Introduzione alle Applicazioni Web

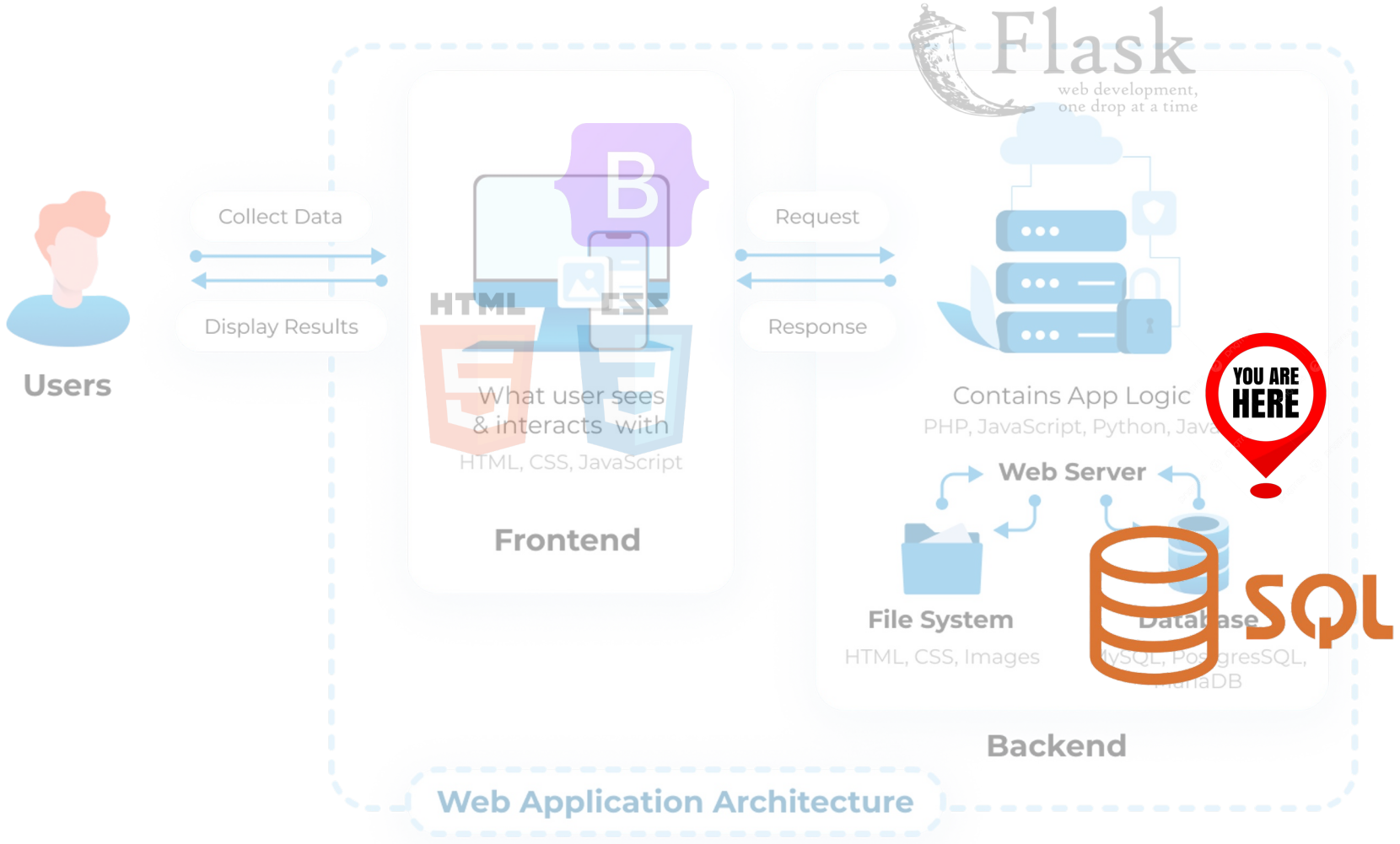
Database

Juan Pablo Sáenz

Goals

- Understand how to make **data persistent** across application restarts
- Learn how to manage large datasets **beyond in-memory storage**
- Use **SQL** to work with complex data and **perform advanced queries**

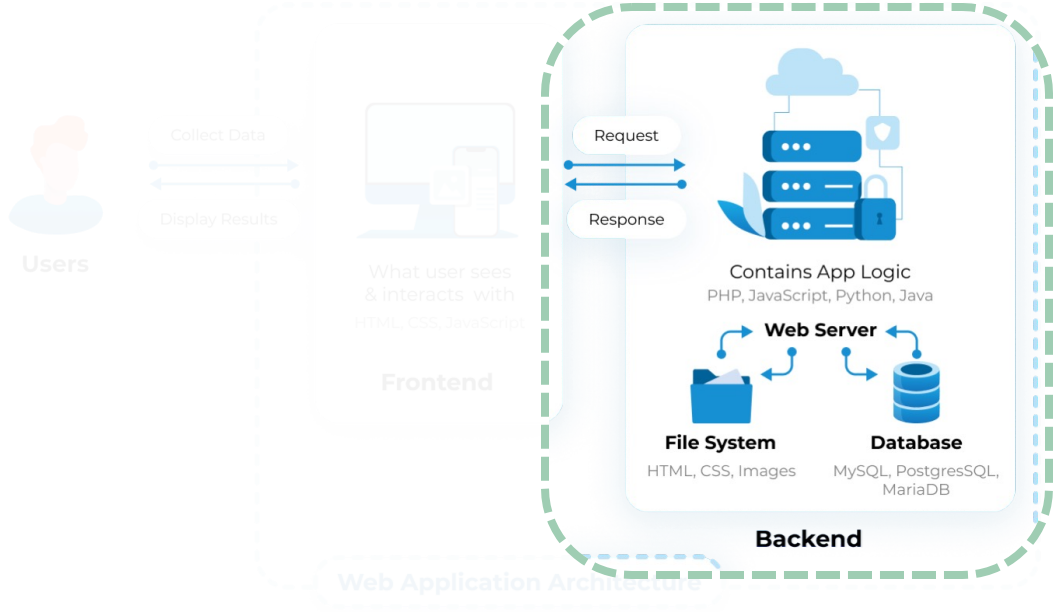
📍 Database: where are we?



Web architecture components: Backend

Database: a system that **stores and organizes data**, making it easy to retrieve, manage, and update.

- It ensures data integrity, security, and performance, often structured in **tables**, **rows**, and **columns**.
- **SQL (Structured Query Language)** is the language used to **interact with databases**, allowing users to search, insert, update, and delete data.

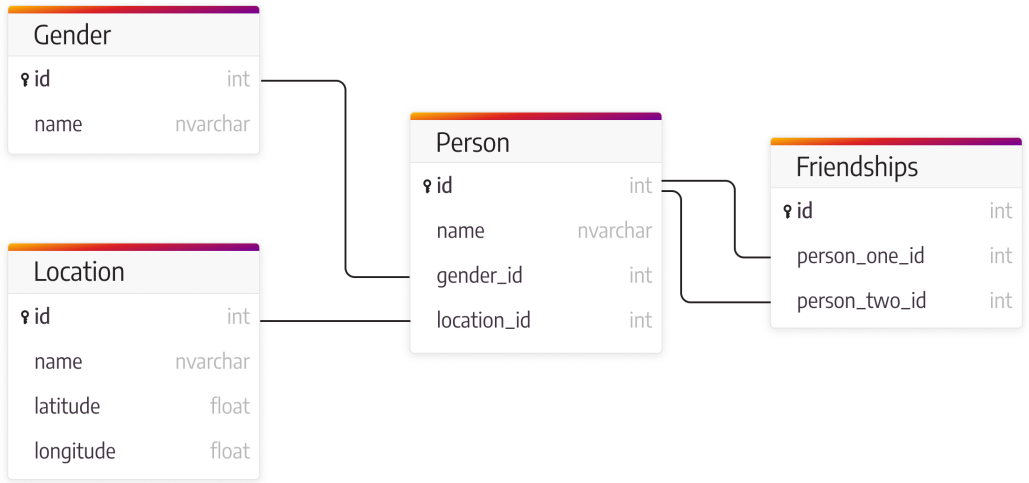


Relational databases

A **structured** way to store data in **tables** (**rows** and **columns**)

Each **table** represents a specific **entity** (e.g., users, products)

- ⚠️ Tables are named in **PLURAL** (e.g., users, orders) to reflect collections

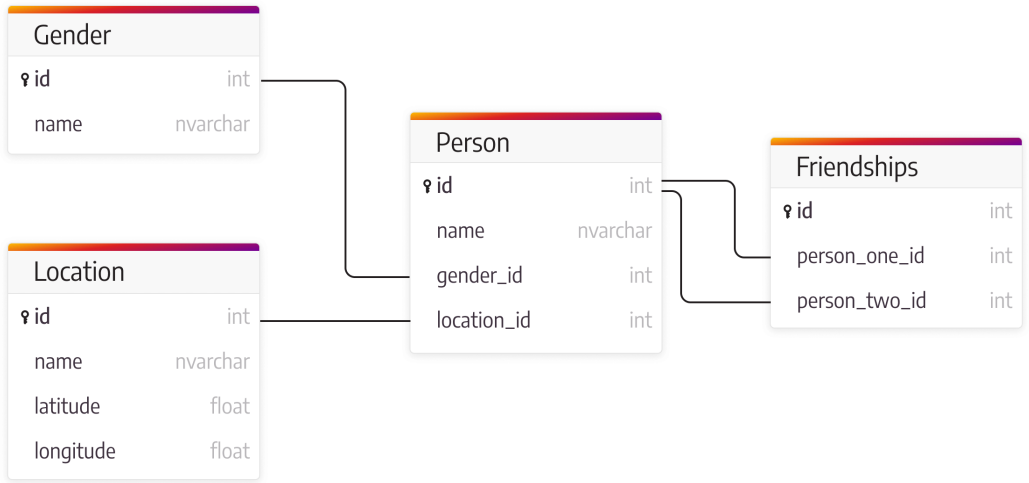


https://memgraph.com/blog/graph-database-vs-relational-database

Relational databases

Tables can be linked through **relationships** (e.g., foreign keys)

Enables **powerful querying using SQL** (Structured Query Language)



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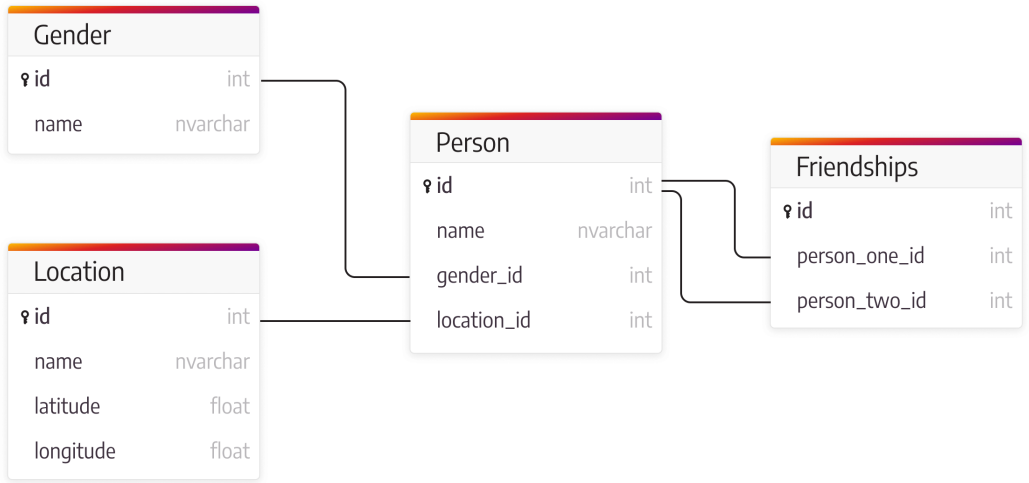
Relational databases

Ensures data integrity through **ACID** properties:

- **A**tomicity: All or nothing: a transaction must **fully happen or not at all**
- **C**onsistency: **Data must stay correct** before and after a transaction
- **I**solation: **Transactions don't mess with each other**, even if run at the same time
- **D**urability: Once saved, **data won't be lost**—even if the system crashes



https://memgraph.com/blog/graph-database-vs-relational-database

Non-relational databases

Also known as **NoSQL** databases

Store data in **flexible formats** like:

- Documents (e.g., MongoDB)
- Key-value pairs (e.g., Redis)
- Graphs (e.g., Neo4j)

Do **not require a fixed schema**, making them ideal for **unstructured** or **evolving** data

Common in real-time applications

⚠ **Out of scope** for this course

Difference between Relational and Non-Relational databases

Relational

student

id	name	surname	age
1	John	Brown	19
2	Emma	Carly	23

Non-Relational

student.json file body:

```
[
 {
  "id": 1,
  "name": "John",
  "surname": "Brown",
  "age": 19
 },
 {
  "id": 2,
  "name": "Emma",
  "surname": "Carly",
  "age": 23
 }
]
```

https://codefinity.com/courses/v2/5ac24d9d-4a16-45b3-8856-07dec028c5e9/c9717913-3062-46d6-b0ef-164aca862b29/64995190-c55f-4482-a71f-ec51d6ae5b80

Relational databases: SQLite

A **lightweight**, **serverless** relational database

Stores data in a **single file** on disk

Commonly used in **mobile applications**, embedded systems, and for **rapid prototyping**

🤩 **Zero Configuration**: No separate server or complex setup required

Step-by-Step Guide to Using SQLite

Step 1: Importing SQLite

Since Python 2.5, **SQLite** has been included by default via the **`sqlite3`** module

```
# app.py

import sqlite3
```

Step-by-Step Guide to Using SQLite

Step 2: Query definition

- Use a regular SQL query stored in a **string**
- If your query includes variable parameters, use **placeholders** (**?**)
- ⚠️ **NEVER** build SQL queries by joining strings
- 📌 Use SQL templates with **placeholders** instead of inserting values directly
- 📌 Pass the actual values using **`.execute()`**

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

sql = "INSERT INTO translation
(original, modified) VALUES (?, ?)"
```

Step-by-Step Guide to Using SQLite

Step 2: Query definition

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

sql = "INSERT INTO translation
(original, modified) VALUES (?, ?)»

# Define the query with a
placeholder
sql = "SELECT id, email FROM users
WHERE name = ?"
```

Step-by-Step Guide to Using SQLite

Step 3: Database connection

- Establishes a connection to a **SQLite database file** named **`example.db`**
- If the file does not exist, **SQLite will automatically create it**
- **`conn`** is a connection object used to:

  Create a **cursor** for executing SQL commands

  Commit changes

  Close the connection

```
conn =
sqlite3.connect('example.db')
```

Step-by-Step Guide to Using SQLite

Step 4: Query execution

- Get a **cursor** from the connection
- Execute a SQL query: **`.execute()`**
- Use **placeholders** to pass parameters safely
- Query parameters are given as a '**tuple**' argument

  ⚠️ One-element tuples require trailing `,`

  ```
  cursor.execute(sql, (txtid,))
  ```

```
sql = "INSERT INTO translation
(original, modified) VALUES (?, ?)"
# Create a cursor object to execute
SQL commands
cursor = conn.cursor()

# Insert a row using placeholders
(note the ? symbols)
cursor.execute(sql, ("Hello",
"Hola"))
```

Step-by-Step Guide to Using SQLite

Step 4: Query execution

- If the query was a **SELECT**

  `cursor.fetchone()`: retrieves the next result

  `cursor.fetchall()`: retrieves all remaining results

Both methods return tuples, representing the selected columns

https://www.python.org/dev/peps/pep-0249/#cursor-methods

```
# Fetch and print the results
rows = cursor.fetchall()
for row in rows:
    print(row)
```

Step-by-Step Guide to Using SQLite

Step 4: Query execution

- For **INSERT**, **UPDATE**, or **DELETE** there is no result
- The changes are not immediately applied to the database; they need to be '**committed**' first
- ⚠️ **Don't forget to commit**, or you might lose your data!
- This must be called before **`conn.close()`**

```
# Save (commit) the changes
conn.commit()

# Always close the connection when done
conn.close()
```

Step-by-Step Guide to Using SQLite

Step 5: Closing the cursor and the connection

- When you're done with the cursor, call **`cursor.close()`**
- Also, close the connection, this frees up resources on the database server: **`conn.close()`**

```
# Close the cursor
cursor.close()

# Always close the connection when done
conn.close()
```

Minimal example

```
conn = sqlite3.connect('example.db’)

sql_insert = "INSERT INTO translation (original, modified) VALUES (?, ?)"

cursor = conn.cursor()

cursor.execute(sql_insert, ("Hello", "Hola"))

conn.commit()

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

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