programs.
- Should build again on MSVC and Solaris.
- Should build with development versions of PostgreSQL (ones with -devel version string.)
- Fixed some tests that failed even when psycopg was right.

# 15.9.6 What's new in psycopg 2.0.9

#### New features:

- "import psycopg2.extras" to get some support for handling times and timestamps with seconds in the time zone offset.
- DictCursors can now be used as named cursors.

#### Bug fixes:

- register\_type() now accept an explicit None as its second parameter.
- psycopg2 should build again on MSVC and Solaris.

### 15.9.7 What's new in psycopg 2.0.9

#### New features:

- COPY TO/COPY FROM queries now can be of any size and psycopg will correctly quote separators.
- float values Inf and NaN are now correctly handled and can round-trip to the database.
- executemany() now return the numer of total INSERTed or UPDATEd rows. Note that, as it has always been, executemany() should not be used to execute multiple SELECT statements and while it will execute the statements without any problem, it will return the wrong value.
- copy\_from() and copy\_to() can now use quoted separators.
- "import psycopg2.extras" to get UUID support.

#### Bug fixes:

- register\_type() now works on connection and cursor subclasses.
- fixed a memory leak when using lobjects.

### 15.9.8 What's new in psycopg 2.0.8

#### New features:

- The connection object now has a get\_backend\_pid() method that returns the current PostgreSQL connection backend process PID.
- The PostgreSQL large object API has been exposed through the Cursor.lobject() method.

#### Bug fixes:

- Some fixes to ZPsycopgDA have been merged from the Debian package.
- A memory leak was fixed in Cursor.executemany().
- A double free was fixed in pq\_complete\_error(), that caused crashes under some error conditions.

## 15.9.9 What's new in psycopg 2.0.7

#### Improved error handling:

- All instances of psycopg2. Error subclasses now have pgerror, pgcode and cursor attributes. They will be set to None if no value is available.
- Exception classes are now chosen based on the SQLSTATE value from the result. (#184)
- The commit() and rollback() methods now set the pgerror and pgcode attributes on exceptions. (#152)
- errors from commit() and rollback() are no longer considered fatal. (#194)
- If a disconnect is detected during execute(), an exception will be raised at that point rather than resulting in "ProgrammingError: no results to fetch" later on. (#186)

#### Better PostgreSQL compatibility:

- If the server uses standard conforming strings, perform appropriate quoting.
- BC dates are now handled if psycopg is compiled with mxDateTime support. If using datetime, an appropriate ValueError is raised. (#203)

#### Other bug fixes:

- If multiple sub-interpreters are in use, do not share the Decimal type between them. (#192)
- Buffer objects obtained from psycopg are now accepted by psycopg too, without segfaulting. (#209)
- A few small changes were made to improve DB-API compatibility. All the dbapi20 tests now pass.

#### Miscellaneous:

- The PSYCOPG\_DISPLAY\_SIZE option is now off by default. This means that display size will always be set to
  "None" in cursor.description. Calculating the display size was expensive, and infrequently used so this should
  improve performance.
- New QueryCanceledError and TransactionRollbackError exceptions have been added to the psycopg2.extensions module. They can be used to detect statement timeouts and deadlocks respectively.
- Cursor objects now have a "closed" attribute. (#164)
- If psycopg has been built with debug support, it is now necessary to set the PSYCOPG\_DEBUG environment variable to turn on debug spew.

# 15.9.10 What's new in psycopg 2.0.6

Better support for PostgreSQL, Python and win32:

- full support for PostgreSQL 8.2, including NULLs in arrays
- support for almost all existing PostgreSQL encodings
- full list of PostgreSQL error codes available by importing the psycopg2.errorcodes module
- full support for Python 2.5 and 64 bit architectures
- better build support on win32 platform

Support for per-connection type-casters (used by ZPsycopgDA too, this fixes a long standing bug that made different connections use a random set of date/time type-casters instead of the configured one.)

Better management of times and dates both from Python and in Zope.

copy\_to and copy\_from now take an extra "columns" parameter.

Python tuples are now adapted to SQL sequences that can be used with the "IN" operator by default if the psycopg2.extensions module is imported (i.e., the SQL\_IN adapter was moved from extras to extensions.)

Fixed some small buglets and build glitches:

- · removed double mutex destroy
- · removed all non-constant initializers
- fixed PyObject\_HEAD declarations to avoid memory corruption on 64 bit architectures
- fixed several Python API calls to work on 64 bit architectures
- applied compatibility macros from PEP 353
- now using more than one argument format raise an error instead of a segfault

# 15.9.11 What's new in psycopg 2.0.5.1

• Now it really, really builds on MSVC and older gcc versions.

#### 15.9.12 What's new in psycopg 2.0.5

- Fixed various buglets such as:
  - segfault when passing an empty string to Binary()
  - segfault on null queries
  - segfault and bad keyword naming in .executemany()
  - OperationalError in connection objects was always None
- Various changes to ZPsycopgDA to make it more zope2.9-ish.
- connect() now accept both integers and strings as port parameter

### 15.9.13 What's new in psycopg 2.0.4

• Fixed float conversion bug introduced in 2.0.3.

### 15.9.14 What's new in psycopg 2.0.3

• Fixed various buglets and a memory leak (see ChangeLog for details)

#### 15.9.15 What's new in psycopg 2.0.2

- Fixed a bug in array typecasting that sometimes made psycopg forget about the last element in the array.
- Fixed some minor buglets in string memory allocations.
- Builds again with compilers different from gcc (#warning about PostgreSQL version is issued only if \_\_GCC\_\_ is defined.)

### 15.9.16 What's new in psycopg 2.0.1

• ZPsycopgDA now actually loads.

# 15.10 What's new in psycopg 2.0

- Fixed handle leak on win32.
- If available the new "safe" encoding functions of libpq are used.
- django and tinyerp people, please switch to psycopg 2 \_without\_ using a psycopg 1 compatibility layer (this release was anticipated so that you all stop grumbling about psycopg 2 is still in beta.. :)

### 15.10.1 What's new in psycopg 2.0 beta 7

- Ironed out last problems with times and date (should be quite solid now.)
- Fixed problems with some arrays.
- Slightly better ZPsycopgDA (no more double connection objects in the menu and other minor fixes.)
- ProgrammingError exceptions now have three extra attributes: .cursor (it is possible to access the query that caused the exception using error.cursor.query), .pgerror and .pgcode (PostgreSQL original error text and code.)
- The build system uses pg\_config when available.
- Documentation in the doc/ directory! (With many kudos to piro.)

### 15.10.2 What's new in psycopg 2.0 beta 6

- Support for named cursors.
- Safer parsing of time intervals.
- Better parsing of times and dates, no more locale problems.
- Should now play well with py2exe and similar tools.
- The "decimal" module is now used if available under Python 2.3.

# 15.10.3 What's new in psycopg 2.0 beta 5

- Fixed all known bugs.
- The initial isolation level is now read from the server and .set\_isolation\_level() now takes values defined in psycopg2.extensions.
- .callproc() implemented as a SELECT of the given procedure.
- Better docstrings for a few functions/methods.
- Some time-related functions like psycopg2. TimeFromTicks() now take the local timezone into account. Also a
  tzinfo object (as per datetime module specifications) can be passed to the psycopg2. Time and psycopg2. Datetime
  constructors.
- All classes have been renamed to exist in the psycopg2.\_psycopg module, to fix problems with automatic documentation generators like epydoc.
- NOTIFY is correctly trapped.

#### 15.10.4 What's new in psycopg 2.0 beta 4

- psycopg module is now named psycopg2.
- No more segfaults when a UNICODE query can't be converted to the backend encoding.
- No more segfaults on empty queries.
- psycopg2.connect() now takes an integer for the port keyword parameter.
- "python setup.py bdist\_rpm" now works.
- Fixed lots of small bugs, see ChangeLog for details.

# 15.10.5 What's new in psycopg 2.0 beta 3

- ZPsycopgDA now works (except table browsing.)
- psycopg build again on Python 2.2.

### 15.10.6 What's new in psycopg 2.0 beta 2

- Fixed ZPsycopgDA version check (ZPsycopgDA can now be imported in Zope.)
- psycopg.extras.DictRow works even after a new query on the generating cursor.
- Better setup.py for win32 (should build with MSCV or mingw.)
- · Generic fixed and memory leaks plugs.

### 15.10.7 What's new in psycopg 2.0 beta 1

- Officially in beta (i.e., no new features will be added.)
- Array support: list objects can be passed as bound variables and are correctly returned for array columns.
- Added the psycopg.psycopg1 compatibility module (if you want instant psycopg 1 compatibility just "from psycopg import psycopg1 as psycopg".)
- Complete support for BYTEA columns and buffer objects.
- Added error codes to error messages.
- The AsIs adapter is now exported by default (also Decimal objects are adapted using the AsIs adapter (when str() is called on them they already format themselves using the right precision and scale.)
- The connect() function now takes "connection\_factory" instead of "factory" as keyword argument.
- New setup.py code to build on win32 using mingw and better error messages on missing datetime headers,
- Internal changes that allow much better user-defined type casters.
- A lot of bugfixes (binary, datetime, 64 bit arches, GIL, .executemany())

#### 15.10.8 What's new in psycopg 1.99.13

- Added missing .executemany() method.
- Optimized type cast from PostgreSQL to Python (psycopg should be even faster than before.)

#### 15.10.9 What's new in psycopg 1.99.12

- .rowcount should be ok and in sync with psycopg 1.
- Implemented the new COPY FROM/COPY TO code when connection to the backend using libpq protocol 3 (this also removes all asprintf calls: build on win32 works again.) A protocol 3-enabled psycopg *can* connect to an old protocol 2 database and will detect it and use the right code.
- getquoted() called for real by the mogrification code.

# 15.10.10 What's new in psycopg 1.99.11

- 'cursor' argument in .cursor() connection method renamed to 'cursor factory'.
- changed 'tuple\_factory' cursor attribute name to 'row\_factory'.
- the .cursor attribute is gone and connections and cursors are properly gc-managed.
- fixes to the async core.

### 15.10.11 What's new in psycopg 1.99.10

- The adapt() function now fully supports the adaptation protocol described in PEP 246. Note that the adapters registry now is indexed by (type, protocol) and not by type alone. Change your adapters accordingly.
- More configuration options moved from setup.py to setup.cfg.
- Fixed two memory leaks: one in cursor deallocation and one in row fetching (.fetchXXX() methods.)

### 15.10.12 What's new in psycopg 1.99.9

- Added simple pooling code (psycopg.pool module).
- Added DECIMAL typecaster to convert postgresql DECIMAL and NUMERIC types (i.e, all types with an OID
  of NUMERICOID.) Note that the DECIMAL typecaster does not set scale and precision on the created objects
  but uses Python defaults.
- ZPsycopgDA back in and working using the new pooling code.
- Isn't that enough?:)

#### 15.10.13 What's new in psycopg 1.99.8

- added support for UNICODE queries.
- added UNICODE typecaster; to activate it just do:

```
psycopg.extensions.register_type(psycopg.extensions.UNICODE)
```

Note that the UNICODE typecaster override the STRING one, so it is not activated by default.

- cursors now really support the iterator protocol.
- solved the rounding errors in time conversions.
- now cursors support .fileno() and .isready() methods, to be used in select() calls.
- .copy\_from() and .copy\_in() methods are back in (still using the old protocol, will be updated to use new one in next release.)
- fixed memory corruption bug reported on win32 platform.

### 15.10.14 What's new in psycopg 1.99.7

- added support for tuple factories in cursor objects (removed factory argument in favor of a .tuple\_factory attribute on the cursor object); see the new module psycopg.extras for a cursor (DictCursor) that return rows as objects that support indexing both by position and column name.
- added support for tzinfo objects in datetime.timestamp objects: the PostgreSQL type "timestamp with time zone" is converted to datetime.timestamp with a FixedOffsetTimezone initialized as necessary.

### 15.10.15 What's new in psycopg 1.99.6

- sslmode parameter from 1.1.x
- · various datetime conversion improvements.
- now psycopg should compile without mx or without native datetime (not both, obviously.)
- included various win32/MSVC fixes (pthread.h changes, winsock2 library, include path in setup.py, etc.)
- ported interval fixes from 1.1.14/1.1.15.
- the last query executed by a cursor is now available in the .query attribute.
- conversion of unicode strings to backend encoding now uses a table (that still need to be filled.)
- cursors now have a .mogrify() method that return the query string instead of executing it.
- connection objects now have a .dsn read-only attribute that holds the connection string.
- moved psycopg C module to \_psycopg and made psycopg a python module: this allows for a neat separation of DBAPI-2.0 functionality and psycopg extensions; the psycopg namespace will be also used to provide pythononly extensions (like the pooling code, some ZPsycopgDA support functions and the like.)

#### 15.10.16 What's new in psycopg 1.99.3

- added support for python 2.3 datetime types (both ways) and made datetime the default set of typecasters when available.
- · added example: dt.py.

#### 15.10.17 What's new in psycopg 1.99.3

- initial working support for unicode bound variables: UTF-8 and latin-1 backend encodings are natively supported (and the encoding.py example even works!)
- added .set\_client\_encoding() method on the connection object.
- added examples: encoding.py, binary.py, lastrowid.py.

# 15.10.18 What's new in psycopg 1.99.2

- better typecasting:
  - DateTimeDelta used for postgresql TIME (merge from 1.1)
  - BYTEA now is converted to a real buffer object, not to a string
- buffer objects are now adapted into Binary objects automatically.
- ported scroll method from 1.1 (DBAPI-2.0 extension for cursors)
- initial support for some DBAPI-2.0 extensions:
  - .rownumber attribute for cursors
  - .connection attribute for cursors
  - .next() and .\_\_iter\_\_() methods to have cursors support the iterator protocol
  - all exception objects are exported to the connection object

### 15.10.19 What's new in psycopg 1.99.1

- implemented microprotocols to adapt arbitrary types to the interface used by psycopg to bind variables in execute;
- moved qstring, phoolean and mxdatetime to the new adapter layout (binary is still missing; python 2.3 datetime needs to be written).

### 15.10.20 What's new in psycopg 1.99.0

- reorganized the whole source tree;
- async core is in place;
- splitted QuotedString objects from mx stuff;
- dropped autotools and moved to pythonic setup.py (needs work.)

**CHAPTER** 

#### SIXTEEN

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# 16.1 psycopg2 and the LGPL

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