

# Databases in Python

## MySql, SQLite

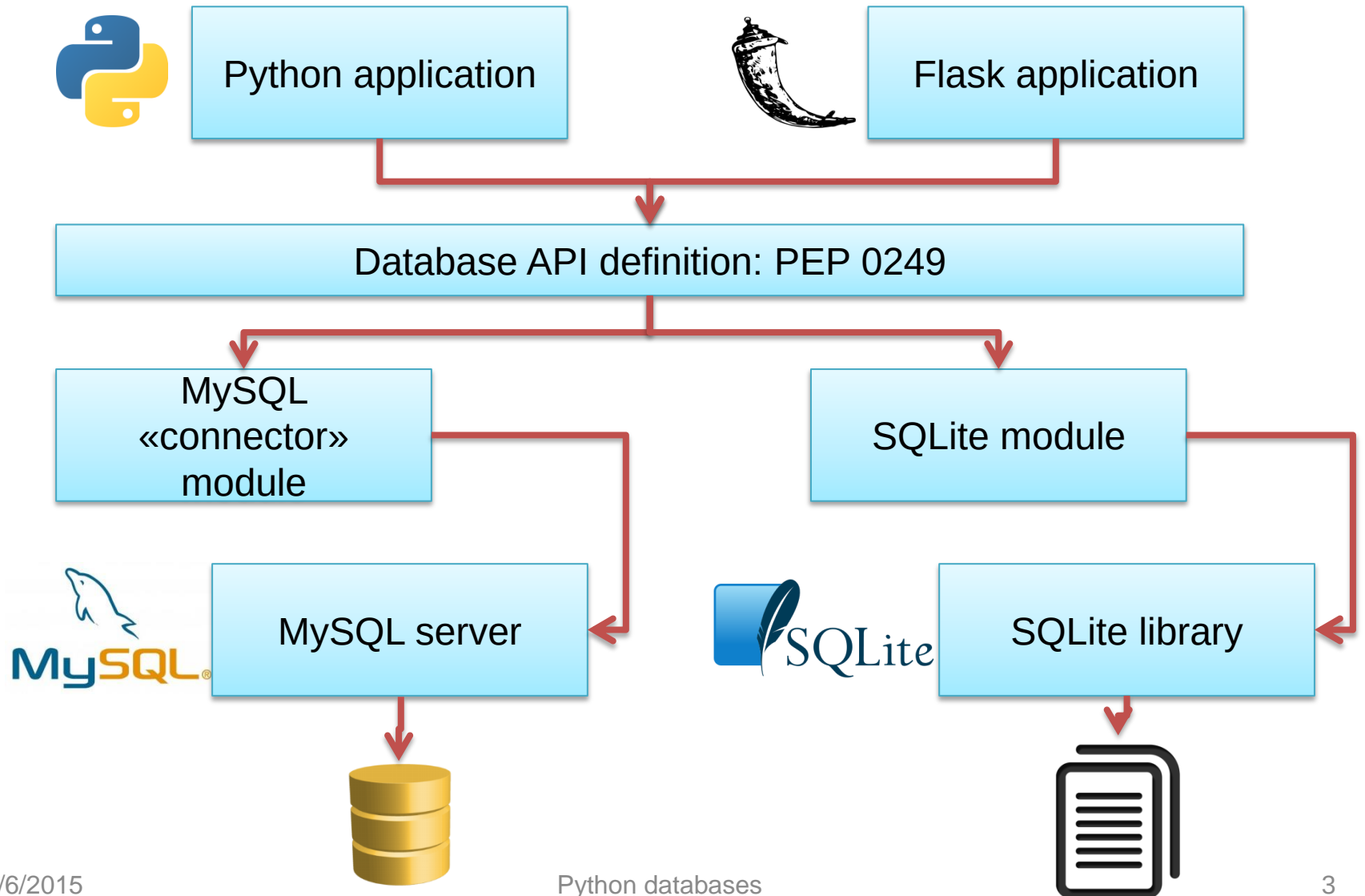
Accessing persistent storage (Relational databases) from Python code



# 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
- Full featured
- Runs as a separate process (may be on a different computer)
- Allows concurrent access
- <http://dev.mysql.com>

## SQLite

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

# Other options

- MariaDB – fork of MySQL
- PostgreSQL – more complex, but more complete than MySQL
- 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`



# 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' placeholders
  - `sql = "INSERT INTO translation (original, modified) VALUES (%s, %s)"`

# 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 5 (a): 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 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

# 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 (b): Clean up

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

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

# 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 includes an abstract, a table of contents, and a section navigation menu. The abstract states: "This manual describes how to install, configure, and develop database applications using MySQL Connector/Python, a self-contained Python driver for communicating with MySQL servers." 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

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

# 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/2/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')
```

# References and Links

- MySQL: <http://dev.mysql.com/>
- SQLite (C library): <https://www.sqlite.org/>
- SQLite for Python (installed by default):
  - Documentation: <https://docs.python.org/2/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/>
- MySQL Connector/Python (mysql.connector)
  - Download & install: <http://dev.mysql.com/downloads/connector/python/>
  - Documentation: <http://dev.mysql.com/doc/connector-python/en/index.html>

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