



Politecnico
di Torino

Introduction to Web Applications

SQL

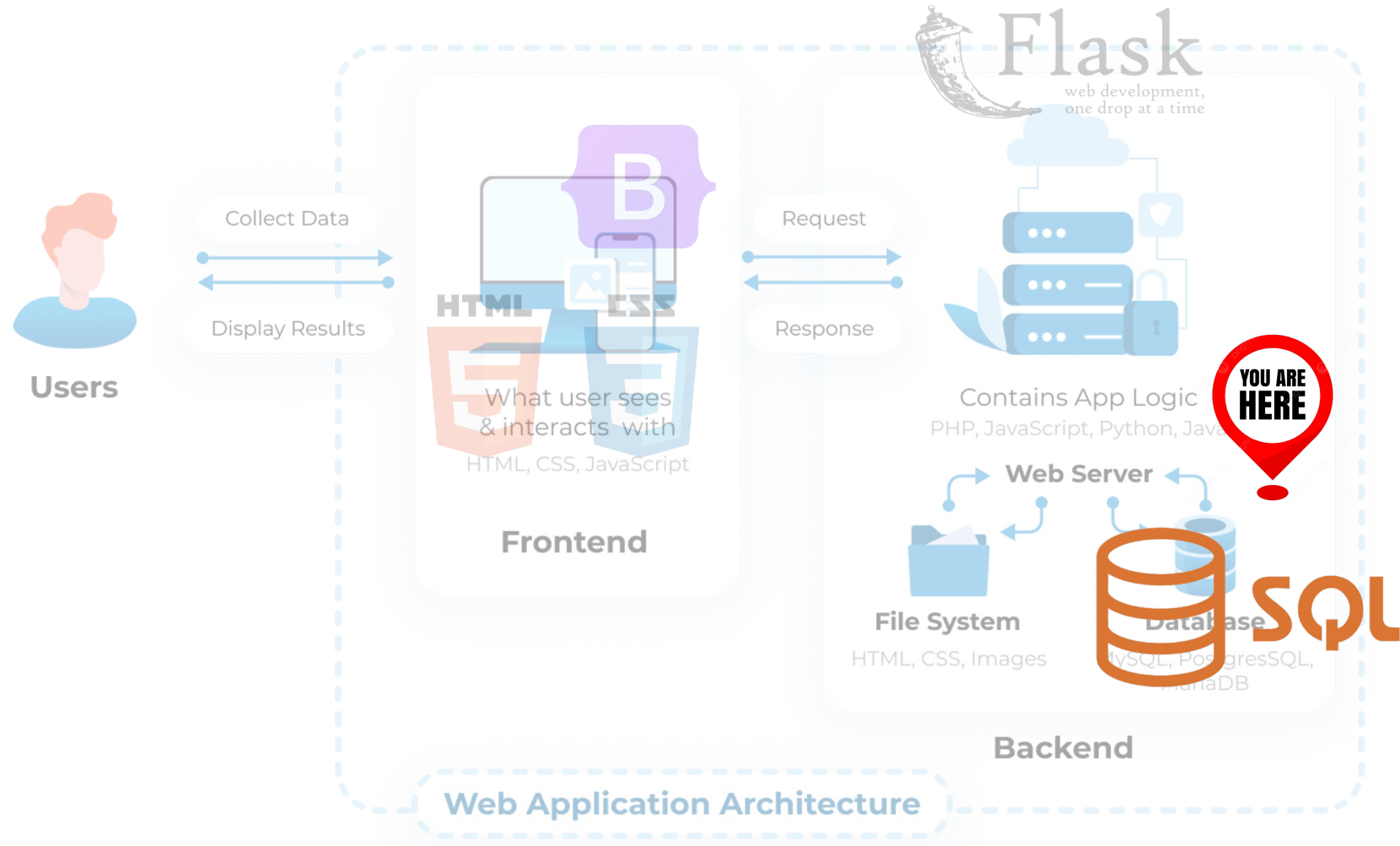
Juan Pablo Sáenz



Goals

- Understand what **SQL** is and why it is important
- Learn the **basic structure** and **syntax** of SQL commands
- Practice **simple queries** to retrieve, insert, update, and delete data

📍 Database: where are we?

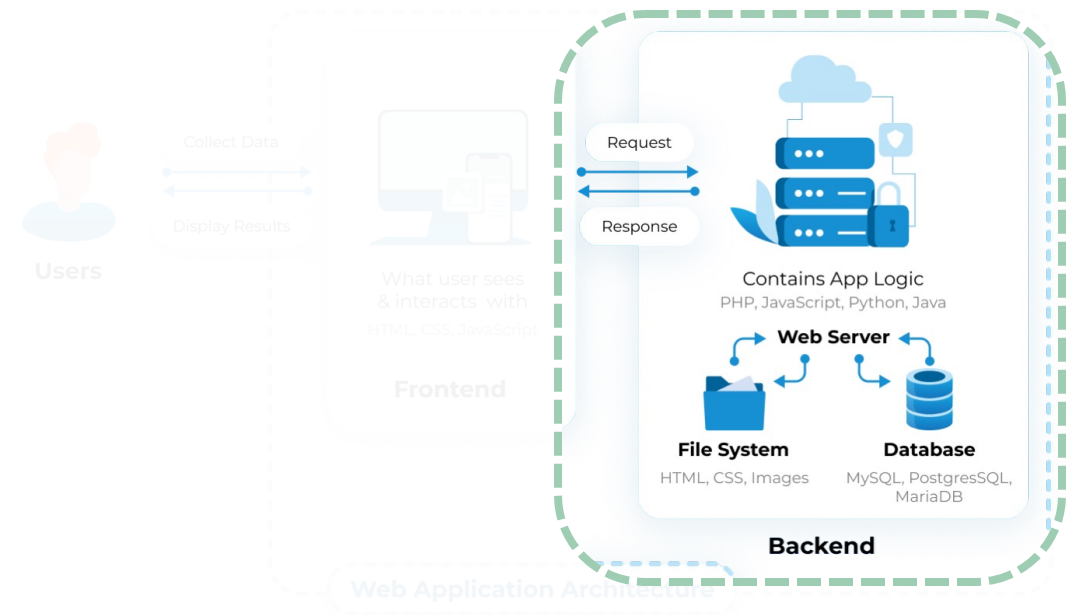




Web architecture components: Backend

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.

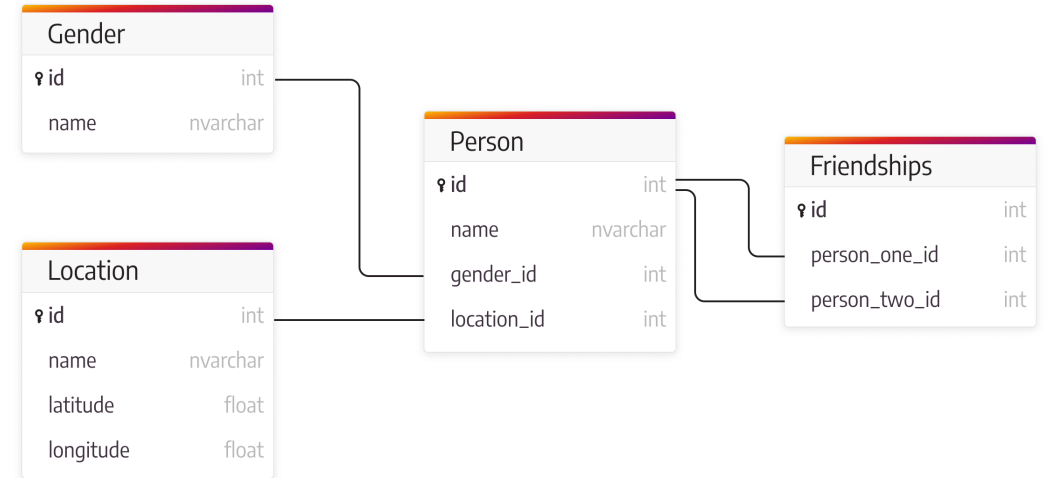


Relational databases

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

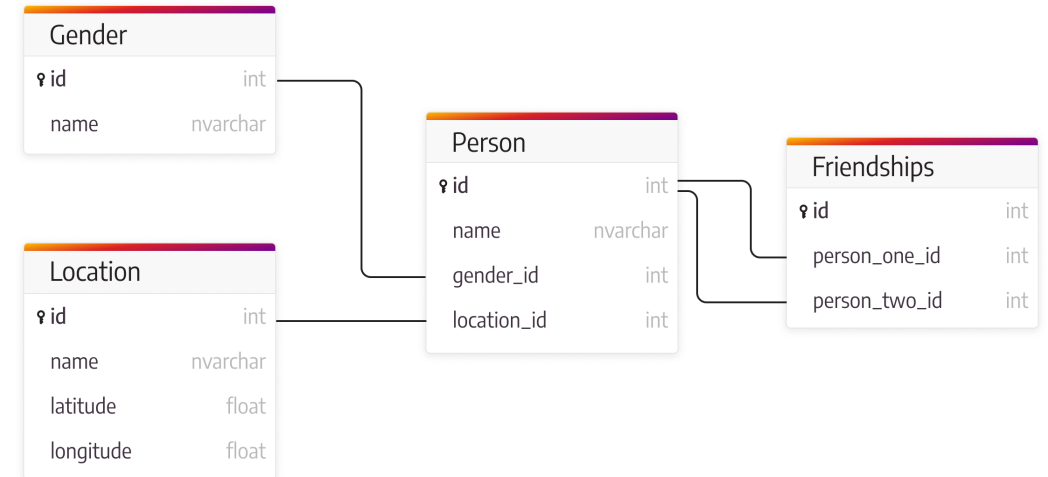


<https://memgraph.com/blog/graph-database-vs-relational-database>

Relational databases

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

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

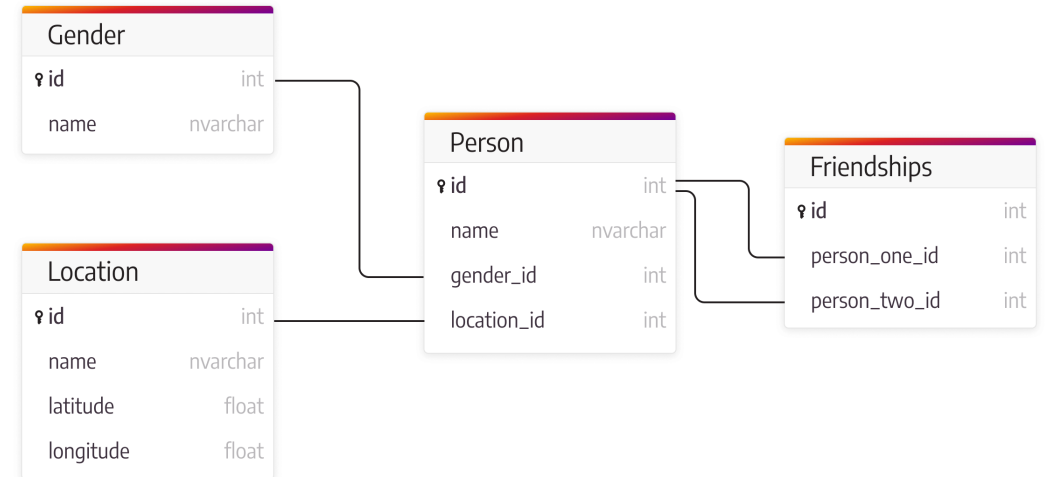


<https://memgraph.com/blog/graph-database-vs-relational-database>

Relational databases

Ensures data integrity through **ACID** properties:

- **Atomicity:** All or nothing: a transaction must **fully happen or not at all**
- **Consistency:** **Data must stay correct** before and after a transaction
- **Isolation:** **Transactions don't mess with each other**, even if run at the same time
- **Durability:** Once saved, **data won't be lost**—even if the system crashes

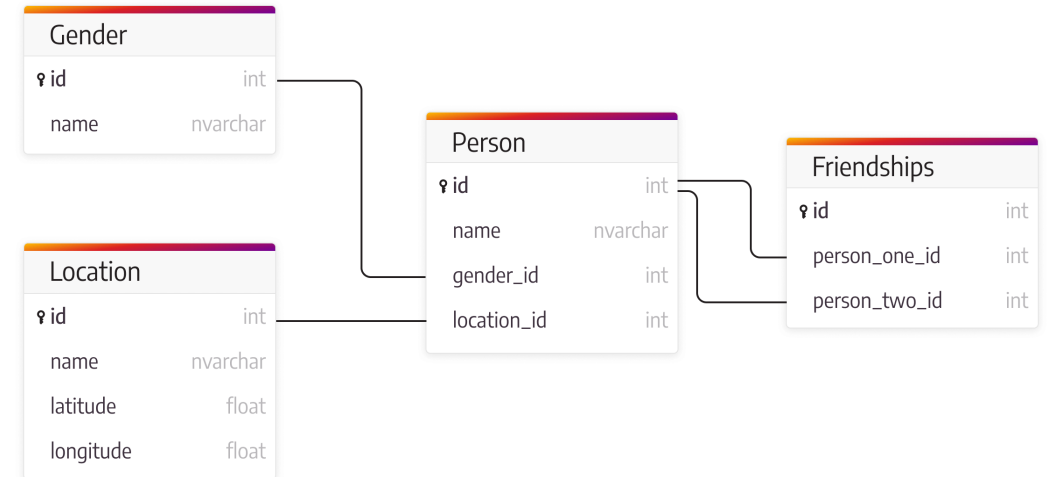


<https://memgraph.com/blog/graph-database-vs-relational-database>

Relational database keys: PK

🔑 Primary Key (PK)

- Uniquely **identifies** each record in a table
- Must contain **unique** values
- **Cannot** contain **NULL** values

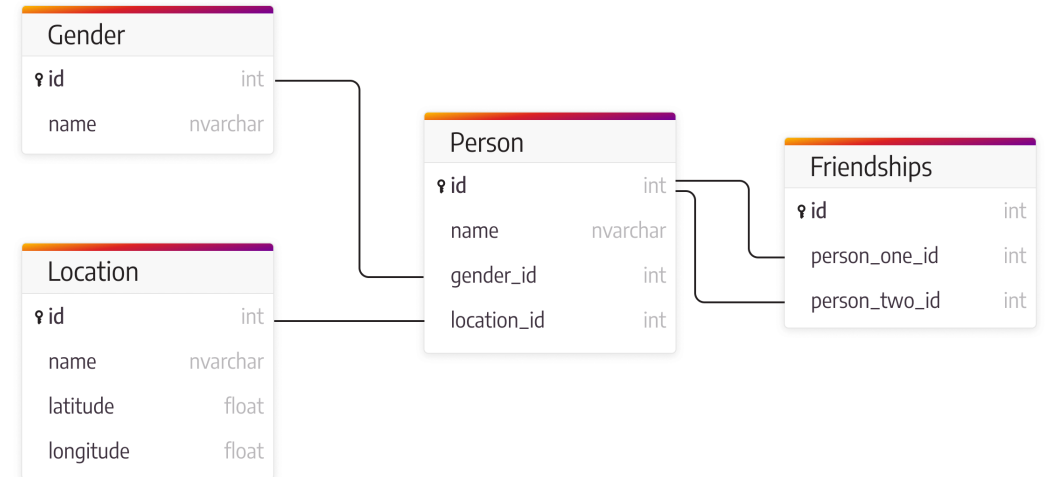


<https://memgraph.com/blog/graph-database-vs-relational-database>

Relational database keys: PK

💡 Important considerations:

- Use a **surrogate key**: a system-generated key, usually an auto-incremented integer
- Use a **single column** for the PK: simpler to manage and index, ensuring better performance
- **Keep It Simple**: A simple primary key is easy to maintain, index, and query



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

Relational database keys: FK and UK

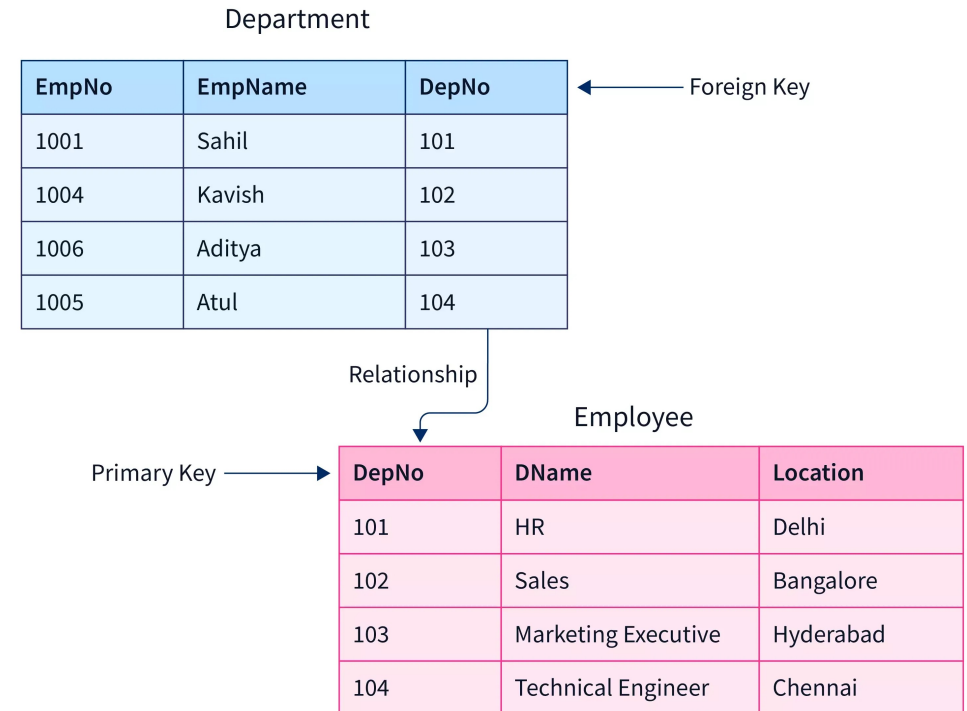
🔑 Foreign Key (FK)

Establishes a **relationship** between two tables

- Linking a column in one table (FK) to the primary key of another

🔑 Unique Key (UK)

- Ensures all values in a column are unique (but can accept NULL values)



<https://businessanalytics.substack.com/p/primary-key-vs-foreign-key-in-sql>

Relational database: Data types

- **INT**: Integer numbers (e.g., employee IDs).
 - **VARCHAR**: Variable-length strings (e.g., names, emails).
 - **DATE**: Stores date values (e.g., hire date).
 - **BOOLEAN**: Stores **TRUE/FALSE** values (e.g., is_active).
 - **DECIMAL(p, s)**: Fixed-point numbers for financial calculations (e.g., salary).
 - **TEXT**: Stores large amounts of text data
- ⚠ In SQLite, **REAL** stores floating-point numbers, while **NUMERIC** offers flexibility, allowing storage as integers or real numbers based on the value

Relational database: Not Null Constraint

🛡️ Ensures that a column **cannot have NULL values**

- Guarantees that data is always present for that column

NOT NULL IN SQL

ID	NAME	DOB
001	Sia	21/01/01
002		15/08/02
003	Sam	04/12/01

Column does not allow NULL

<https://www.scaler.com/topics/not-null-in-sql/>

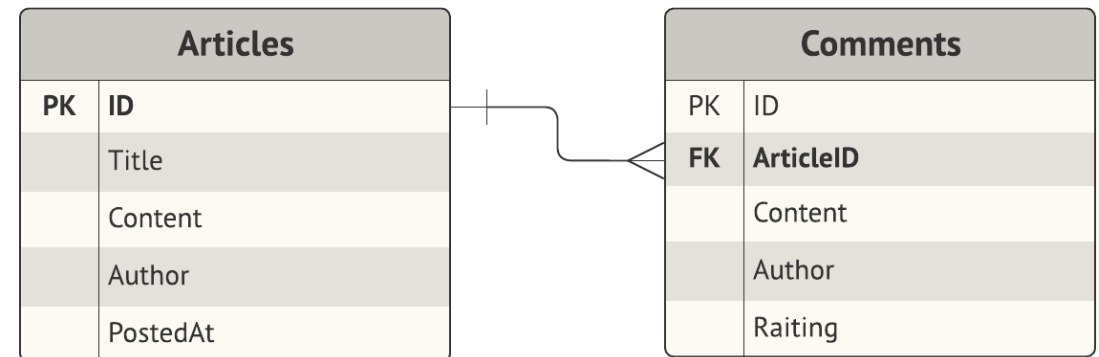
Relational database: Cardinality

One-to-One (1:1)

- One record in a table corresponds to exactly one record in another table

One-to-Many (1:N)

- One record in a table corresponds to multiple records in another table
- A blog post has many comments



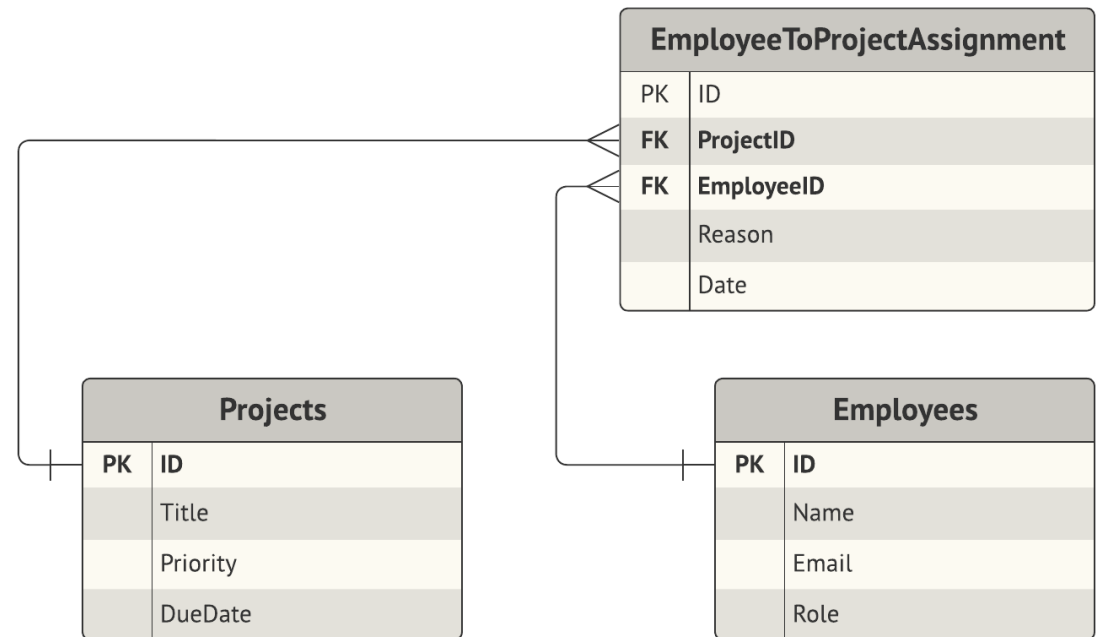
Many-to-One (N:1)

<https://levelup.gitconnected.com/many-to-many-one-relationships-are-simple-in-sql-but-hard-in-nosql-2b3cfeeb70eb>

Relational database: Cardinality

Many-to-Many (N:M)

- Multiple records in one table correspond to multiple records in another table
- Implemented via a **junction table**
- Students can enroll in **multiple courses**, and each course can have **many students**



<https://levelup.gitconnected.com/many-to-many-one-relationships-are-simple-in-sql-but-hard-in-nosql-2b3cfeeb70eb>

SQL

A **domain-specific language**, designed for managing and manipulating data in databases

- Unlike **general-purpose** programming languages (like Python, Java, or C++), SQL focuses only on **database operations**

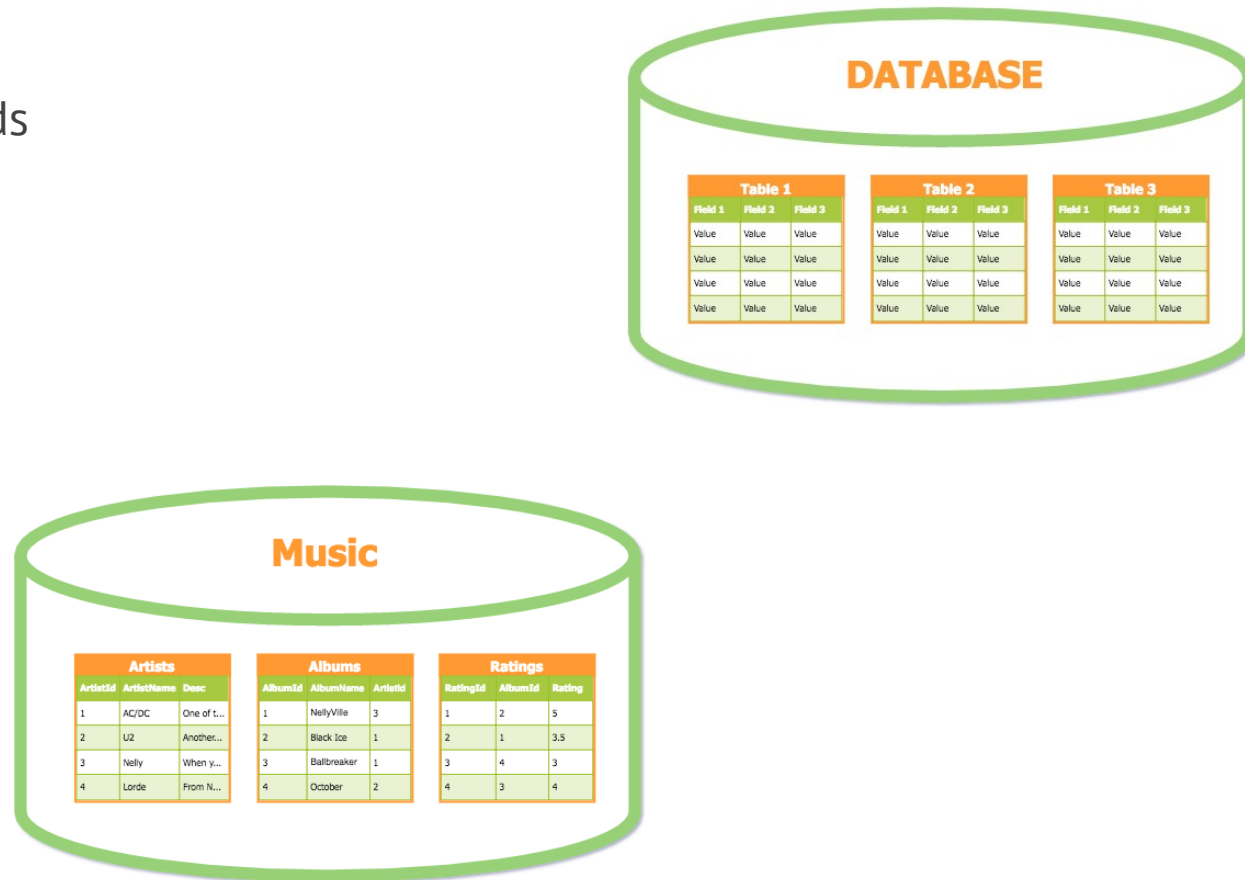
It is **declarative**: you tell the database **what you want**, not how to do it

SQL capabilities

Create and modify tables and databases

Insert, retrieve, update, and delete records

Set permissions on database objects



<https://database.guide/database-tutorial-part-1-about-databases-creating-databases-tables/>

SQL syntax

SQL commands are written in **English-like** statements

Keywords are case-insensitive, but often written in **uppercase**

```
SELECT name FROM students  
WHERE grade > 90;
```

SQL main commands

We will focus on Data Manipulation Language (**DML**) and Data Query Language (**DQL**) commands

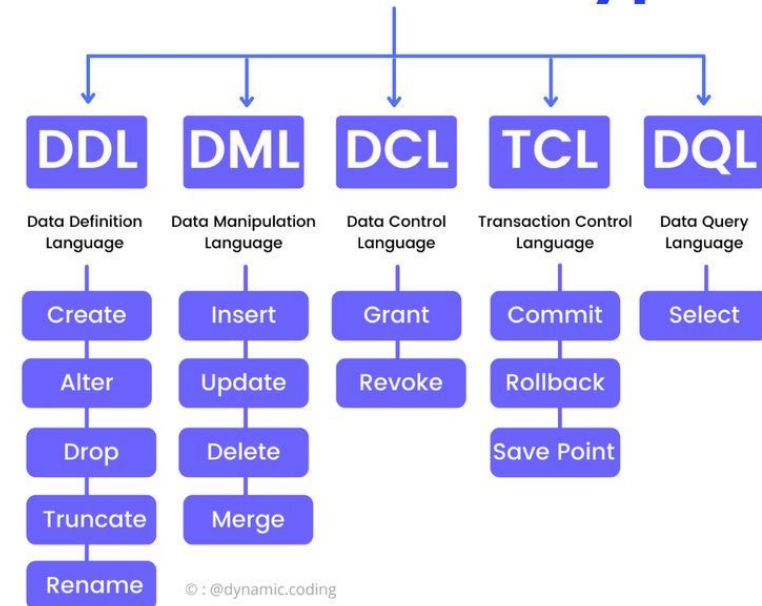
SELECT: Retrieve data from a table

INSERT: Add new records

UPDATE: Modify existing records

DELETE: Remove records

SQL Command Types



<https://it.pinterest.com/pin/1016898790832478504/>

SQL main commands

SELECT: Retrieve data from a table

INSERT: Add new records

UPDATE: Modify existing records

DELETE: Remove records

```
SELECT column1, column2, ...  
FROM table_name;
```

```
SELECT first_name, last_name  
FROM employees;
```

SQL main commands

SELECT: Retrieve data from a table

INSERT: Add new records

UPDATE: Modify existing records

DELETE: Remove records

```
SELECT column1, column2
FROM table_name
WHERE condition;
```

```
SELECT first_name, last_name
FROM employees
WHERE department = 'Sales';
```

SQL main commands

SELECT: Retrieve data from a table

INSERT: Add new records

UPDATE: Modify existing records

DELETE: Remove records

```
SELECT column1, column2
FROM table_name
ORDER BY column1 [ASC|DESC];
```

```
SELECT first_name, last_name
FROM employees
ORDER BY last_name ASC;
```

SQL main commands

SELECT: Retrieve data from a table

INSERT: Add new records

UPDATE: Modify existing records

DELETE: Remove records

```
SELECT column1
FROM table_name
WHERE condition1 [AND | OR]
condition2;
```

```
SELECT first_name, last_name
FROM employees
WHERE department = 'Sales' AND
salary > 50000;
```

SQL main commands

SELECT: Retrieve data from a table

INSERT: Add new records

UPDATE: Modify existing records

DELETE: Remove records

```
SELECT column1
FROM table_name
LIMIT number;
```

```
SELECT first_name, last_name
FROM employees
LIMIT 5;
```

SQL main commands

SELECT: Retrieve data from a table

INSERT: Add new records

UPDATE: Modify existing records

DELETE: Remove records

```
INSERT INTO table_name (column1,  
column2, column3, ...)  
VALUES (value1, value2, value3, ...);
```

```
INSERT INTO Students (ID, Name, Age)  
VALUES (1, 'John Doe', 22);
```

```
-- If a column is auto-incremented  
(like an ID), you may omit it in the  
INSERT statement.
```

SQL main commands

SELECT: Retrieve data from a table

INSERT: Add new records

UPDATE: Modify existing records

DELETE: Remove records

```
UPDATE table_name
SET column1 = value1, column2 =
value2, ...
WHERE condition;
```

```
UPDATE Students
SET Age = 23
WHERE ID = 1;
```

```
-- Without WHERE, all records will
be updated
```

SQL main commands

SELECT: Retrieve data from a table

INSERT: Add new records

UPDATE: Modify existing records

DELETE: Remove records

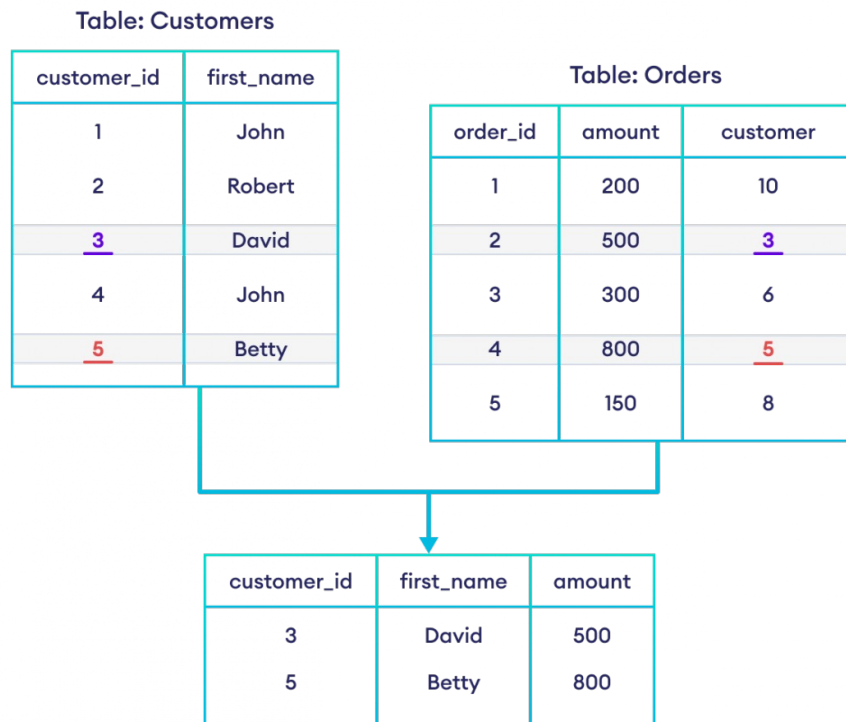
```
DELETE FROM table_name  
WHERE condition;
```

```
DELETE FROM Students  
WHERE ID = 1;
```

```
-- Sometimes, it may be better  
to disable a row rather than delete  
it (e.g., marking it as "inactive")
```

SQL JOIN operations

INNER JOIN: Returns records that have matching values in both tables



<https://www.programiz.com/sql>

```
SELECT employees.name,  
       departments.name  
FROM employees  
INNER JOIN departments ON  
employees.department_id =  
departments.id;
```

SQL JOIN operations

- **LEFT JOIN (LEFT OUTER JOIN):** Returns **all records from the left table**, and the matched records from the right table

Table: Customers

customer_id	first_name
1	John
2	Robert
<u>3</u>	David
4	John
<u>5</u>	Betty

Table: Orders

order_id	amount	customer
1	200	10
2	500	<u>3</u>
3	300	6
4	800	<u>5</u>
5	150	8

Result of LEFT JOIN:

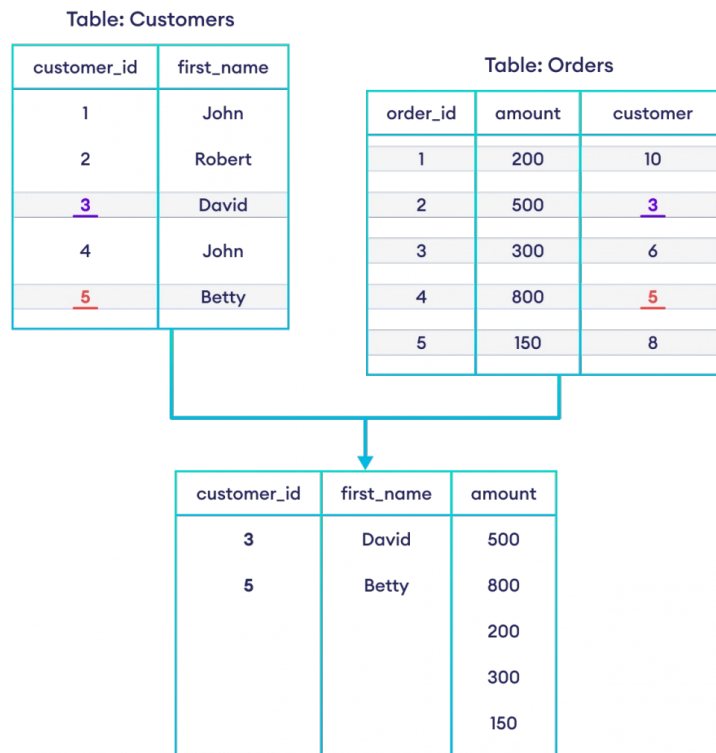
customer_id	first_name	amount
1	John	
2	Robert	
3	David	500
4	John	
5	Betty	800

<https://www.programiz.com/sql>

```
SELECT employees.name,  
       departments.name  
FROM employees  
LEFT JOIN departments ON  
employees.department_id =  
departments.id;
```

SQL JOIN operations

- **RIGHT JOIN (RIGHT OUTER JOIN):** Returns **all records from the right table**, and the matched records from the left table

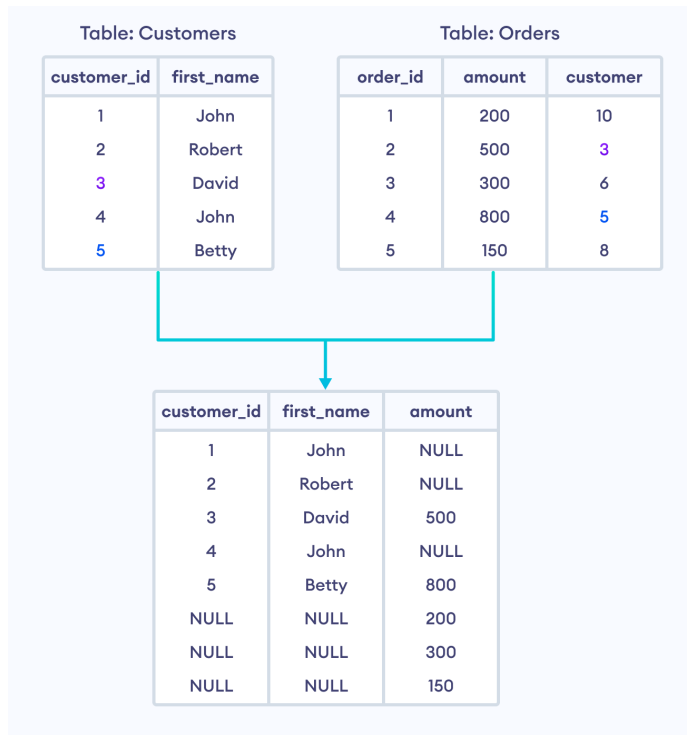


<https://www.programiz.com/sql>

```
SELECT employees.name,  
       departments.name  
FROM employees  
RIGHT JOIN departments ON  
employees.department_id =  
departments.id;
```

SQL JOIN operations

- **FULL JOIN (FULL OUTER JOIN):** Returns **records when there is a match in either left or right table**

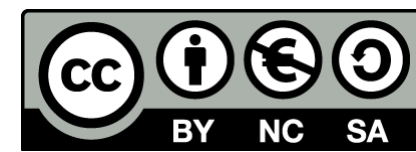


<https://www.programiz.com/sql>

```
-- Combines the results of both  
LEFT and RIGHT JOINS, returning  
all employees and all  
departments, with NULL for  
unmatched rows
```

```
SELECT employees.name,  
departments.name  
FROM employees  
FULL OUTER JOIN departments ON  
employees.department_id =  
departments.id;
```

Let's see it in practice



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