

Databases in Python

MySQL, SQLite

Accessing persistent storage (Relational databases) from Python code



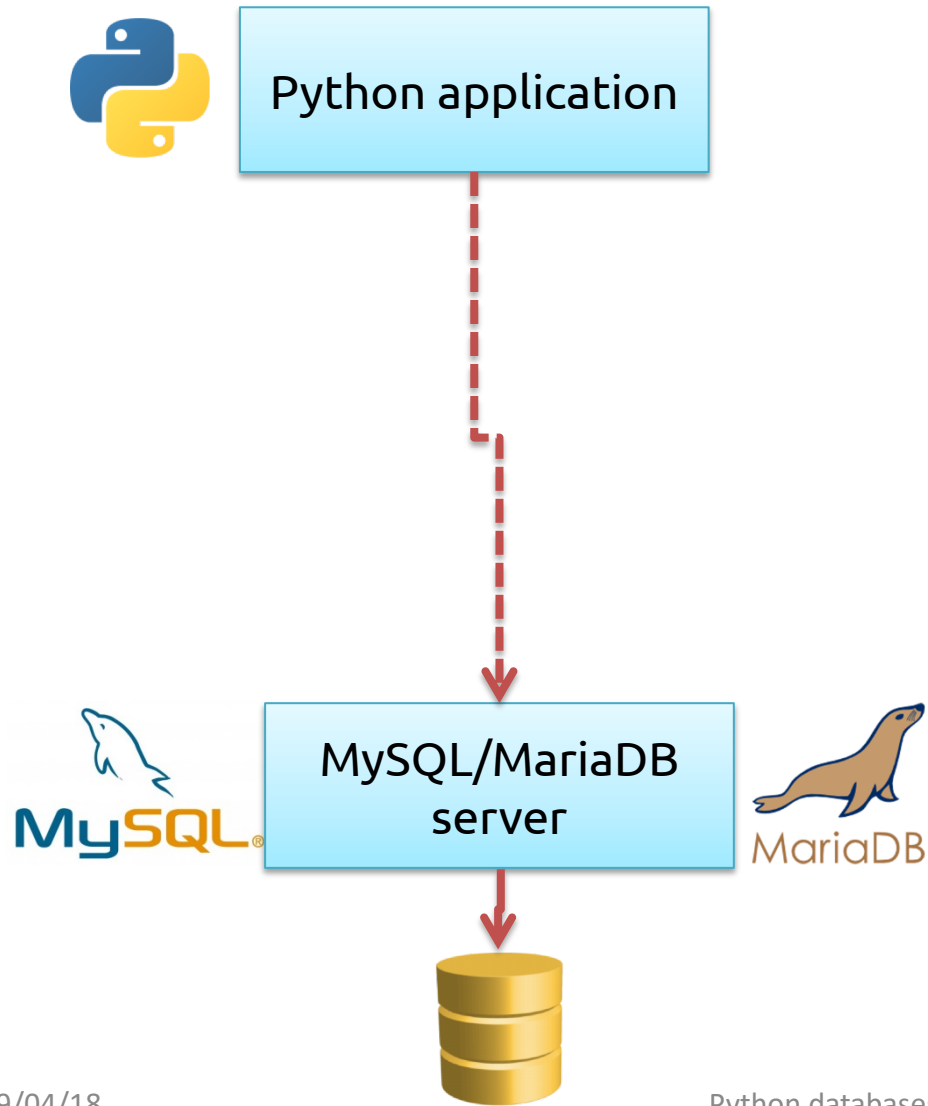
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Goal

- Making some data 'persistent'
 - When application restarts
 - When computer restarts
- Manage big amounts of data
 - Not all in-memory
- Exploit the power of SQL
 - Complex data
 - Complex queries

General Architecture



Analyzed databases

MySQL



- Open source database server (from Oracle)
- Full featured
- Runs as a separate process (may be on a different computer)
- Allows concurrent access
- <http://dev.mysql.com>

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MariaDB



- Open source fork of MySQL server
- Community-driven
- 99% compatible
- In some cases, faster
- On most Linux distributions
- <http://mariadb.org/>

General Architecture



Python application



SQLite library



Analyzed databases

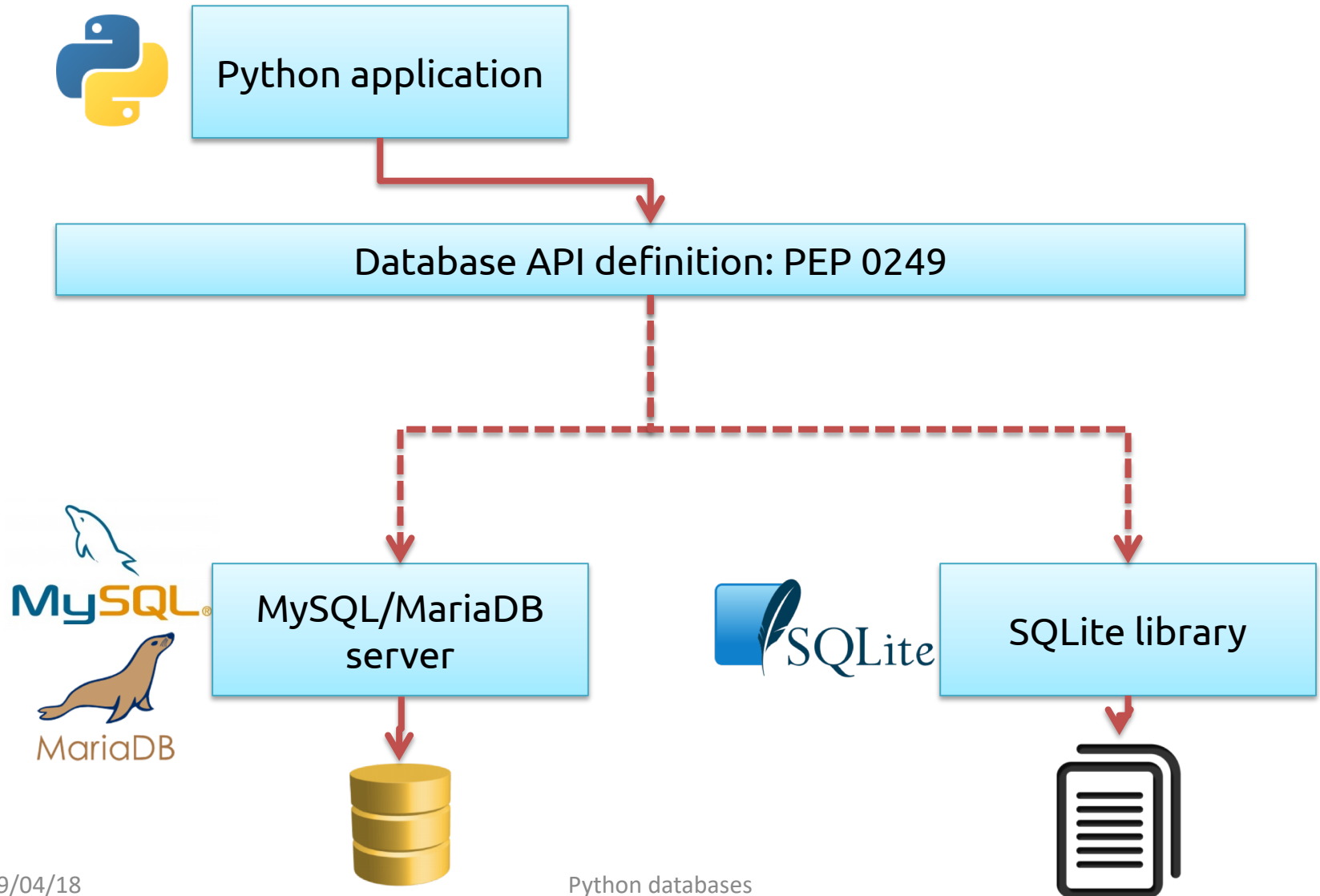
MySQL / MariaDB

SQLite

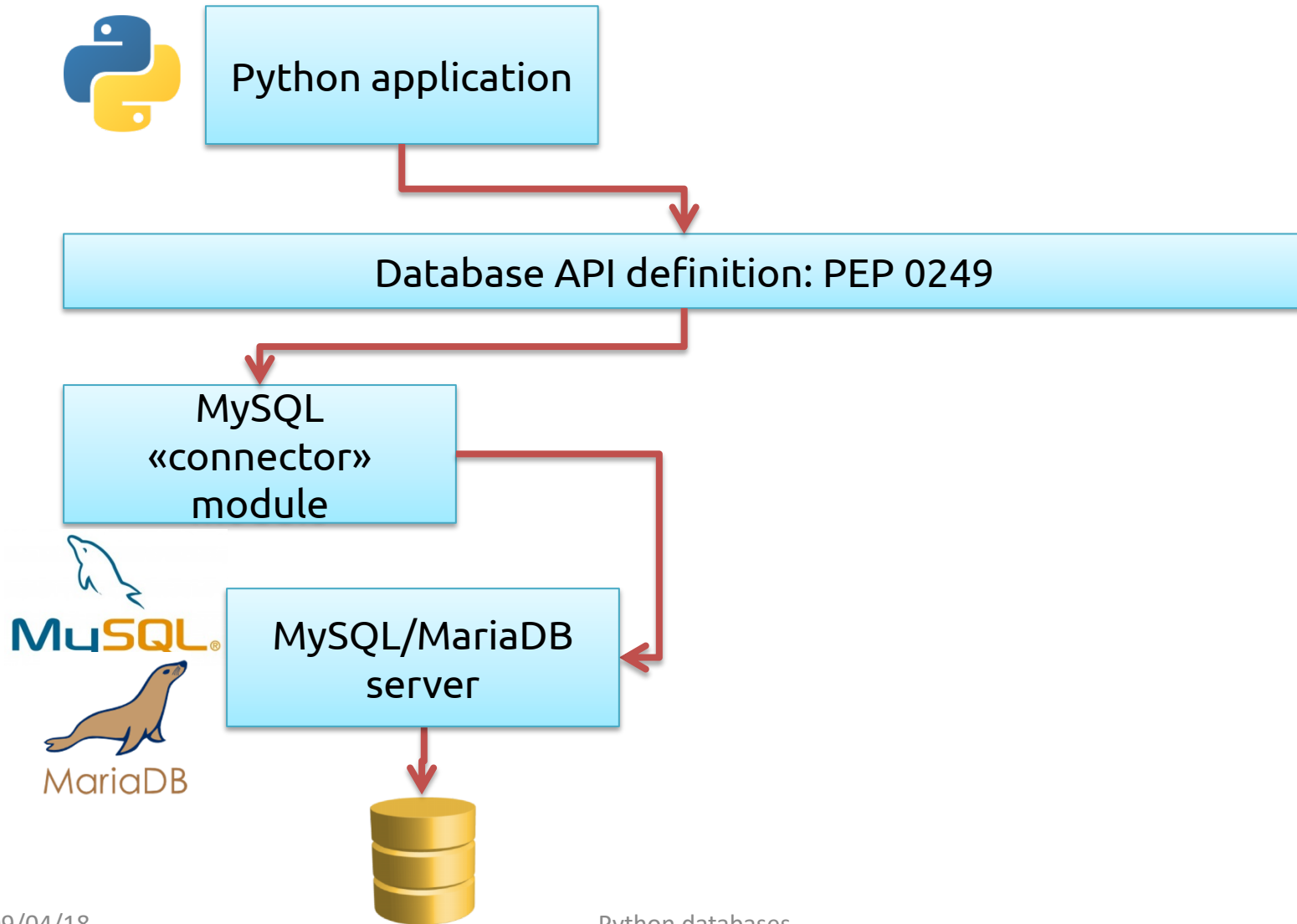


- Open source file-based storage
- Software library integrated in your program (serverless)
- Self-contained
- <https://www.sqlite.org/>

General Architecture



General Architecture



General Architecture



Python application

Database API definition: PEP 0249

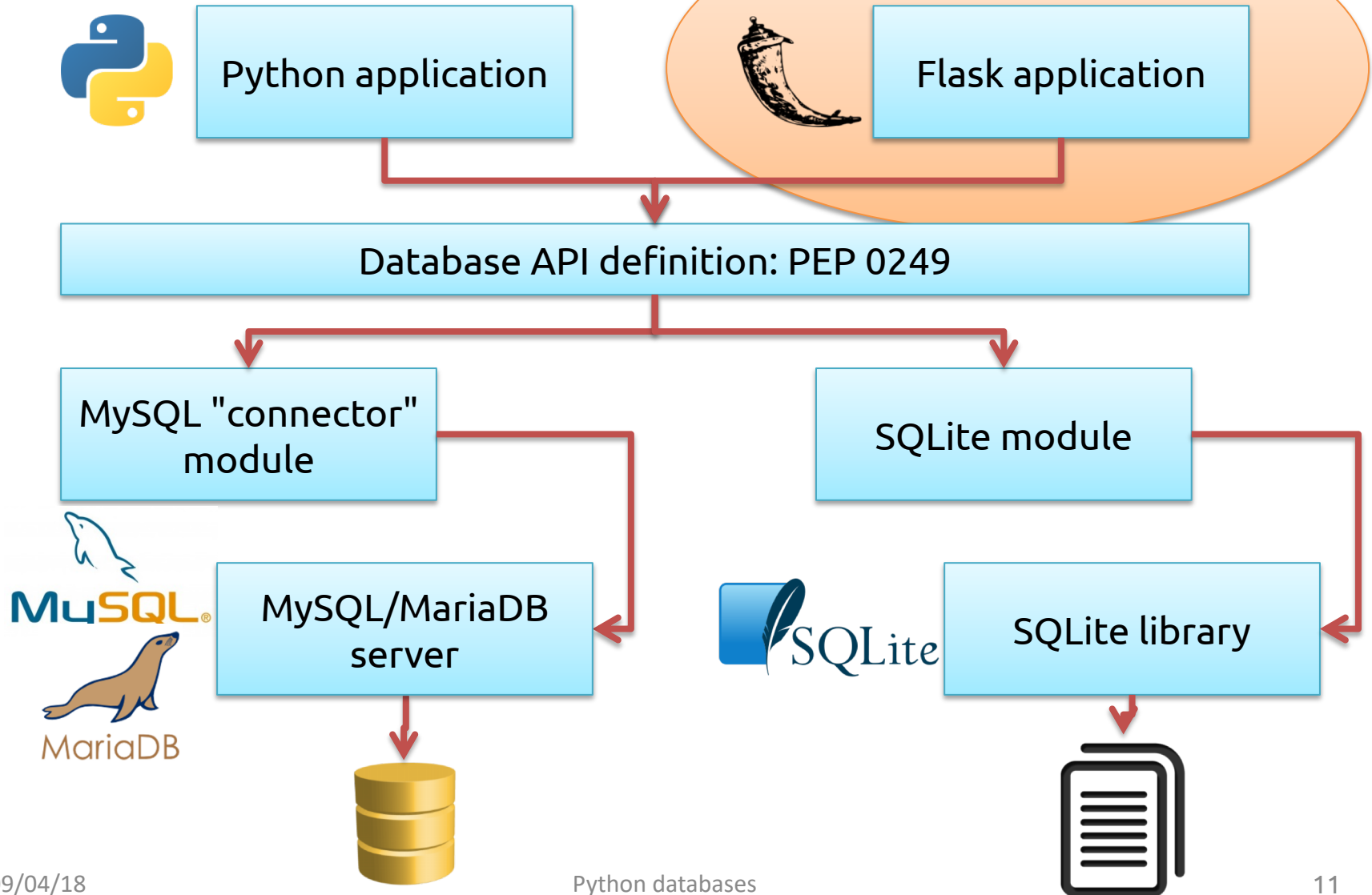
SQLite module



SQLite library



General Architecture Next week....



Other options

- PostgreSQL – more complex, but more complete than MySQL/MariaDB
- Non-relational databases (“NoSQL”) – won’t be considered here

PEP 0249

- Python Database API Specification v2.0
 - <https://www.python.org/dev/peps/pep-0249/>
- Specifies a standard API that Python modules that are used to access databases should implement
- Does not provide a library nor a module
- Third party modules may adhere to these specifications

Main concepts in PEP 249

- Access to database is provided through a **connect** method, that returns a **Connection** object
- For executing queries, you need a **Cursor** object, that can be obtained by the Connection
- A **cursor** may **execute()** a SQL query, with parameters
- A **cursor** may **fetch** the **results** of the query

Minimal example

1 `sql = "SELECT id, original, modified FROM translation"`

2 `conn = mysql.connector.connect(user='root', password='',
host='localhost', database='funnyecho')`

3 `cursor = conn.cursor()
cursor.execute(sql)`

4 `translations = cursor.fetchall()`

5 `cursor.close()
conn.close()`

6 `return translations`

Minimal example

1 `sql = "SELECT id, original, modified FROM translation"`

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conn.close()`

6 `return translations`

The **only** step that depends on
the type of database

Step 1: defining the query

- Write a correct SQL statement, stored as a Python string
 - `sql = "SELECT id, original, modified FROM translation"`
- Variable arguments may be specified with '%s' or '?' placeholders
 - `sql = "INSERT INTO translation (original, modified) VALUES (%s, %s)"`
 - `sql = "INSERT INTO translation (original, modified) VALUES (?, ?)"`

Placeholders

- Never use string concatenation over SQL statements. N-E-V-E-R! Huge security problems (SQL Injection)
- SQL statement "templates" that include placeholders
- Actual values passed in the `.execute` call
- Different libraries use different types of placeholder

Placeholder syntax

MySQL/MariaDB

- C-like format string
- `...WHERE name=%s`
- Beware: always use `%s`, even for numeric data – not `%d` or `%f`

SQLite

- Question mark
- `...WHERE name=?`

Step 2: Connecting to the database

- Depending on the library, use the provided 'connect' method
- The method parameters are dependent on the module implementation (non-standard)
 - `conn = mysql.connector.connect(user='root', password='', host='localhost', database='funnyecho')`

Step 3: execute the query

- First, obtain a cursor from the connection
 - `cursor = conn.cursor()`
- Then, execute the query
 - `cursor.execute(sql)`
- Query parameters (%s/? placeholders) are specified as a 'tuple' argument
 - `cursor.execute(sql, (txtbefore, txtafter))`
 - `cursor.execute(sql, (txtid,))`
 - Beware: one-element tuples require trailing `,`

Step 4 (SELECT): Analyze the result

- Only if the query was a SELECT
- Use various methods of **cursor**:
 - `cursor.fetchone()` # next result
 - `cursor.fetchall()` # all remaining results
 - They return tuples, corresponding to the SELECT'ed columns
 - <https://www.python.org/dev/peps/pep-0249/#cursor-methods>

Step 4 (UPDATE): Commit the change

- For INSERT, UPDATE and DELETE there is no result
- The change is not applied immediately to the database, but needs to be «committed»
- `conn.commit()`
 - Will commit all pending executed queries in the connection
- Must be called before `conn.close()`
- **Don't forget, or you'll lose your data**

Step 5 (a): Clean up

- When the cursor is no longer needed
- `cursor.close()`

Step 5 (b): Clean up

- Don't forget to close the connection, thus freeing up resources on the database server
 - `conn.close()`
- Write the close statement immediately, otherwise you'll forget it
- Remember not to 'return' the function before cleaning up

Step 6: Use the results

- Analyze the returned data, and do what the application requires for them.
- If further queries are needed, go back to step 3 (re-use the same Connection, creating new Cursors)

Using MySQL

- Pre-requisite: a working installation of the MySQL server
 - `sudo apt-get install mysql-server`
 - or download from <http://dev.mysql.com/downloads/mysql/>
- Pre-requisite: a working installation of the MariaDB server
 - `sudo apt-get install mariadb-server`

MySQL connectors

Official connector (Oracle)

- Download and install the "MySQL Connector for Python"
 - <http://dev.mysql.com/downloads/connector/python/>
 - Provides the package "mysql.connector"

Alternative (from pip)

- Pure Python implementation
 - <https://github.com/PyMySQL/PyMySQL/>
 - pip install pymysql
 - Provides the package "pymysql"
- Nearly drop-in replacement
- Easier to install

MySQL Python Connector

- To use: import `mysql.connector`
- Well-done documentation at
 - <http://dev.mysql.com/doc/connector-python/en/index.html>



The screenshot shows the MySQL Connector/Python Developer Guide page. The page is titled "MySQL Connector/Python Developer Guide" and is part of the MySQL documentation library. The main content area includes an abstract, a table of contents, and a section navigation menu. The table of contents lists sections from 1 to 11, including "Preface and Legal Notices", "Introduction to MySQL Connector/Python", "Guidelines for Python Developers", "Connector/Python Versions", "Connector/Python Installation", "Connector/Python Coding Examples", "Connector/Python Tutorials", "Connector/Python Connection Establishment", "The Connector/Python C Extension", "Connector/Python Other Topics", "Connector/Python API Reference", and "Connector/Python C Extension API Reference". The section navigation menu on the right side of the page lists the same sections, with "Preface and Legal Notices" selected.

Connecting with MySQL (Oracle)

- Basic form
 - `import mysql.connector`
 - `cnx = mysql.connector.connect (`
 - `user='joe',`
 - `password='xxx',`
 - `database='test',`
 - `host='localhost')`
- Additional parameters
 - <http://dev.mysql.com/doc/connector-python/en/connector-python-connectargs.html>

Connecting with MySQL (Oracle)

- Alternate form
 - `import mysql.connector`
 - `params = {`
 - `'user': 'joe',`
 - `'password': 'xxx',`
 - `'host': 'localhost',`
 - `'database': 'test',`
 - `'use_unicode': True }`
 - `cnx = mysql.connector.connect(**params)`

Connecting with PyMySQL

```
– import pymysql  
– cnx = pymysql.connect ( ... )  
– cursor = cnx.cursor()
```

- ... Same connection parameters
- ... Same placeholder (%s)
- ... When in doubt, check the Oracle documentation

SQLite and Python

- SQLite is a simple file-based storage library
- Since Python 2.5, it is included by default, in the "sqlite3" package
 - <https://docs.python.org/3/library/sqlite3.html>
 - Developed at <https://github.com/ghaering/pysqlite>
- The «connection» just means specifying the file name
 - `import sqlite3`
 - `conn = sqlite3.connect('example.db')`
- Remember: placeholder = ?

References and Links

- MySQL: <http://dev.mysql.com/>
- MariaDB: <http://mariadb.org/>
- SQLite (C library): <https://www.sqlite.org/>
- SQLite for Python (installed by default):
 - documentation: <https://docs.python.org/3/library/sqlite3.html>
 - developer: <https://github.com/ghaering/pysqlite>
- PEP 249 "Python Database API Specification v2.0": <https://www.python.org/dev/peps/pep-0249/>
- PyMySQL "pure python" connector
 - <https://github.com/PyMySQL/PyMySQL>

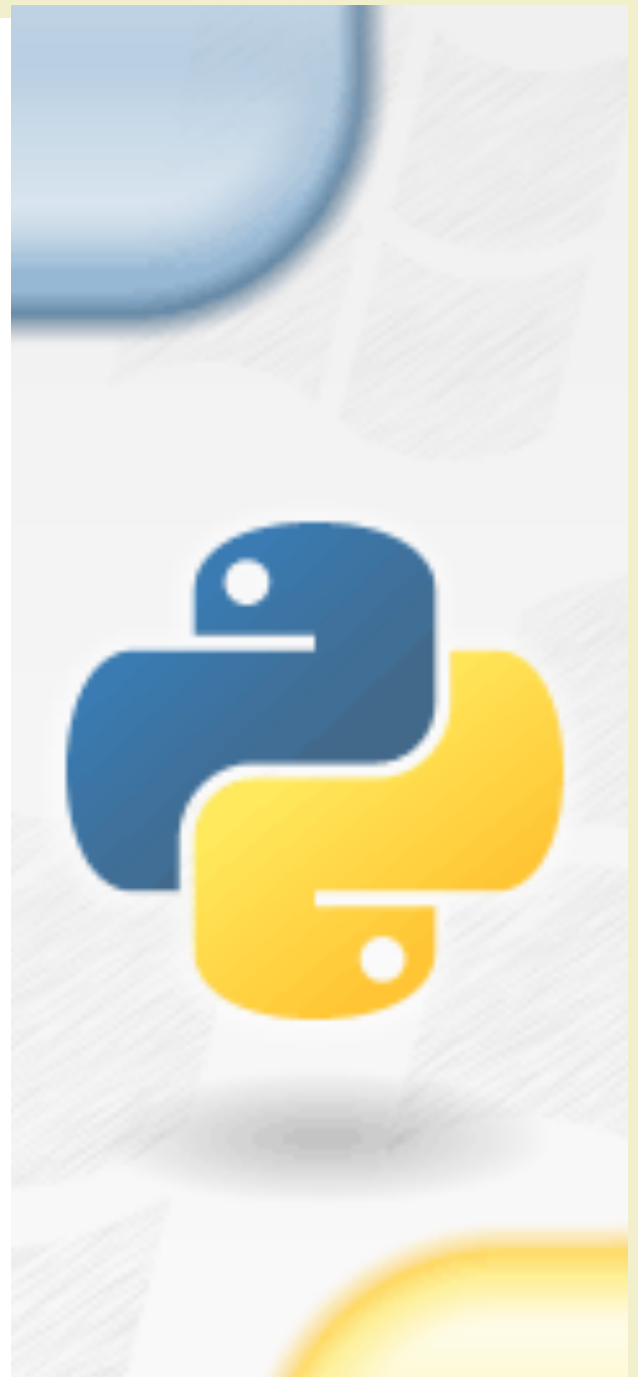
Questions?

01QZP AMBIENT INTELLIGENCE




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