



Module 34

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Das

Objectives &
Outline

PostgreSQL and
Python

Python
Frameworks for
PostgreSQL

Flask

Module Summary

Database Management Systems

Module 34: Application Design and Development/4: Python and PostgreSQL

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Objectives & Outline

PostgreSQL and
Python

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Module Summary

- Introduced the use of SQL from a programming language



Module Objectives

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PostgreSQL and
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Module Summary

- To understand how to access PostgreSQL database from Python
- To understand Python Web Application with PostgreSQL



Module Outline

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Module Summary

- Accessing PostgreSQL from Python
- Developing Web Application with Python



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Module Summary

Working with PostgreSQL and Python



Python Modules for PostgreSQL

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Module Summary

Following Python modules that can be used to work with a PostgreSQL database server:

- **psycopg2**
- pg8000
- py-postgresql
- PyGreSQL
- ocpgdb
- bpgsql
- SQLAlchemy (needs any of the above to be installed separately)

Source: <https://pynative.com/python-postgresql-tutorial/>



Package psycopg2

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Module Summary

Advantages of psycopg2

- Most popular and stable module to work with PostgreSQL
- Used in most of the Python and Postgres frameworks
- An actively maintained package and supports Python 2.x and 3.x
- Thread-safe and designed for heavily multi-threaded applications.

Installing Psycopg2 using pip command

- The following pip command installs psycopg2 on different operating systems including Windows, MacOS, Linux, and Unix
`pip install psycopg2`
- For installing specific version, the following command can be used
`pip install psycopg2=2.8.6`

Source: <https://pynative.com/python-postgresql-tutorial/>



Steps to access PostgreSQL from Python

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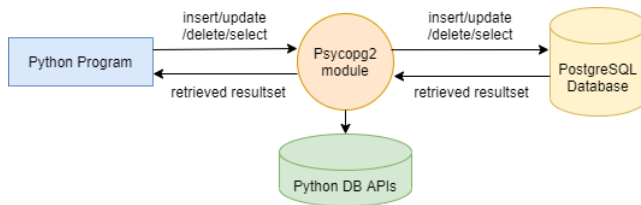
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Module Summary

Steps to access PostgreSQL from Python using Psycopg

- Create connection
- Create cursor
- Execute the query
- Commit/rollback
- Close the cursor
- Close the connection



Source: <https://pynative.com/python-postgresql-tutorial/>



Python psycopg2 Module APIs: connection objects

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Module Summary

- `psycopg2.connect(database="mydb", user="myuser", password="mypass" host="127.0.0.1", port="5432")`

This API opens a connection to the PostgreSQL database. If database is opened successfully, it returns a connection object.

- `connection.close()`

This method closes the database connection.

Important **psycopg2** module routines for managing cursor object:

- `connection.cursor()`

This routine creates a cursor which will be used throughout the program.

- `cursor.close()`

This method closes the cursor.

Source: https://www.tutorialspoint.com/postgresql/postgresql_python.htm



Python psycopg2 Module APIs: insert, delete, update & stored procedures

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Module Summary

- `cursor.execute(sql [, optional parameters])`
This routine executes an SQL statement. The SQL statement may be parameterized (i.e., placeholders instead of SQL literals). The **psycopg2** module supports placeholder using %s sign. For example: `cursor.execute("insert into people values (%s, %s)", (who, age))`
- `cursor.executemany(sql, seq_of_parameters)`
This routine executes an SQL command against all parameter sequences or mappings found in the sequence SQL.
- `cursor.callproc(procname[, parameters])`
This routine executes a stored database procedure with the given name. The sequence of parameters must contain one entry for each argument that the procedure expects.
- `cursor.rowcount`
This is a read-only attribute which returns the total number of database rows that have been modified, inserted, or deleted by the last `execute()`.

Source: https://www.tutorialspoint.com/postgresql/postgresql_python.htm



Python psycopg2 Module APIs: select

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Module Summary

- `cursor.fetchone()`

This method fetches the next row of a query result set, returning a single sequence, or None when no more data is available.

- `cursor.fetchmany([size=cursor.arraysize])`

This routine fetches the next set of rows of a query result, returning a list. An empty list is returned when no more rows are available. The method tries to fetch as many rows as indicated by the size parameter.

- `cursor.fetchall()`

This routine fetches all (remaining) rows of a query result, returning a list. An empty list is returned when no rows are available.

Source: https://www.tutorialspoint.com/postgresql/postgresql_python.htm



Python psycopg2 Module APIs: commit & rollback

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Module Summary

- `connection.commit()`

This method commits the current transaction. If you do not call this method, anything you did since the last call to `commit()` is not visible to other database connections.

- `connection.rollback()`

This method rolls back any changes to the database since the last call to `commit()`.

Source: https://www.tutorialspoint.com/postgresql/postgresql_python.htm



Connect to a PostgreSQL Database Server

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Module Summary

```
import psycopg2
def connectDb(dbname, username, pwd, address, portnum):
    conn = None
    try:
        # connect to the PostgreSQL database
        conn = psycopg2.connect(database = dbname, user = username, \
                                password = pwd, host = address, port = portnum)
        print ("Database connected successfully")
    except (Exception, psycopg2.DatabaseError) as error:
        print(error)
    finally:
        conn.close()                # close the connection
connectDb("mydb", "myuser", "mypass", "127.0.0.1", "5432") # function call
```

Output:

Database connected successfully

psycopg2.DatabaseError: Exception raised for errors that are related to the PostgreSQL database.

We assume the following for all the programs in this module:

- Database Name: *mydb*
- Username: *myuser*
- Password: *mypass*
- Host Name: *localhost* or IP address *127.0.0.1*



Steps to execute SQL commands

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Module Summary

1. Use the `psycopg2.connect()` method with the required arguments to connect PostgreSQL. It would return a Connection object if the connection established successfully.
2. Create a cursor object using the `cursor()` method of connection object.
3. The `execute()` methods run the SQL commands and return the result.
4. Use `cursor.fetchall()` or `fetchone()` or `fetchmany()` to read query result.
5. Use `commit()` to make the changes in database persistent, or use `rollback()` to revert the database changes.
6. Use `cursor.close()` and `connection.close()` method to close the cursor and PostgreSQL connection.

Source: <https://pynative.com/python-postgresql-tutorial/>



CREATE new PostgreSQL tables

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Module Summary

```
import psycopg2
def createTable():
    conn = None
    try:
        conn = psycopg2.connect(database = "mydb", user = "myuser", \
                                password = "mypass", host = "127.0.0.1", port = "5432") # connect to the database
        cur = conn.cursor() # create a new cursor
        cur.execute('''CREATE TABLE EMPLOYEE \
                    (emp_num INT PRIMARY KEY      NOT NULL, \
                     emp_name VARCHAR(40)        NOT NULL, \
                     department VARCHAR(40)       NOT NULL)''') # execute the CREATE TABLE statement
        conn.commit()      # commit the changes to the database
        print ("Table created successfully")
        cur.close()        # close the cursor
    except (Exception, psycopg2.DatabaseError) as error:
        print(error)
    finally:
        if conn is not None:
            conn.close()    # close the connection
createTable()             #function call
```

Output (if table EMPLOYEE does not exist): Table created successfully

Output (if table EMPLOYEE already exists): relation "employee" already exists



Executing INSERT statement from Python

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Module Summary

```

import psycopg2
def insertRecord(num, name, dept):
    conn = None
    try:
        # connect to the PostgreSQL database
        conn = psycopg2.connect(database = "mydb", user = "myuser", \
                                password = "mypass", host = "127.0.0.1", port = "5432")
        cur = conn.cursor()          # create a new cursor
        # execute the INSERT statement
        cur.execute("INSERT INTO EMPLOYEE (emp_num, emp_name, department) \
                    VALUES (%s, %s, %s)", (num, name, dept))
        conn.commit()               # commit the changes to the database
        print("Total number of rows inserted :", cur.rowcount);
        cur.close()                 # close the cursor
    except (Exception, psycopg2.DatabaseError) as error:
        print(error)
    finally:
        if conn is not None:
            conn.close()            # close the connection
insertRecord(110, 'Bhaskar', 'HR') #function call

```

Output: Total number of rows inserted : 1
duplicate key value violates unique constraint "employee_pkey"
Output: DETAIL: Key (emp_num)=(110) already exists.

If a row already exists with emp_num = 110



Executing DELETE statement from Python

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Module Summary

```
import psycopg2
def deleteRecord(num):
    conn = None
    try:
        # connect to the PostgreSQL database
        conn = psycopg2.connect(database = "mydb", user = "myuser", \
                                password = "mypass", host = "127.0.0.1", port = "5432")
        cur = conn.cursor()      # create a new cursor
        # execute the DELETE statement
        cur.execute("DELETE FROM EMPLOYEE WHERE emp_num = %s", (num,))
        conn.commit()           # commit the changes to the database
        print ("Total number of rows deleted :", cur.rowcount)
        cur.close()             # close the cursor
    except (Exception, psycopg2.DatabaseError) as error:
        print(error)
    finally:
        conn.close()            # close the connection
deleteRecord(110)              #function call
```

Output: Total number of rows deleted : 1

Output: Total number of rows deleted : 0

If the row does not exist



Executing UPDATE statement from Python

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Module Summary

```
import psycopg2
def updateRecord(num, dept):
    conn = None
    try:
        # connect to the PostgreSQL database
        conn = psycopg2.connect(database = "mydb", user = "myuser", \
                                password = "mypass", host = "127.0.0.1", port = "5432")
        cur = conn.cursor()      # create a new cursor
        # execute the UPDATE statement
        cur.execute("UPDATE EMPLOYEE set department = %s where emp_num = \
                    %s", (dept, num))
        conn.commit()           # commit the changes to the database
        print ("Total number of rows updated :", cur.rowcount)
        cur.close()             # close the cursor
    except (Exception, psycopg2.DatabaseError) as error:
        print(error)
    finally:
        conn.close()            # close the connection
updateRecord(110, "Finance")    #function call
```

Output: Total number of rows updated : 1

Output: Total number of rows updated : 0

If the row does not exist



Executing SELECT statement from Python

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Module Summary

```
import psycopg2
def selectAll():
    conn = None
    try:
        # connect to the PostgreSQL database
        conn = psycopg2.connect(database = "mydb", user = "myuser", \
                                password = "mypass", host = "127.0.0.1", port = "5432")
        cur = conn.cursor()      # create a new cursor
        # execute the SELECT statement
        cur.execute("SELECT emp_num, emp_name, department FROM EMPLOYEE")
        rows = cur.fetchall()    # fetches all rows of the query result set
        for row in rows:
            print (print ("Employee ID = ", row[0], ", NAME = ", \
                           row[1], ", DEPARTMENT = ", row[2]))
        cur.close()              # close the cursor
    except (Exception, psycopg2.DatabaseError) as error:
        print(error)
    finally:
        conn.close()             # close the connection
selectAll()                     # function call
```

Output:

```
Employee ID = 110, NAME = Bhaskar, DEPARTMENT = HR
Employee ID = 111, NAME = Ishaan, DEPARTMENT = FINANCE
Employee ID = 112, NAME = Jairaj, DEPARTMENT = TECHNOLOGY
Employee ID = 113, NAME = Ananya, DEPARTMENT = TECHNOLOGY
```



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Module Summary

Python Frameworks for PostgreSQL



Web and Internet Development using Python

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Module Summary

Python offers several frameworks such as **bottle.py**, **Flask**, **CherryPy**, **Pyramid**, **Django** and **web2py** for web development.

- **Python offers many choices for web development**
 - Frameworks such as **Django** and **Pyramid**.
 - Micro-frameworks such as **Flask** and **Bottle**.
 - Advanced content management systems such as **Plone** and **django CMS**.
- **Python's standard library supports many internet protocols**
 - **HTML** and **XML**
 - **JSON**
 - **E-mail** processing
 - Support for **FTP**, **IMAP**, and other Internet protocols
 - Easy-to-use socket interface
- **The package Index has more libraries**
 - **Requests**, a powerful HTTP client library.
 - **Beautiful Soup**, an HTML parser that can handle all sorts of HTML.
 - **Feedparser** for parsing RSS/Atom feeds.
 - **Paramiko**, implementing the SSH2 protocol.
 - **Twisted Python**, a framework for asynchronous network programming.



Flask Web Application Framework

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Module Summary

- Flask is a lightweight **WSGI** (Web Server Gateway Interface) web application framework. It is designed to make *getting started* quick and easy, with the ability to scale up to complex applications.
- It began as a simple wrapper around **Werkzeug** (Werkzeug WSGI toolkit) and **Jinja** (Jinja template engine) and has since then become one of the most popular Python web application frameworks.
- Flask offers suggestions, but does not enforce any dependencies or project layouts. It is up to the developer to choose the tools and libraries they want to use.
- There are many extensions provided by the community that make adding new functionality easy.

Installing Flask using pip command

- `pip install -U Flask`

Source: <https://pypi.org/project/Flask/>



A Simple Example

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Module Summary

```
from flask import Flask
app = Flask(__name__)

@app.route('/')
def hello_world():
    return "Hello World"

if __name__ == '__main__':
    app.run()
```

- Importing flask module in the project is mandatory. Our WSGI application is an object of Flask class.
- Flask constructor takes the name of **current module** (`__name__`) as argument.

- The `route()` function of the Flask class is a decorator, which tells the application which URL should call the associated function.
`app.route(rule, options)`
 - The **rule** parameter represents URL binding with the function.
 - The **options** is a list of parameters to be forwarded to the underlying Rule object.
- In the above example, '/' URL is bound with `hello_world()` function. Hence, when the home page of web server is opened in browser, the output of this function will be rendered.
- Finally the `run()` method of Flask class runs the application on the local development server.

Source: https://www.tutorialspoint.com/flask/flask_application.htm

A Simple Example (2)

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Module Summary

```
app.run(host, port, debug, options)
```

- **host**: Hostname to listen on. Defaults to 127.0.0.1 (localhost). Set to '0.0.0.0' to have server available externally
- **port**: Defaults to 5000
- **debug**: Defaults to false. If set to true, provides a debug information
- **options**: To be forwarded to underlying Werkzeug server.

Executing the code:

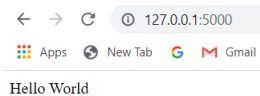
- `Python Hello.py`

Output:

A message in Python shell:

- * Running on `http://127.0.0.1:5000/` (Press CTRL+C to quit)

Open the above URL (127.0.0.1:5000) in the browser





- Consider the table **Candidate** (in PostgreSQL) as shown below:

Table "public.candidate"				
Column	Type	Collation	Nullable	Default
cno	integer		not null	
name	character varying(30)			
email	character varying(30)			

Indexes:

"candidate_pkey" PRIMARY KEY, btree (cno)

- Code segment in Python:

```
from flask import Flask, \
    render_template, request
import psycopg2

app = Flask(
    __name__,
    template_folder='templates'
)

#functions to be added here for
#different actions
```

```
if __name__ == '__main__':
    # Run the Flask app
    app.run(
        host='127.0.0.1',
        debug=True,
        port=5000
    )
```



Python: Flask (2)

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Module Summary

- Source code for [index.html](#):

```
<!DOCTYPE html>
<html>
<head>
<title>Candidate Email Database</title>
</head>
<body>
  <h2>Candidate Email Database</h2>
  <a href="/add">Add Email</a><br><br>
  <a href="/viewall">View Email</a>
</body>
</html>
```

- Source code for rendering [index.html](#) and [add.html](#) pages:

```
@app.route("/")
def index():
    return render_template("index.html");

@app.route("/add")
def add():
    return render_template("add.html")
```



Python: Flask (3)

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http://127.0.0.1:5000/

← → ↻ ⓘ 127.0.0.1:5000

Apps New Tab G Mail YouTube

Candidate Email Database

[Add Email](#)

[View Email](#)



Python: Flask (4)

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Module Summary

- Source code for [add.html](#) (in HTML):

```
<!DOCTYPE html>
<html>
<head>
    <title>Add Email</title>
</head>
<body>
    <h2>Email Information</h2>
    <form action = "/savedetails" method="post">
        <table>
            <tr><td>CNO</td><td><input type="text" name="cno" required></td></tr>
            <tr><td>Name</td><td><input type="text" name="name" required></td></tr>
            <tr><td>Email</td><td><input type="text" name="email" required></td></tr>
            <tr><td><input type="submit" value="Submit"></td></tr>
        </table>
    </form>
</body>
</html>
```



Python: Flask (5)

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Module Summary

- `saveDetails()` function for [add.html](#) (in Python):

```
@app.route("/savedetails", methods = ["POST"])
def saveDetails():
    cno = request.form["cno"]
    name = request.form["name"]
    email = request.form["email"]
    conn = None
    try:
        conn = psycopg2.connect(database = "mydb", user = "myuser", \
                                password = "mypass", host = "127.0.0.1", port = "5432") # connect to the PostgreSQL database
        cur = conn.cursor() # create a new cursor
        cur.execute("INSERT INTO Candidate (cno, name, email) \
                    VALUES (%s, %s, %s)", (cno, name, email)) # execute the INSERT statement
        conn.commit() # commit the changes to the database
        cur.close() # close the cursor
    except (Exception, psycopg2.DatabaseError) as error:
        render_template("fail.html")
    finally:
        if conn is not None:
            conn.close() # close the connection
    return render_template("success.html")
```



Python: Flask (6)

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<http://127.0.0.1:5000/add>

← → ↻ ⓘ 127.0.0.1:5000/add

Apps New Tab Gmail

Mobile Information

CNO

Name

Email

Submit

<http://127.0.0.1:5000/savedetails>

← → ↻ ⓘ 127.0.0.1:5000/savedetails

Apps New Tab Gmail YouTube

Data Successfully Added

[Go Home](#)



Python: Flask (7)

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Module Summary

- `viewAll()` function for [viewall.html](#) (in Python):

```
@app.route("/viewall")
def viewAll():
    conn = None
    try:
        # connect to the PostgreSQL database
        conn = psycopg2.connect(database = "mydb", user = "myuser", \
                                password = "mypass", host = "127.0.0.1", port = "5432")
        cur = conn.cursor()      # create a new cursor
        # execute the SELECT statement
        cur.execute("SELECT cno, name, email FROM Candidate")
        results = cur.fetchall() # fetches all rows of the query result set
        cur.close()             # close the cursor
    except (Exception, psycopg2.DatabaseError) as error:
        render_template("fail.html")
    finally:
        conn.close()            # close the connection
    return render_template("viewall.html", rows = results)
```



Python: Flask (8)

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Module Summary

- Source code for [viewall.html](#) (in HTML):

```
<!DOCTYPE html>
<html>
<head>
  <title>Email List</title>
</head>
<body>

<h3>Email List</h3>
<table border=5>
  <tr>
    <th>CNO</th><th>Name</th><th>Email</th>
  </tr>
  {% for row in rows %}
    <tr>
      <td>{{row[0]}}</td> <td>{{row[1]}}</td> <td>{{row[2]}}</td>
    </tr>
  {% endfor %}
</table>
<br><br>
<a href="/">Go Home</a>
</body>
</html>
```




Python: Flask (9)

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<http://127.0.0.1:5000/viewall>

← → ↻ ⓘ 127.0.0.1:5000/viewall

Apps New Tab G M Gmail

Email List

CNO	Name	Mobile
101	Ishaan	ishaan@mymail.com
102	Jairaj	Jairaj@mymail.com
103	Ananya	ananya@mymail.com
104	Barkha	barkha@myemail.com
105	Piyush	piyush@mymail.com

[Go Home](#)



Module Summary

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Module Summary

- Learnt how to access PostgreSQL database from Python
- Learnt to build Python Web Application with PostgreSQL and Flask

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