Data Engineering LTAT.02.007

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Relational DBs (PostgreSQL)

Lab. 02

https://courses.cs.ut.ee/2020/dataeng

```
[~]$ whoami
```

- Mohamed Ragab, PhD Candidate, Starting **3rd** year.
- Masters in Information Systems, “**Trust management in Social Networks**”.
- My PhD Centered around “**Large Graph Processing, Querying and Optimizations**”.
- I also work on Benchmarking Big Data engines (Spark) for Processing Large graph Datasets.

https://bigdata.cs.ut.ee/mohamed-ragab

Lab Agenda

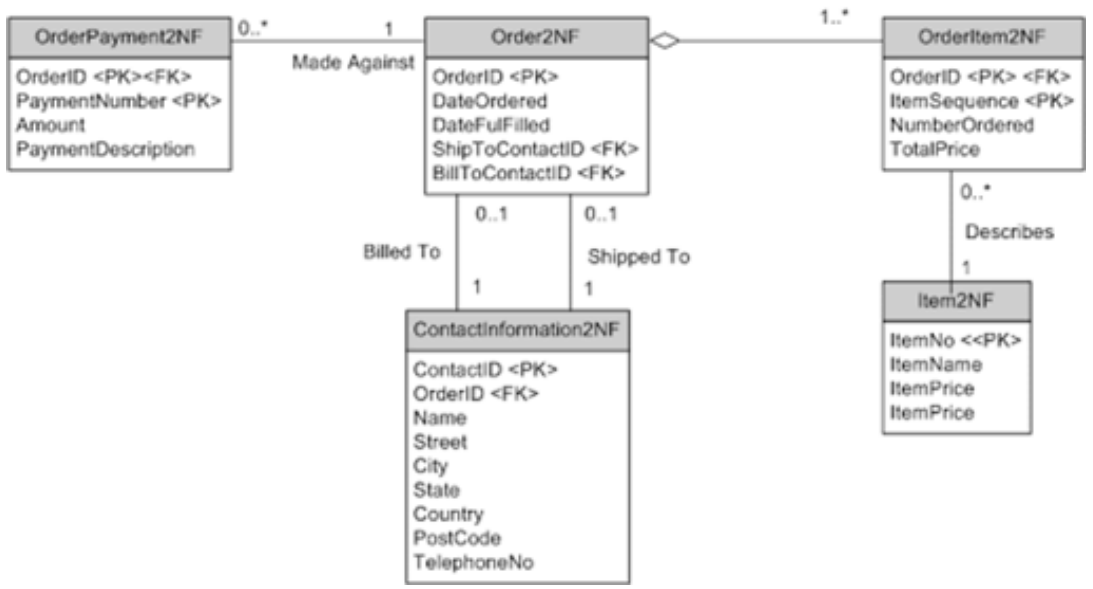
- What is the Relational Model?
- What is Relational DBs?!
- What is DBMS With Examples?
- What is PostgreSQL?
- SQL language
  - **D**ata **D**efinition **L**ang. **DDL**(Create DB, Create Tables,..)
  - **D**ata **Q**uery **L**ang. **DQL** (Selections, Projections, Sorting, Filtering, SQL Joins,..)
  - Data Manipulation Language **DML** (Insert, Update, Delete)

What is Relational Model?

- **RELATIONAL MODEL (RM)** represents the database as a collection of relations.
- A relation is nothing but a "**table**" of values.
- Every row in the table represents a collection of related data values.
- These rows in the table denote a real-world entity or relationship.

The Relational Model Cont.

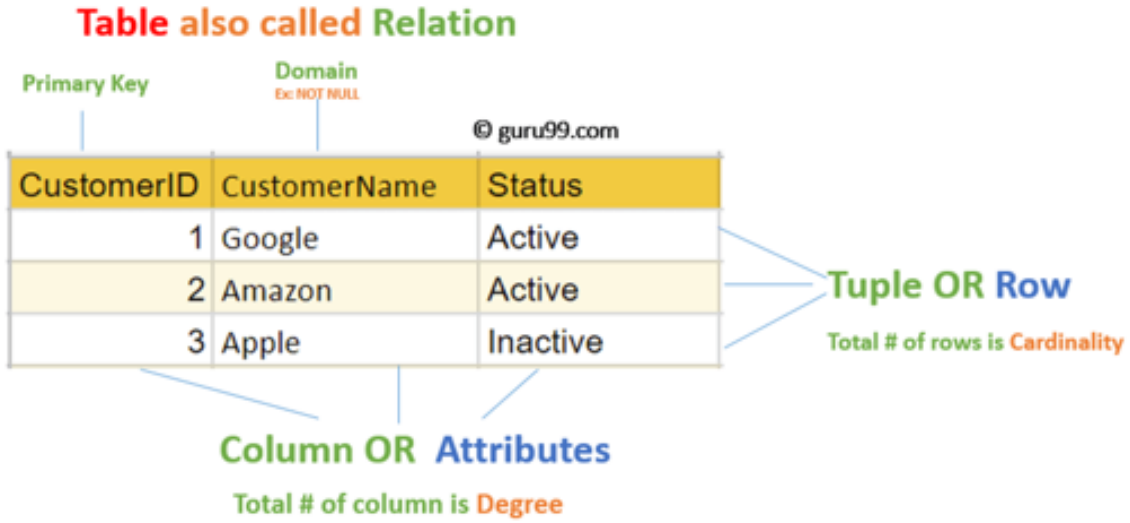
- The data are represented as a set of relations.
- In the relational model, data are stored as tables (Conceptually).
- However, the physical storage of the data is independent of the way the data are logically organized.



https://www.guru99.com/relational-data-model-dbms.html

Relational Model Concepts

- **Tables(Relations)**
- **Attributes (Fields)**
- **Tuples (Rows)**
- **Relation Schema**(Table name + attributes)
- **Degree (**# attributes **)**
- **Cardinality (**# of rows**)**
- **Relation key**
  - Attribute(s) that uniquely identify each tuple in a relation .



https://en.wikipedia.org/wiki/Relational_database

Database Management Systems (DBMSs)

- A software package designed to define, manipulate, retrieve and manage data in a database.

And Many More…

What is PostgreSQL?

- PostgreSQL is an advanced, enterprise-class, and open-source relational database system.
- It supports both SQL (**relational**) and JSON (**non-relational**) querying.
- It is highly stable database with more than **20years** of development by the **open-source** community.

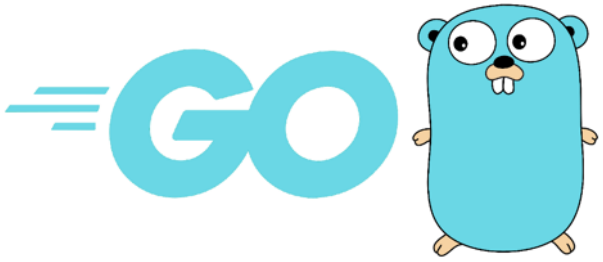
https://www.postgresqltutorial.com/what-is-postgresql /

Common Use cases of PostgreSQL

- **A robust database in many applications**
  - PostgreSQL is primarily used as a robust back-end database that powers many dynamic websites and web applications.
- **General purpose transaction database**
  - Large corporations and startups alike use PostgreSQL as primary databases to support their applications and products.
- **Geospatial database**
  - PostgreSQL with the PostGIS extension supports geospatial databases for geographic information systems (GIS).

PostgreSQL Language Support

Perl



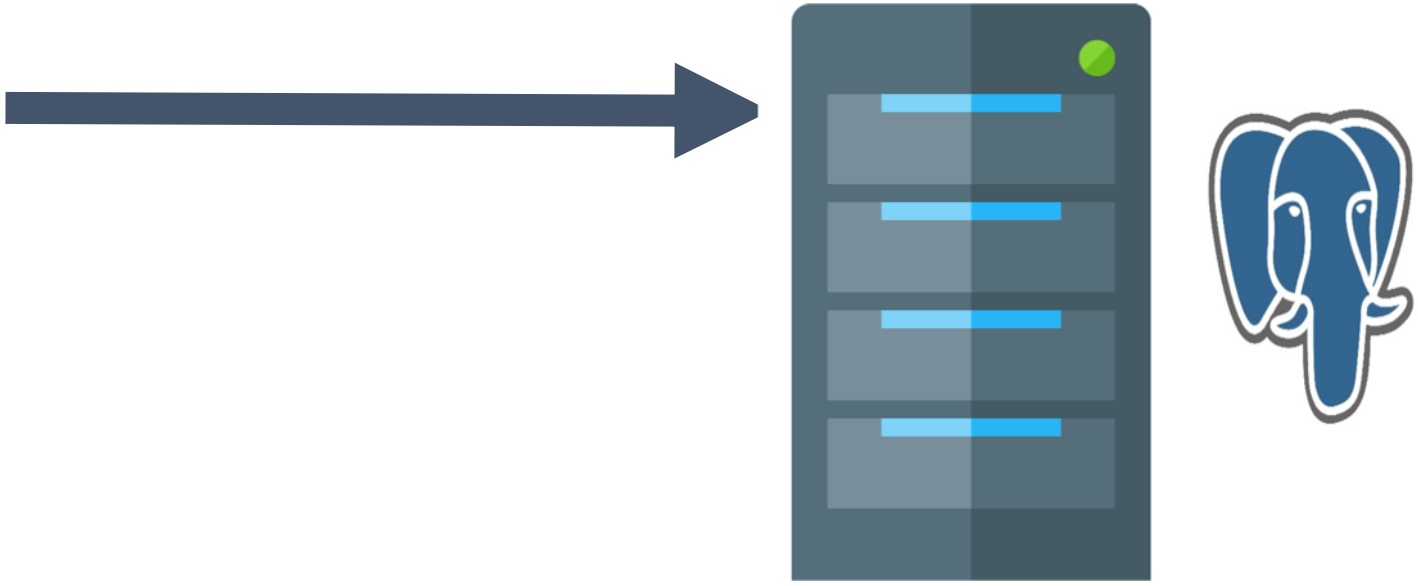
Connecting to DB server

Connect using Client

Client GUI

Terminal/CMD

Application



DB Server

https://www.postgresqltutorial.com/connect-to-postgresql-database/

How To Connect to PostgreSQL

- Using the **PSQL Shell**
  - Or the command prompt after adding psql to your path (environment variables)

- Using the **pgAdmin** (The GUI to manage PostgreSQL DBs)

- Using other **third-party client GUI** softwares.

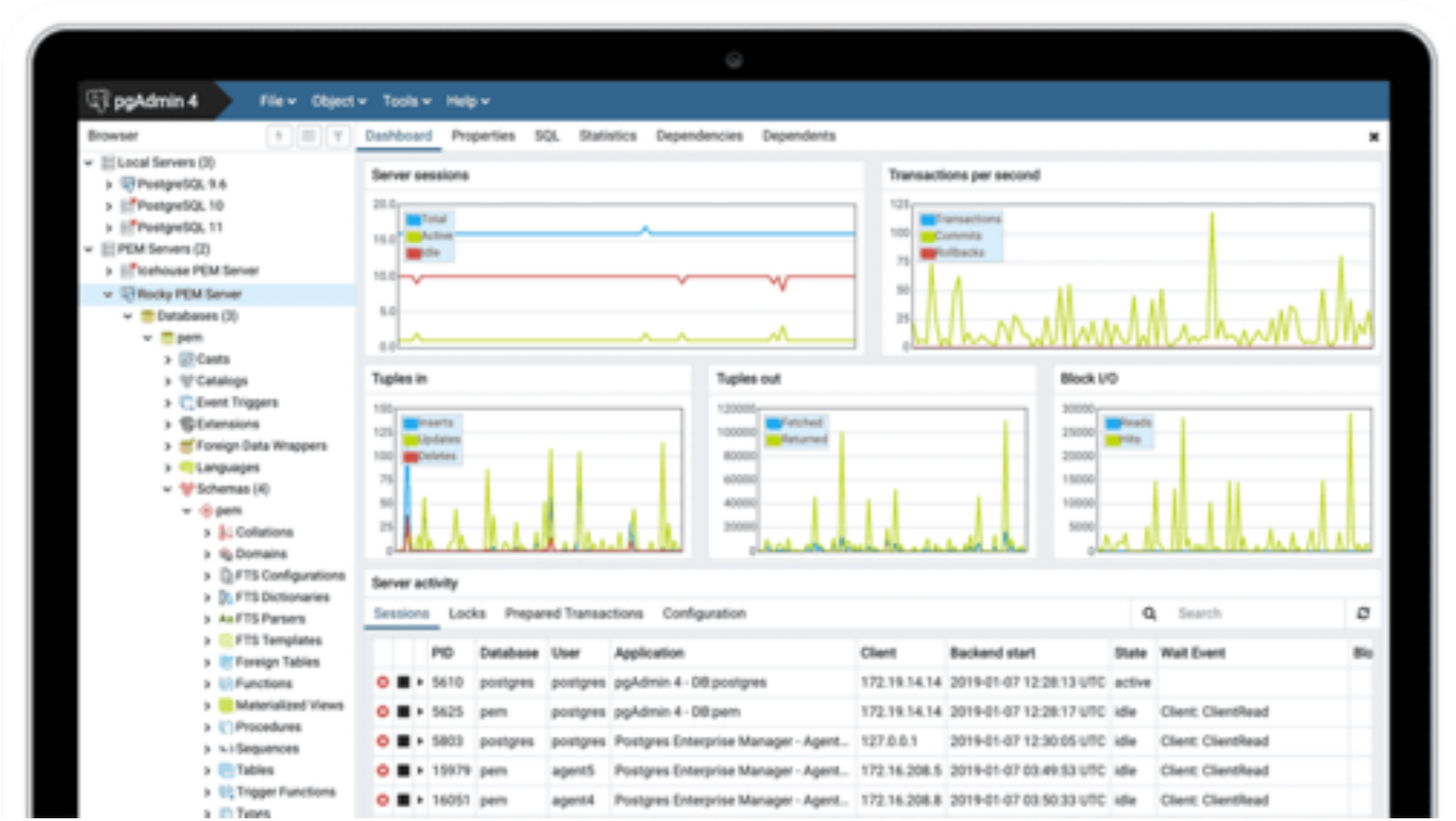
https://www.postgresqltutorial.com/connect-to-postgresql-database/

1- PSQL Shell

```
postgres=# \l
                                  List of databases
   Name    |  Owner   | Encoding |        Collate         |         Ctype          |   Access privileges
-----------+----------+----------+------------------------+------------------------+-----------------------
 exercises | postgres | UTF8     | Estonian_Estonia.1257 | Estonian_Estonia.1257 |
 moviedb   | postgres | UTF8     | Estonian_Estonia.1257 | Estonian_Estonia.1257 |
 postgres  | postgres | UTF8     | Estonian_Estonia.1257 | Estonian_Estonia.1257 |
 socialmedai | postgres | UTF8     | Estonian_Estonia.1257 | Estonian_Estonia.1257 |
 socialmedia | postgres | UTF8     | Estonian_Estonia.1257 | Estonian_Estonia.1257 |
 template0 | postgres | UTF8     | Estonian_Estonia.1257 | Estonian_Estonia.1257 | =c/postgres          +
           |          |          |                        |                        | postgres=CTc/postgres
 template1 | postgres | UTF8     | Estonian_Estonia.1257 | Estonian_Estonia.1257 | =c/postgres          +
           |          |          |                        |                        | postgres=CTc/postgres
(7 rows)
```

- To get more familiar with PSQL SHELL commands, You can follow this link: (https://www.postgresql.org/docs/current/app-psql.html)

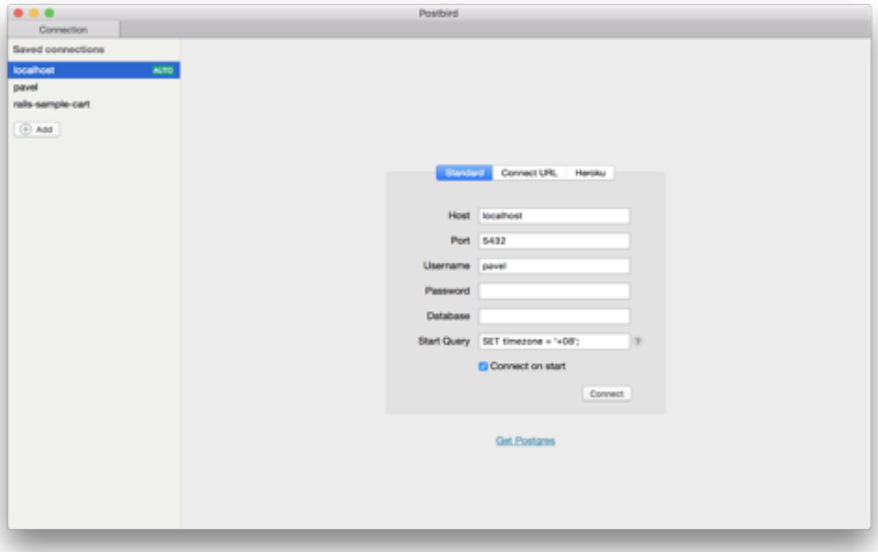
2. pgAdmin: the GUI of PostgreSQL



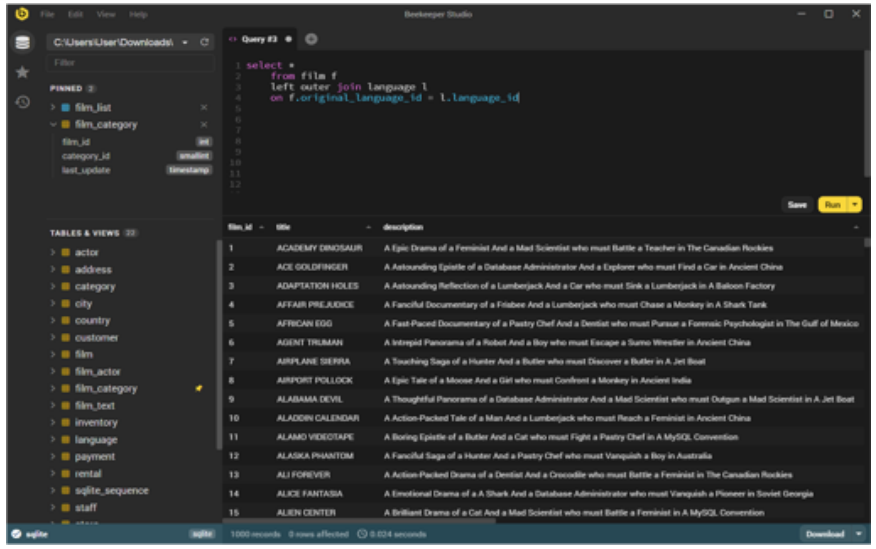
https://www.pgadmin.org/download/

3. Other GUI Client Options

- Paxa/postbird
  - Open source PostgreSQL GUI client for macOS, Linux and Windows
  - https://github.com/paxa/postbird



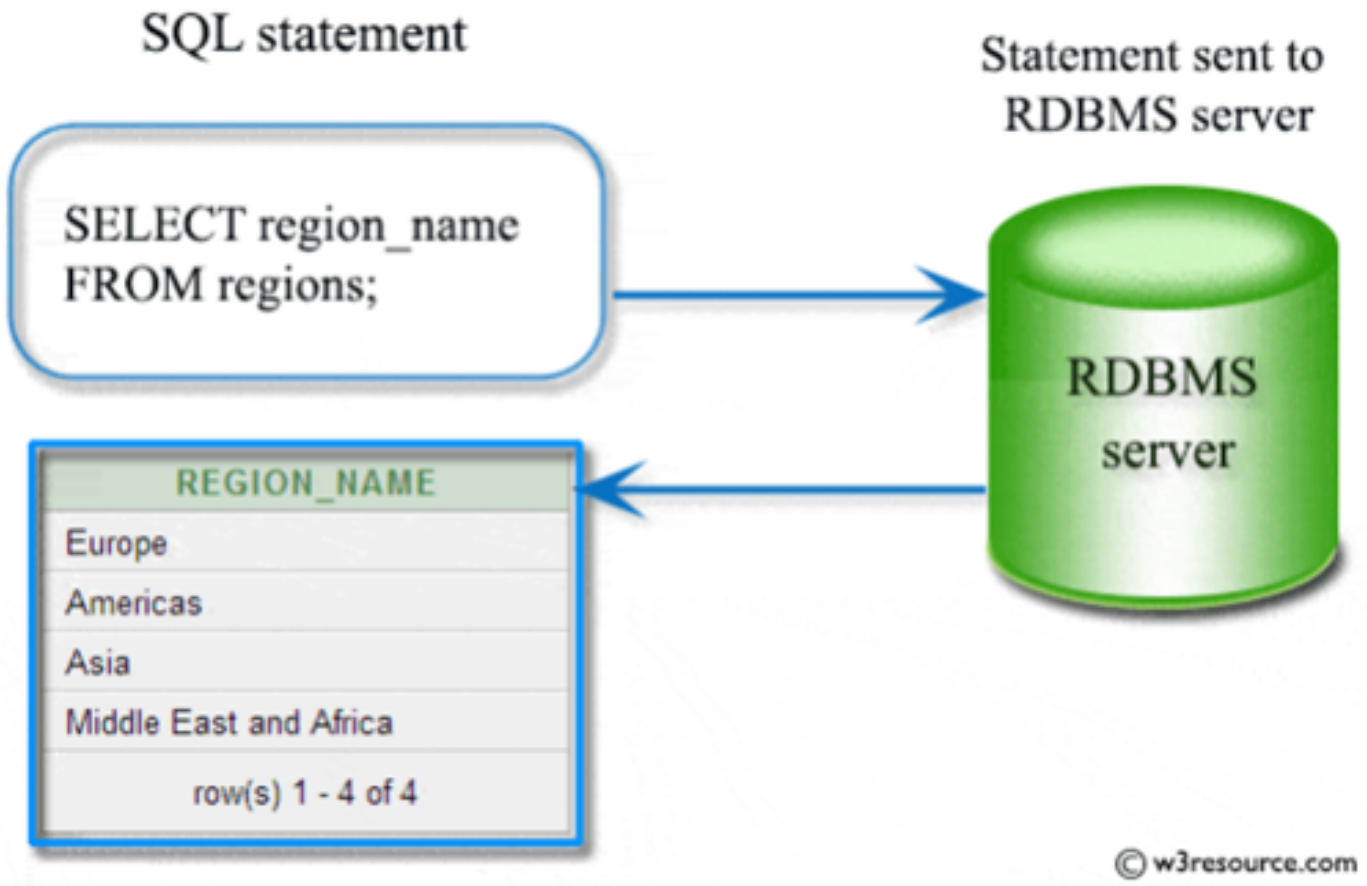
- Beekeeper Studio
  - Open Source SQL Editor and Database Manager
  - https://www.beekeeperstudio.io/



What is SQL?

- SQL stands for Structured Query Language.
- It is the standard language for relational database management systems.
- SQL statements are used to perform tasks such as update data on a database, or retrieve data from a database.
- Most of the common relational database management systems that use SQL .

How SQL Works ?



Creating a Database

```
CREATE DATABASE Dbname;
```

Example:

```
CREATE DATABASE tartupurchases;
```

- Let’s Try it on Jupyter Notebook ----------->

Create our first Table (Customer)

CREATE TABLE table_name (column_Name + DataType + constraints if any)

Example:

```
CREATE TABLE Customer (
id INT PRIMARY KEY NOT NULL,
name TEXT  NOT NULL,
country Text NOT NULL,
email Text )
```

Customer			
-	id	[INT]	PRIMARY KEY NOT NULL
-	name	[TEXT]	NOT NULL
-	country	[TEXT]	NOT NULL
-	email	[TEXT]	

PostgreSQL Data Types https://www.postgresql.org/docs/9.5/datatype.html

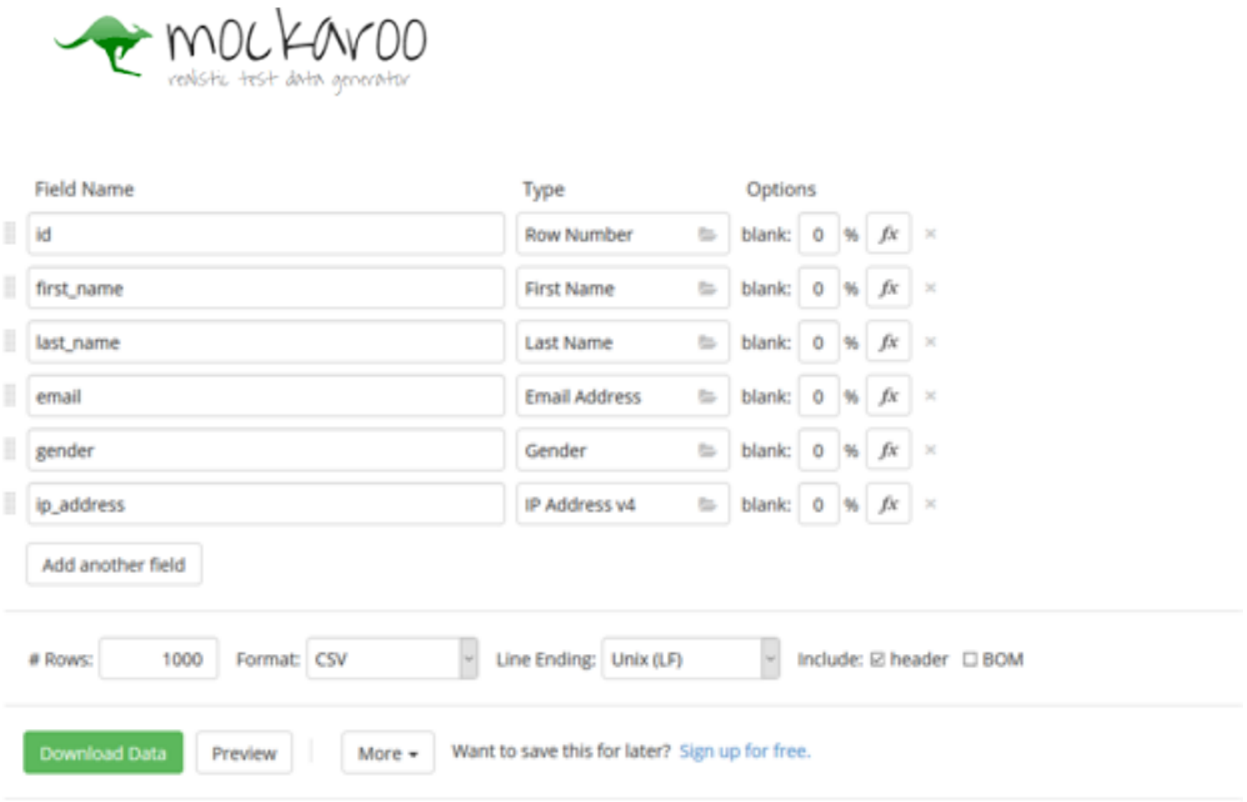
Load Some data to the table (Insert)

- Not our focus though!!

INSERT INTO customer (id, name, country, email)

VALUES (1, “Mohamed Ragab”, “Egypt”, “ragab@ut.ee”)

- Use the “Mockrow” website for generating mock data (https://www.mockaroo.com/)



Query your Table (get All customers)

- To Fetch/Retrieve data from DB Table we use:

```
SELECT * FROM table_name;
```

- ‘*’ means get all columns from that table.

Example:

```
SELECT * FROM customer;
```

Query your Table (project on some fields)

- Projection retrieves only the specified columns.

```
SELECT
col_name1, col_name2,…col_name_n
FROM table_name;
```

```
SELECT name, country FROM customer;
```

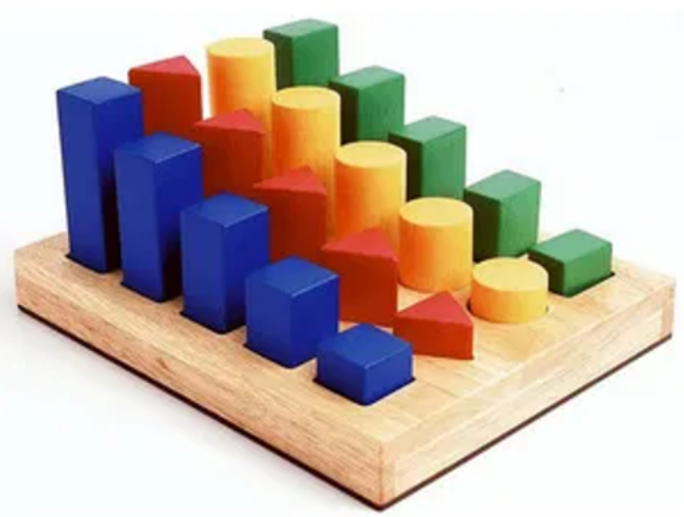
Sorting results (ORDER BY)

- Use **ORDER BY** clause to sort results by some columns.

```
SELECT * FROM customer ORDER BY name ASC
```

```
SELECT * FROM customer ORDER BY name DESC
```

- Take Care of ASC, and DESC for Ascending and Descending sortings.



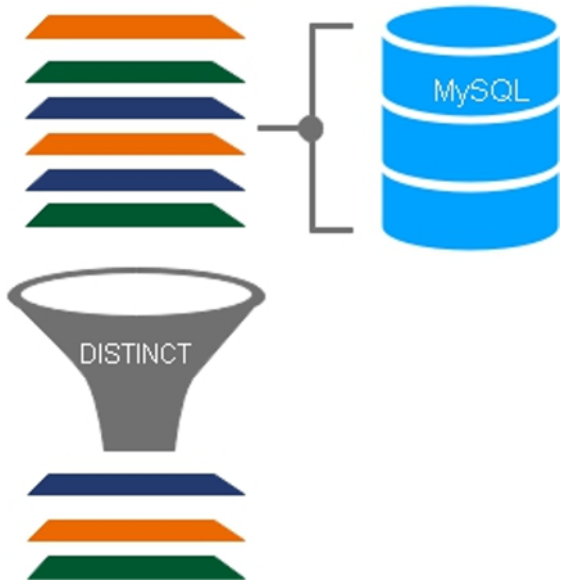
Unique Results (DISTINCT)

- The SELECT **DISTINCT** statement is used to return only distinct (different) values.

SELECT DISTINCT *column1*, *column2, ...*
FROM *table_name*;

Example:

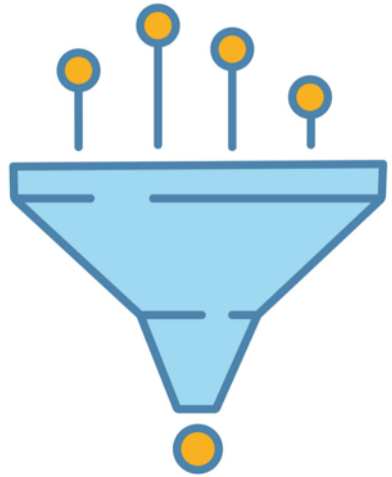
```
SELECT DISTINCT country from customer;
```



Filtering the Results (WHERE)

- The **WHERE** clause is used to filter records.
- It‘s used to extract only those records that fulfill a specified condition.

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



Example:

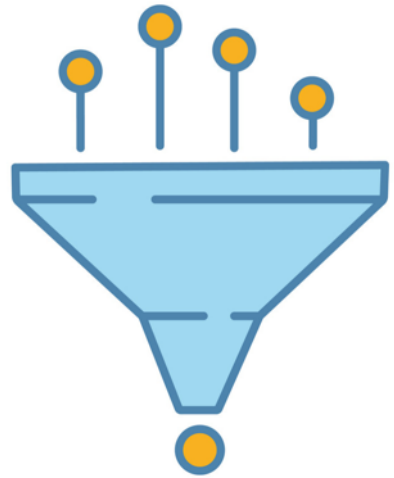
Get only the customers who have emails (filter out who don't have).

```
SELECT * FROM customer WHERE email  != ''  ;
```

SQL AND, OR and NOT Operators

- The WHERE clause can be combined with AND, OR, and NOT operators.

```
SELECT column1, column2, ...
FROM table_name
WHERE condition1 AND condition2 AND condition3 ...;
```



```
SELECT column1, column2, ...
FROM table_name
WHERE condition1 OR condition2 OR condition3 ...;
```

Example:

```
SELECT * FROM customer WHERE country = 'Egypt'  AND email !=''
```

Pagination in SQL ("**LIMIT**" and "**OFFSET**")

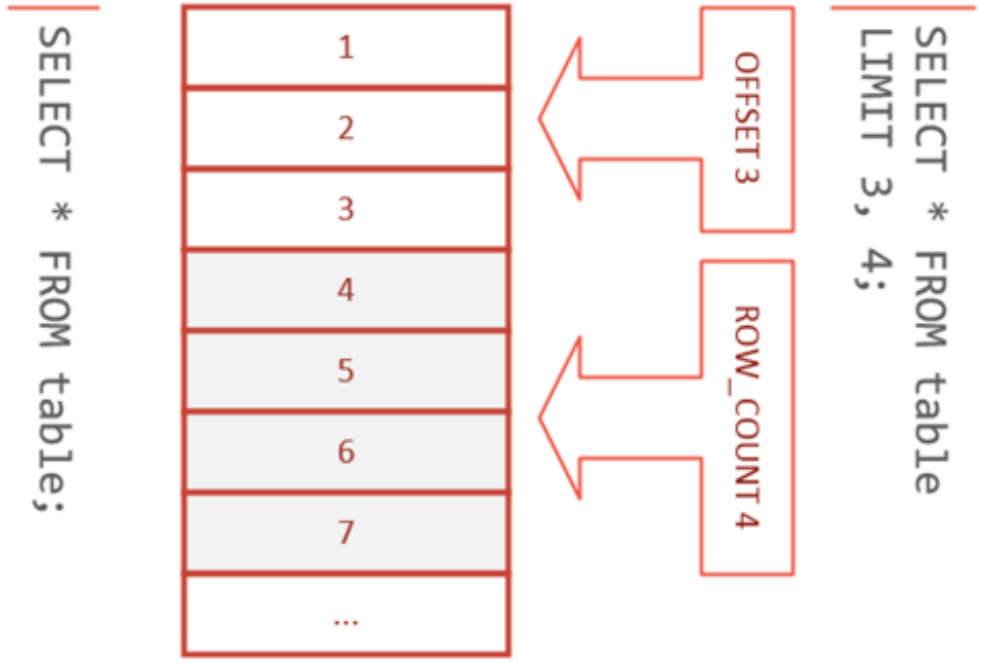
- LIMIT and OFFSET allow you to retrieve just a portion of the rows that are generated by the rest of the query.

SELECT select_list

FROM table_expression

[LIMIT { number | ALL }] [OFFSET number]

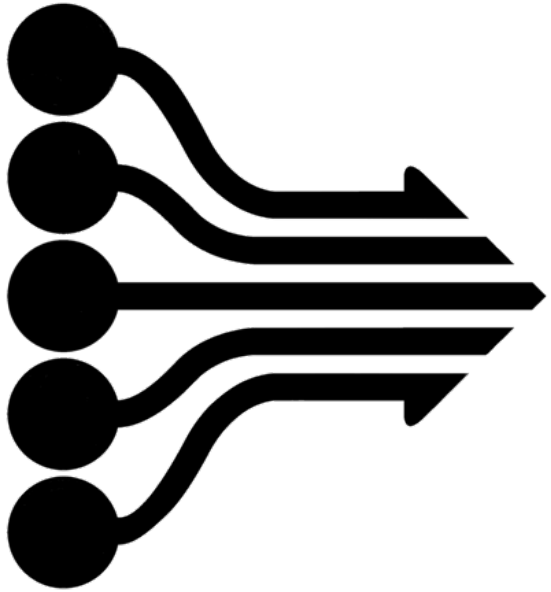
- Example in The Notebook



Aggregations and GROUP BY

- The **GROUP BY** statement groups rows that have the same values into summary rows.
  - Example: "Find the number of customers in each country".
- The GROUP BY statement is often used with aggregate functions (**COUNT**, **MAX**, **MIN**, **SUM**, **AVG**) to group the result-set by one or more columns.

```
SELECT column_name(s)
FROM table_name
GROUP BY column_name(s);
```



GROUP BY … HAVING

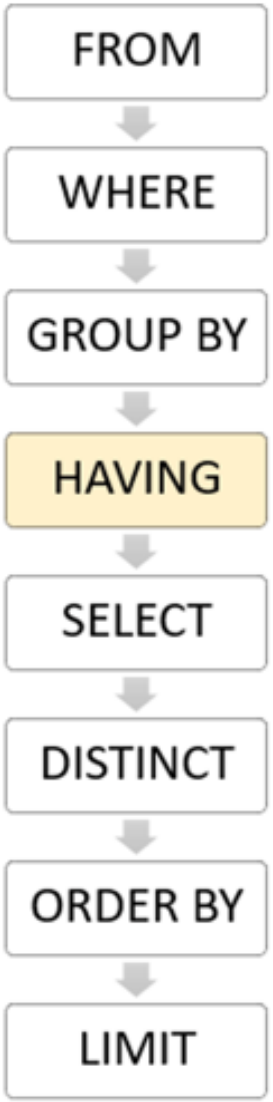
- The HAVING clause specifies a search condition for a group or an aggregate.
- The HAVING clause is often used with the GROUP BY clause to filter groups or aggregates based on a specified condition.

SELECT column1, aggregate_function (column2)

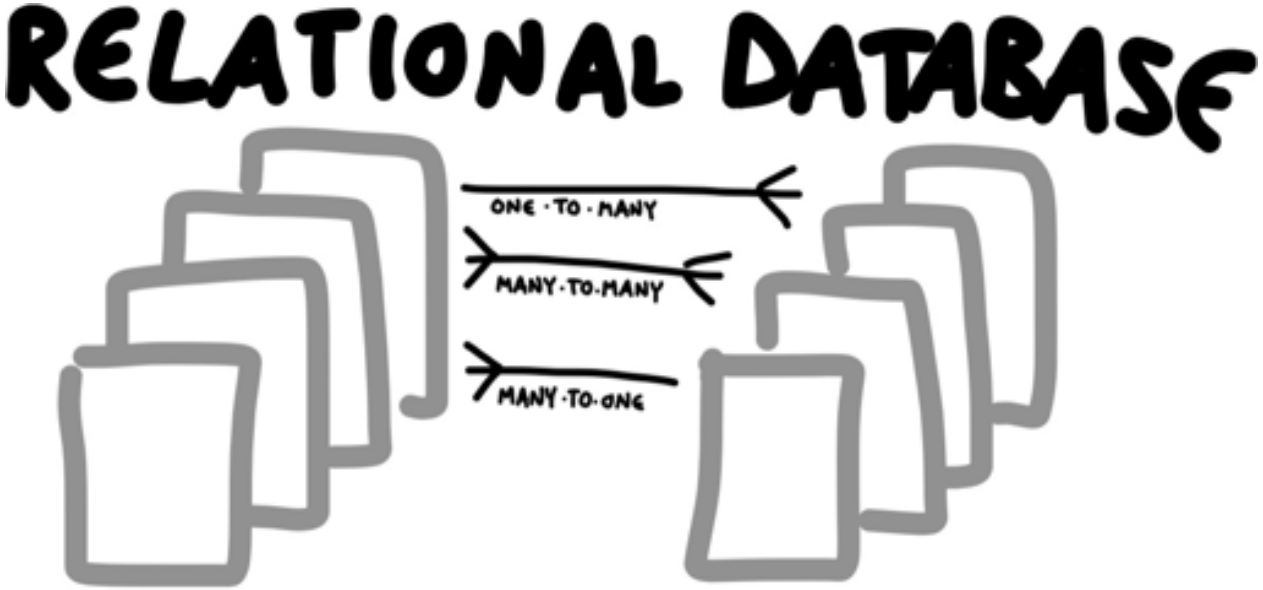
FROM table_name

GROUP BY column1

HAVING condition;



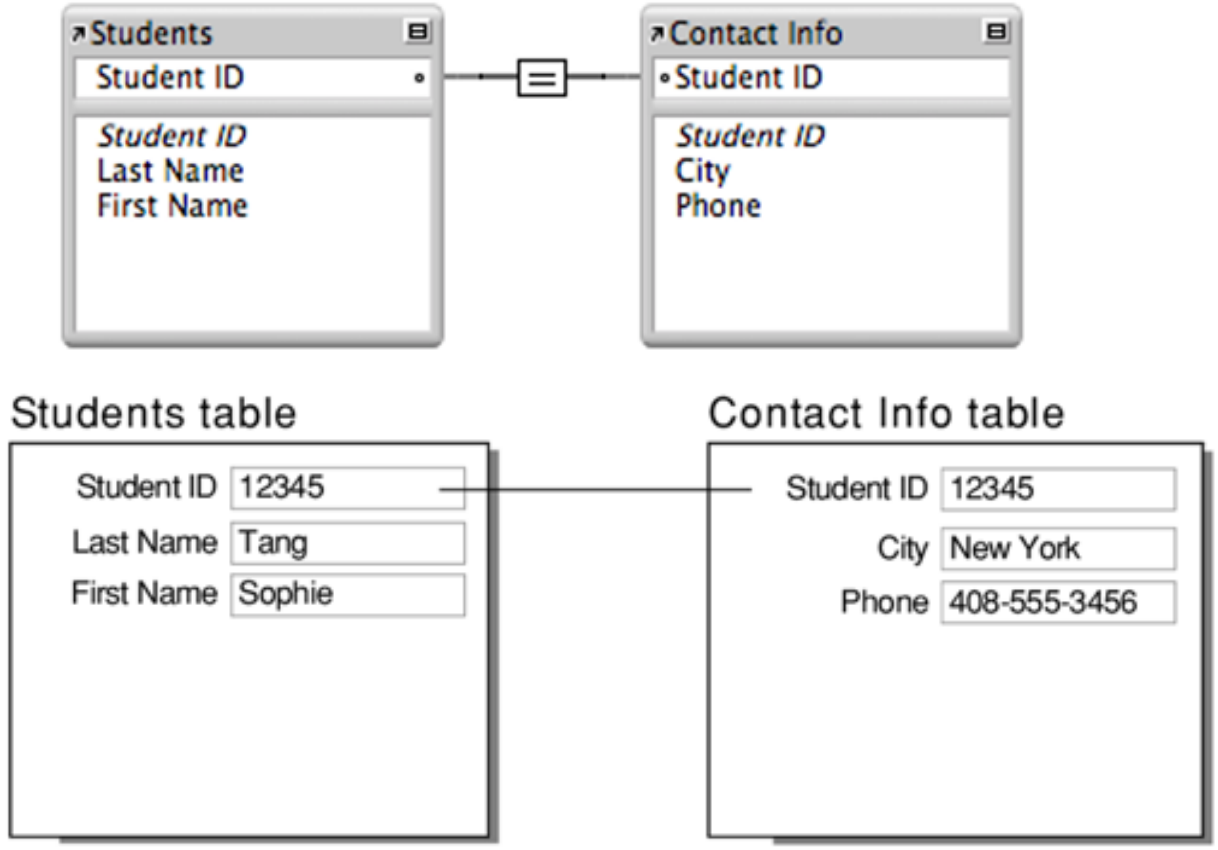
RELATIONSHIPS



RELATIONSHIPS

- **ONE-to-ONE Relationship:** occurs when one record in a table is associated with one and only one record in another table.

- Example:
  - In a school database:
    - Each student **has only one** student ID.
    - Each student ID **is assigned to only one** person.



https://fmhelp.filemaker.com/help/18/fmp/en/index.html#page/FMP_Help%2Frelationships.html%23

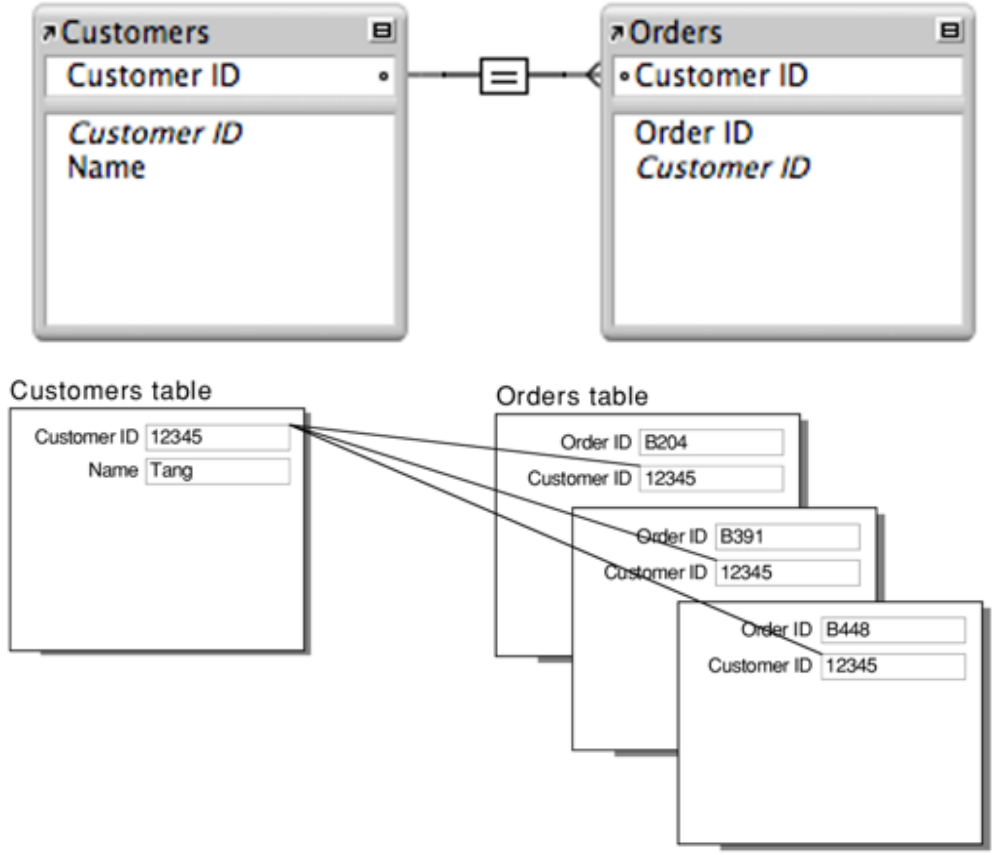
RELATIONSHIPS Cont.

- **ONE-to-Many Relationship**: occurs when one record in a table can be associated with one or more records in another table.

- Example:

- Customer can **make** several/multiple Orders
- While, Order **can be made** by only one Customer.

  - Put the PK in the one-side as a FK in the many-side.



Question?!!!

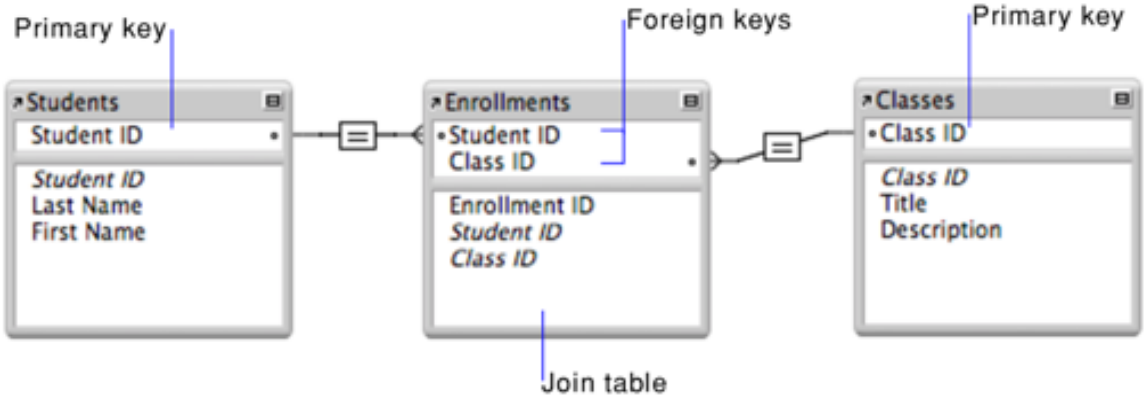
Why we can't make it the other way around !!?

RELATIONSHIPS Cont.

- **Many-to-Many Relationship**: occurs when multiple records in a table are associated with multiple records in another table.
- Example:
- Student can **attend** many classes.
- Meanwhile, Class **is attended** by many students

Question?!!!

- Assume we have "**grade**" attribute, so to which table we should we put it ?

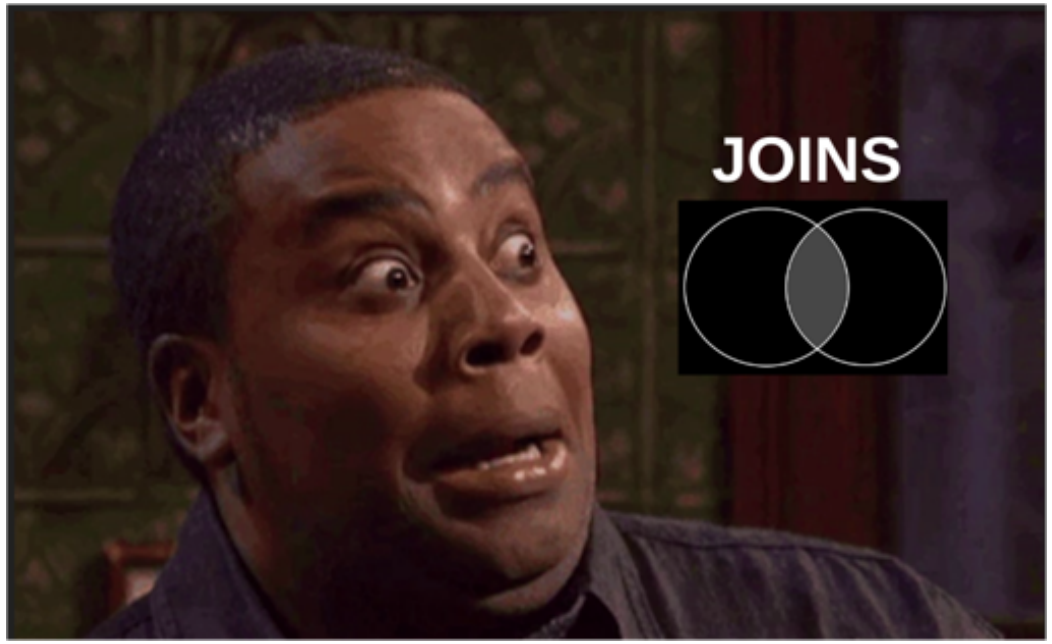



THIS DATABASE ISN'T FUN ANYMORE
CAN WE PLEASE GO HOME?

Bring Data From Multiple Tables (**SQL JOINS**)

SQL JOINS

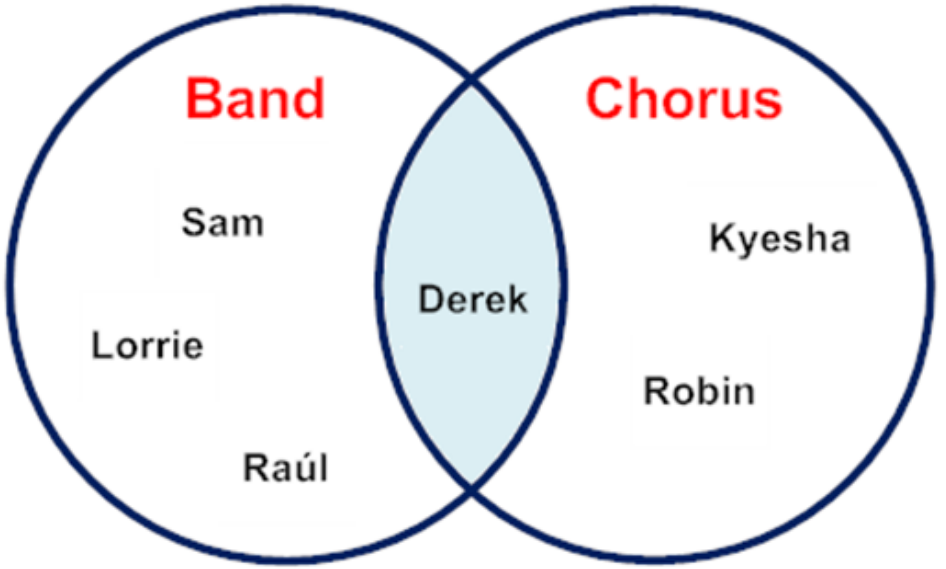
- Joins are one of the key elements of relational DBs.
- They allow us to retrieve data from multiple tables at once.
- Let’s go over some different types of Joins.



Joins are like Sets Operations

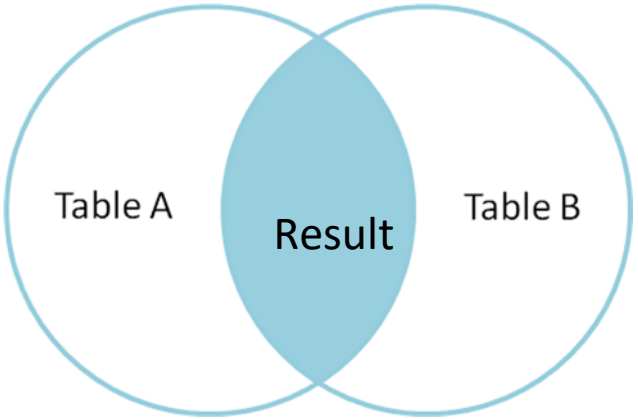
- Sets in python: unordered groups of unique elements.
- JOINS treat rows of data as if they were Sets.
- We can Perform Set operations on the tables.

- Example: Intersect
- Set intersection is the elements common to two sets.
- Here the intersection is {Drek}



INNER JOIN

- The SQL INNER JOIN is similar to the **Set intersection**.
- INNER JOIN selects rows from table1 and table2 where they match the selecting column.



Customers

ID	Name
1	Jose
2	Rolf
3	Anna
4	Robert

Orders

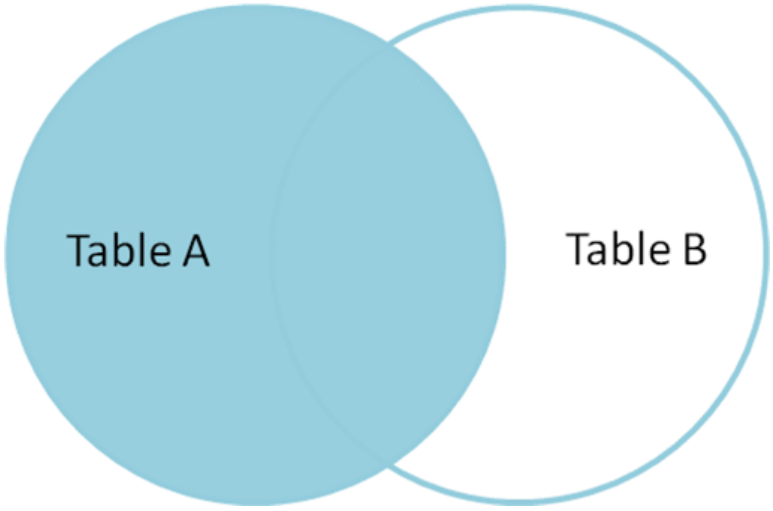
ID	Customer_ID	Product
1	1	Chair
2	1	Pen
3	1	Monitor
4	3	Headphones

```
SELECT * FROM Customers
INNER JOIN Orders
ON Customers.ID = Orders.Customer_ID
```

Customers.ID	Customers.Name	Orders.ID	Orders.Customer_ID	Orders.Product
1	Jose	1	1	Chair
1	Jose	2	1	Pen
1	Jose	3	1	Monitor
3	Anna	4	3	Headphones

LEFT JOIN

- This selects all rows from the table1 (on the left), the rows from the table2 (on the right) if they match.
- If they don't match, the data for the right table is blank (NULLS).



Customers

ID	Name
1	Jose
2	Rolf
3	Anna
4	Robert

Orders

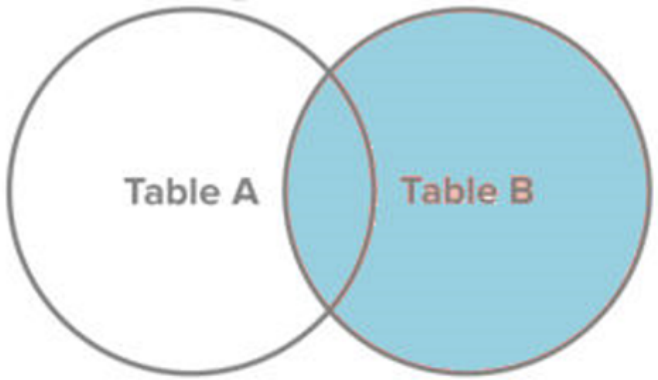
ID	Customer_ID	Product
1	1	Chair
2	1	Pen
3	1	Monitor
4	3	Headphones

```
SELECT * FROM Customers
LEFT JOIN Orders
ON Customers.ID = Orders.Customer_ID
```

Customers.ID	Customers.Name	Orders.ID	Orders.Customer_ID	Orders.Product
1	Jose	1	1	Chair
1	Jose	2	1	Pen
1	Jose	3	1	Monitor
3	Anna	4	3	Headphones
2	Rolf			
4	Robert			

RIGHT JOIN

- Opposite to LEFT JOIN
- This selects all the rows from the table on the right, and then rows from the left if they match.
- If they don't match, the data for the table on the left is blank (NULLS).



Customers

ID	Name
1	Jose
2	Rolf
3	Anna
4	Robert

Orders

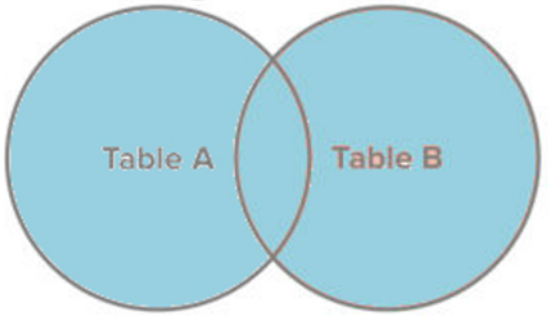
ID	Customer_ID	Product
1	1	Chair
2		Pen
3	1	Monitor
4	3	Headphones

```
SELECT * FROM Customers
RIGHT JOIN Orders
ON Customers.ID = Orders.Customer_ID
```

Customers.ID	Customers.Name	Orders.ID	Orders.Customer_ID	Orders.Product
1	Jose	1	1	Chair
1	Jose	3	1	Monitor
		2		Pen
3	Anna	4	3	Headphones

FULL JOIN

- This selects all rows from both tables, matching them if there is a match on the selecting column.
- Think of it as a LEFT and a RIGHT join.



Customers

ID	Name
1	Jose
2	Rolf
3	Anna
4	Robert

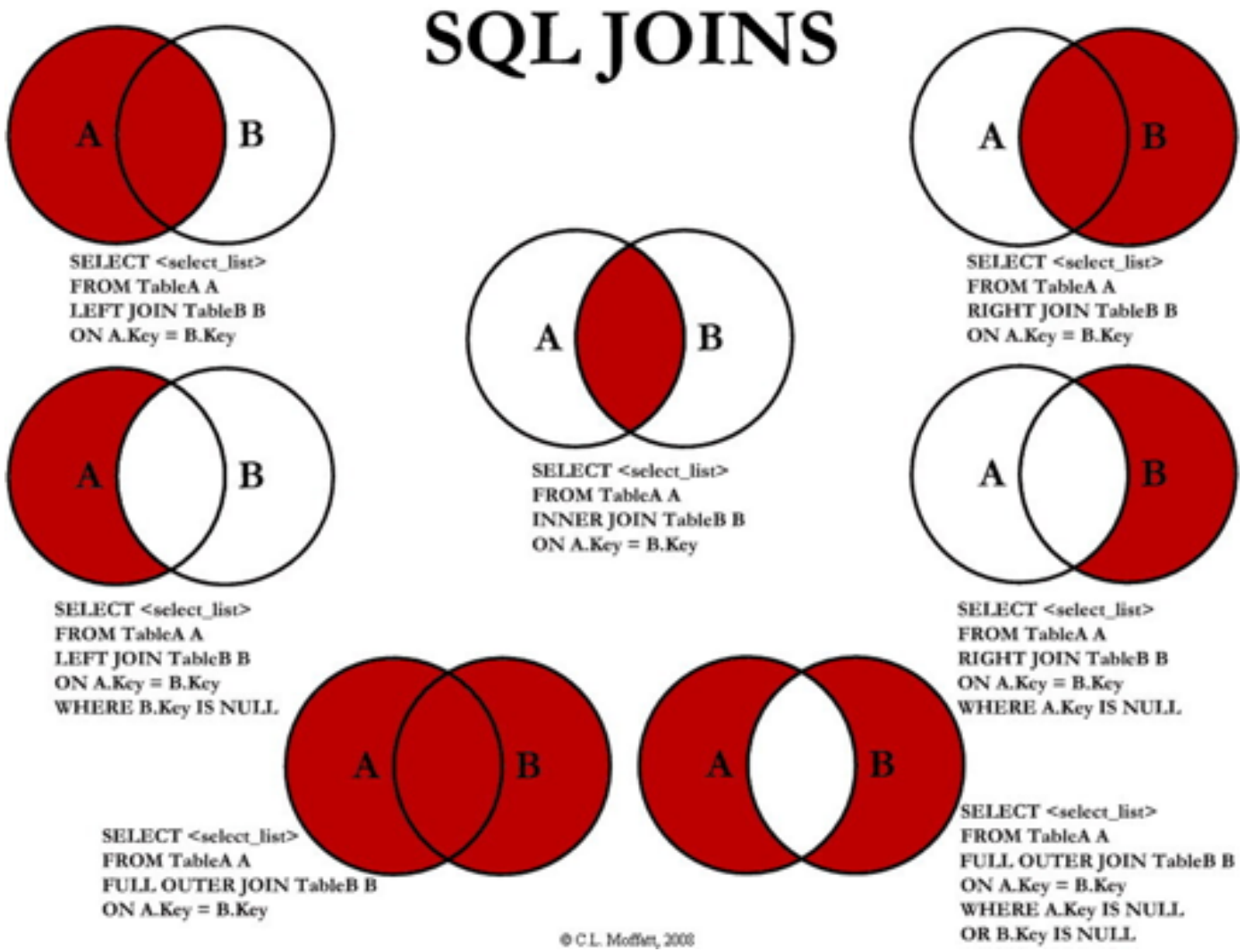
Orders

ID	Customer_ID	Product
1	1	Chair
2		Pen
3	1	Monitor
4	3	Headphones

```
SELECT * FROM Customers
FULL JOIN Orders
ON Customers.ID = Orders.Customer_ID
```

Customers.ID	Customers.Name	Orders.ID	Orders.Customer_ID	Orders.Product
1	Jose	1	1	Chair
1	Jose	3	1	Monitor
2	Rolf			
		2		Pen
3	Anna	4	3	Headphones
4	Robert			

JOINS with More types..



SQL Data Updates (UDATE)

- The UPDATE statement is used to modify the existing records in a table.

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

Example:

```
UPDATE customer
SET email = "aisha.kareem@gmail.com"
WHERE id=3;
```

SQL Data Deletions (DELETE)

- The DELETE statement is used to delete existing records in a table.
- **Note**: Be careful when deleting records in a table!
  - Notice the WHERE clause in the DELETE statement.

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

Example:

```
DELETE FROM customer WHERE name="Mohamed Ragab";
```

Now, It’s time to say …