Databases

Relational Databases and MySQL

SoftUni Team

Technical Trainers

Software University

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Relational Databases

Tables, Relationships and SQL

What is a Database?

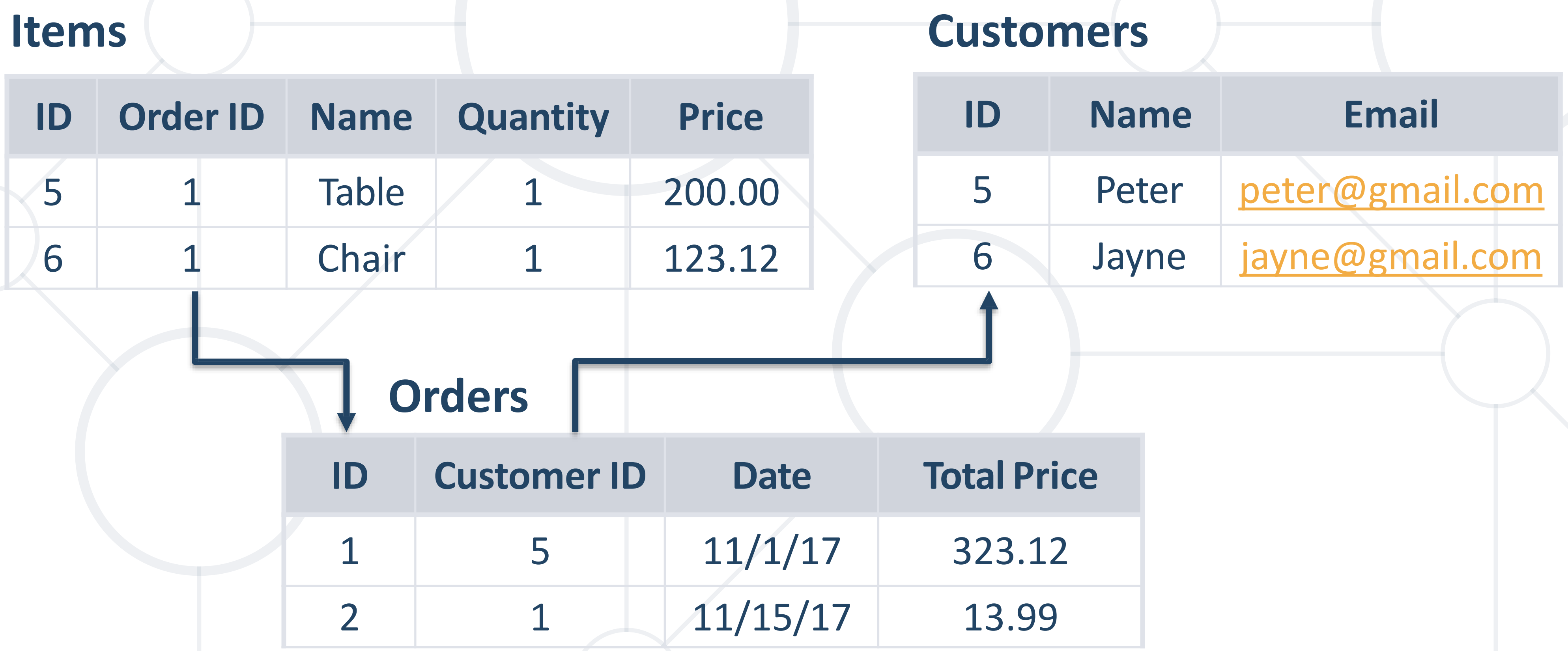
- A **database** is a collection of data, organized to be easily accessed, managed and updated
- Modern databases are managed by **Database Management Systems** (DBMS)
  - Define database **structure**, e. g. tables, collections, columns, relations, indexes
  - **C**reate / **R**ead / **U**pdate / **D**elete data (**CRUD** operations)
  - Execute **queries** (filter / search data)

SQL Databases (Relational Databases)

- Relational (**SQL**) databases organize data in **tables**
  - Tables have strict structure (**columns** of certain **data types**)
  - Can have **relationships** to other tables
- Relational databases use the **structured query language** (**SQL**) for defining and manipulating data
  - Extremely powerful for complex queries
- **Relational databases** are the most widely used data management technology

The Relational DB Model

- Relational data is stored into one or more **tables** with a **unique key** identifying each row and **foreign keys** defining **relationships**



Items

ID	Order ID	Name	Quantity	Price
5	1	Table	1	200.00
6	1	Chair	1	123.12

Customers

ID	Name	Email
5	Peter	peter@gmail.com
6	Jayne	jayne@gmail.com

Orders

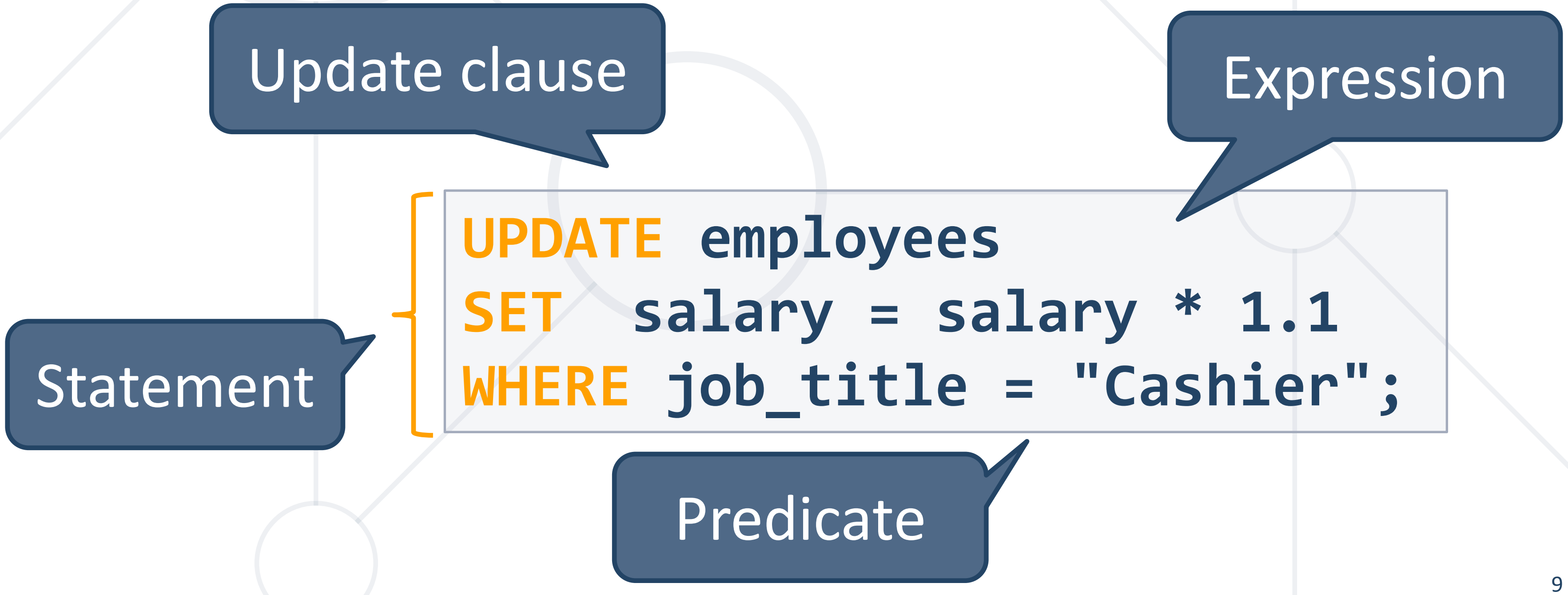
ID	Customer ID	Date	Total Price
1	5	11/1/17	323.12
2	1	11/15/17	13.99

SQL and MySQL

Powerful Data Management

Structured Query Language (SQL)

- **SQL** == query language designed for managing data in **relational** databases (RDBMS)
- Subdivided into several language elements
  - Queries
  - Clauses
  - Expressions
  - Predicates
  - Statements



```sql
UPDATE employees
SET   salary = salary * 1.1
WHERE job_title = "Cashier";
```

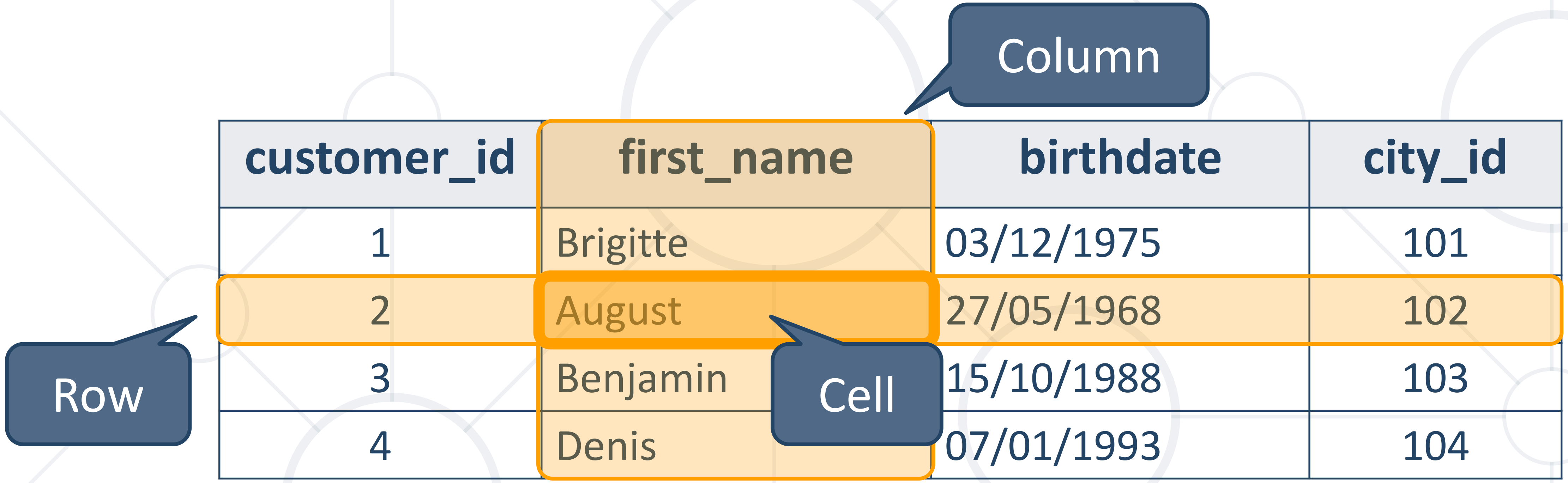
Structured Query Language (2)

- Logically divided in four sections:
  - **Data Definition (DDL)** – describe the structure of our data
  - **Data Manipulation (DML)** – store and retrieve data
  - **Data Control (DCL)** – define who can access the data
  - **Transaction Control (TCL)** – bundle operations and allow rollback

DDL	DML	DCL	TCL
CREATE	SELECT	GRANT	BEGIN TRAN
ALTER	INSERT	REVOKE	COMMIT
DROP	UPDATE	DENY	ROLLBACK
TRUNCATE	DELETE		SAVE

Database Table Elements

- The table is the main **building block** of any database



customer_id	first_name	birthdate	city_id
1	Brigitte	03/12/1975	101
2	August	27/05/1968	102
3	Benjamin	15/10/1988	103
4	Denis	07/01/1993	104

- Each **row** is called a **record** or **entity**
- Columns (**fields**) define the **type** of data they contain

Why MySQL?

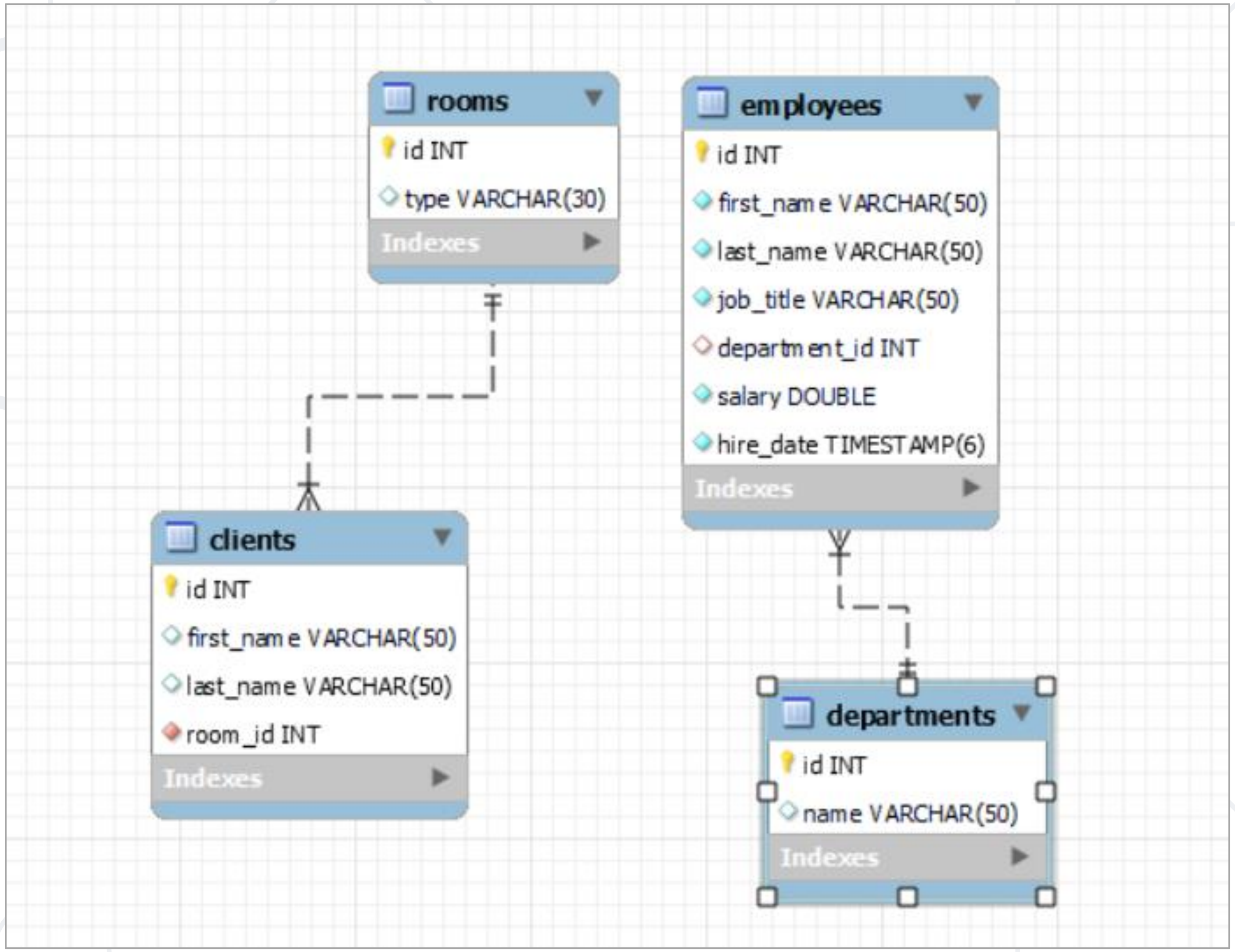
- MySQL is a specific database management system (**DBMS**)
- It is a software that **implements the SQL language** and provides a platform to store, manage, and retrieve data efficiently
- One of the **most popular** and **widely used** relational database management systems
- **Open-source** and **free** to use
- Download **MySQL Community Server**
  - **Windows**: `https://dev.mysql.com/downloads/mysql/`
  - **Ubuntu/Debian**: `https://dev.mysql.com/downloads/repo/apt/`

Retrieving Data

Using SQL SELECT

Hotel Database

- Run the Hotel_DB.sql script to create the database



Capabilities of SQL SELECT

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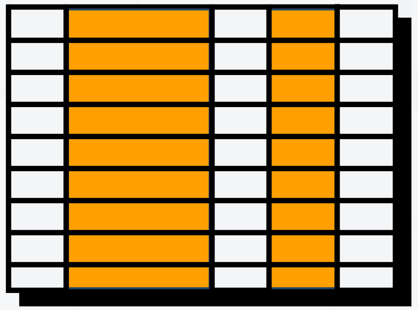
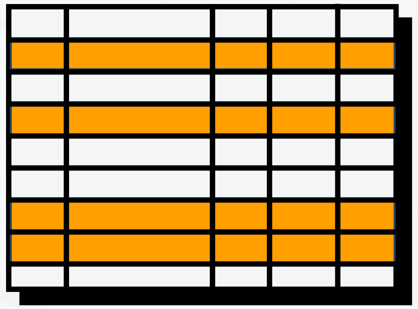
Projection

Take a subset of the columns



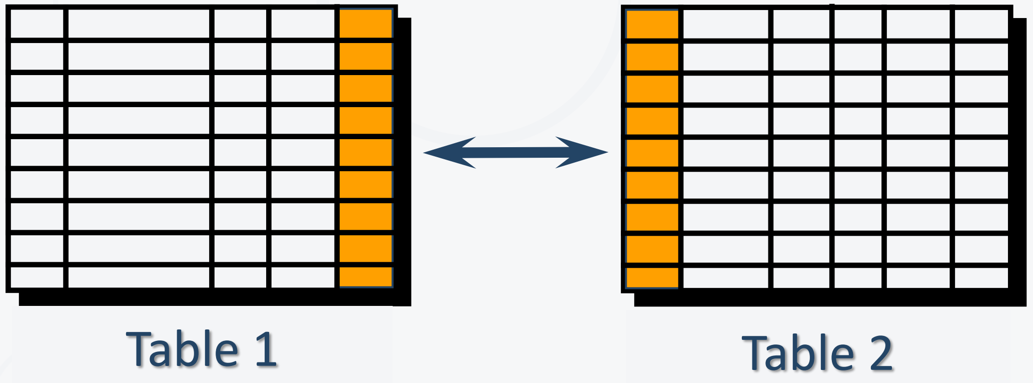
Selection

Take a subset of the rows



Join

Combine tables by some column



Related Tables

- We split the data and introduce **relationships** between the tables to **avoid** repeating information

user_id	first	last	registered
203	David	Rivers	05/02/2016
204	Sarah	Thorne	07/17/2016
205	Michael	Walters	11/23/2015

user_id	email
203	drivers@mail.cx
204	sarah@mail.cx
205	walters_michael@mail.cx
203	david@homedomain.cx

Primary Key

Foreign Key

- Connection via **Foreign Key** in one table pointing to the **Primary Key** in another

SELECT – Examples

- Selecting all columns from the "employees" table

id	first_name	last_name	job_title	department_id	salary
1	John	Smith	Manager	1	900
2	John	Johnson	Customer Service	1	880
3	Smith	Johnson	Porter	2	1100
…	…	…	…	…	…

```sql
SELECT * FROM employees;
```

List of columns (* for all)

Table name

Problem: Select Employee Information

- Write a query to **select** all employees from "**Hotel**" database
  - **Retrieve** information about their **id, first_name, last_name** and **job_title**
  - **Ordered** by id
- Note: Query **Hotel** database

id	first_name	last_name	job_title
1	John	Smith	Manager
2	John	Johnson	Customer Service
3	Smith	Johnson	Porter
…	…	…	…

Solution: Select Employee Information

```
SELECT id, first_name, last_name, job_title
FROM employees
ORDER BY id;
```

List of columns

Table name

- **Aliases** rename a table or a column heading:

```
SELECT e.id AS 'No.',
e.first_name AS 'First Name',
e.last_name AS 'Last Name',
e.job_title AS 'Job Title'
FROM employees AS e ORDER BY id;
```

Concatenation

- **concat()** - returns the string that results from concatenating the arguments
  - String literals are enclosed in ['](**single quotes**)
  - Table and column names containing special symbols use [`] (**backtick**)

```
SELECT concat(`first_name`,' ',`last_name`) AS 'Full Name',
     `job_title` as  'Job Title',
       `id` AS 'No.'
  FROM `employees`;
```

Problem: Select Employees with Filter

- Find information about all employees, listing their:
  - **Full Name**
  - **Job title**
  - **Salary**
- Use **concatenation** to display first and last names as **one field**
- Note: Query **Hotel** database

Solution: Select Employees with Filter

Concatenation

```
SELECT concat(`first_name`,' ',`last_name`) AS
     'Full name',
     `job_title` AS 'Job title',
       `salary` AS 'Salary'
  FROM `employees` WHERE salary > 1000;
```

Column alias

Filtering the Selected Rows

- Use **DISTINCT** to eliminate duplicate results

```
SELECT DISTINCT department_id
FROM employees;
```

- You can filter rows by specific conditions using the **WHERE** clause

```
SELECT last_name, department_id
FROM employees
WHERE department_id = 1;
```

- Other **logical operators** can be used for better control

```
SELECT last_name, salary
FROM employees
WHERE salary <= 2000;
```

Other Comparison Conditions

- Conditions can be combined using **NOT**, **OR**, **AND** and brackets

```
SELECT first_name, last_name FROM employees
WHERE NOT (department_id = 3 OR department_id = 4);
```

- Using **BETWEEN** operator to specify a range:

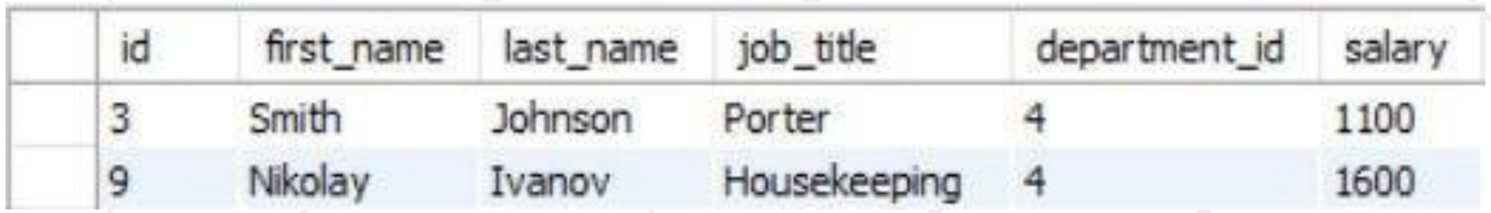
```
SELECT last_name, salary FROM employees
WHERE salary BETWEEN 1200 AND 2200;
```

- Using **IN / NOT IN** to specify a set of values:

```
SELECT first_name, last_name, department_id
FROM employees
WHERE department_id IN (1,3,4);
```

Problem: Select Employees by Multiple Filters

- Write a query to **retrieve** information about employees, order by id
  - Who are in **department 4**
  - Have salary **higher or equal to 1000**



id	first_name	last_name	job_title	department_id	salary
3	Smith	Johnson	Porter	4	1100
9	Nikolay	Ivanov	Housekeeping	4	1600

```sql
SELECT * FROM employees AS e
WHERE e.department_id = 4 AND e.salary >= 1000;
```

Comparing with NULL

- NULL is a special value that means missing value
  - Not the same as 0 or a blank space
- Checking for NULL values

This is false and it won't return results!

```sql
SELECT last_name, department_id
FROM employees
WHERE department_id = NULL;
```

```sql
SELECT last_name, department_id
FROM employees
WHERE department_id IS NULL;
```

```sql
SELECT last_name, department_id
FROM employees
WHERE department_id IS NOT NULL;
```

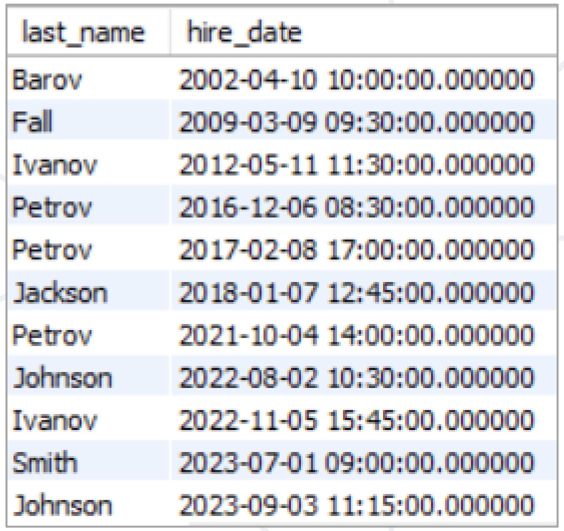
Sorting with ORDER BY

- Sort rows with the **ORDER BY** clause
  - **ASC**: ascending order, default

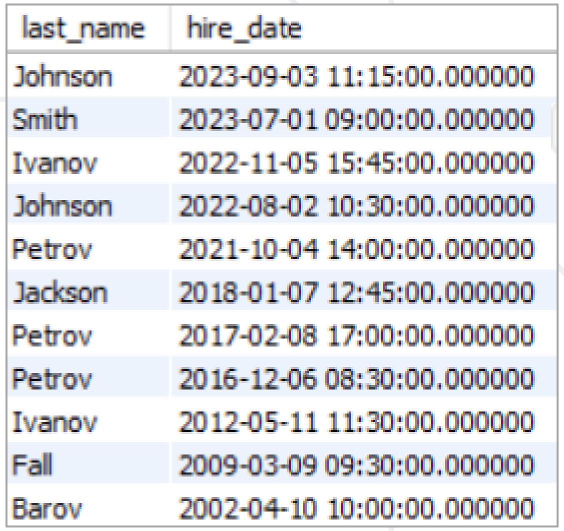
```
SELECT last_name, hire_date
FROM employees
ORDER BY hire_date;
```

  - **DESC**: descending order

```
SELECT last_name, hire_date
FROM employees
ORDER BY hire_date DESC;
```



last_name	hire_date
Barov	2002-04-10 10:00:00.000000
Fall	2009-03-09 09:30:00.000000
Ivanov	2012-05-11 11:30:00.000000
Petrov	2016-12-06 08:30:00.000000
Petrov	2017-02-08 17:00:00.000000
Jackson	2018-01-07 12:45:00.000000
Petrov	2021-10-04 14:00:00.000000
Johnson	2022-08-02 10:30:00.000000
Ivanov	2022-11-05 15:45:00.000000
Smith	2023-07-01 09:00:00.000000
Johnson	2023-09-03 11:15:00.000000



last_name	hire_date
Johnson	2023-09-03 11:15:00.000000
Smith	2023-07-01 09:00:00.000000
Ivanov	2022-11-05 15:45:00.000000
Johnson	2022-08-02 10:30:00.000000
Petrov	2021-10-04 14:00:00.000000
Jackson	2018-01-07 12:45:00.000000
Petrov	2017-02-08 17:00:00.000000
Petrov	2016-12-06 08:30:00.000000
Ivanov	2012-05-11 11:30:00.000000
Fall	2009-03-09 09:30:00.000000
Barov	2002-04-10 10:00:00.000000

Writing Data in Tables

Using SQL INSERT

Inserting Data (1)

- The SQL **INSERT** command

```
INSERT INTO departments (name) VALUES ('Human Resources');
```

```
INSERT INTO employees (first_name, last_name, job_title,
department_id, salary, hire_date)
VALUES
('Michael', 'Scott', 'Regional Manager', 5, 2500.00,
'2023-07-12 09:30:00');
```

Specify columns

- **Bulk data** can be recorded in a single query, separated by comma

Inserting Data (2)

- You can use existing records to create a **new table**

```
CREATE TABLE employee_contacts
AS
SELECT id, first_name, CONCAT(first_name, '.', last_name,
'@hotel.com’)
AS email,
'N/A' AS phone
FROM employees;
```

New table name

Existing source

Modifying Existing Records

Using SQL UPDATE and DELETE

Updating Data

- The SQL **UPDATE** command

```sql
UPDATE employees
   SET last_name = 'Brown'
 WHERE employee_id = 1;
```

New values

```sql
UPDATE employees
   SET salary = salary * 1.10,
       job_title = CONCAT('Senior',' ', `job_title`)
 WHERE department_id = 3;
```

- Note: Don't forget the **WHERE** clause!

Problem: Update Employees Salary

- **Update** all employees salaries whose **job_title** is "**Housekeeper**" by **100**

```sql
UPDATE employees
SET salary = salary + 100
WHERE job_title = 'Housekeeper';
SELECT salary
FROM employees;
```

Deleting Data

- Deleting specific rows from a table

```
DELETE FROM employees
WHERE employee_id = 1;
```

Condition

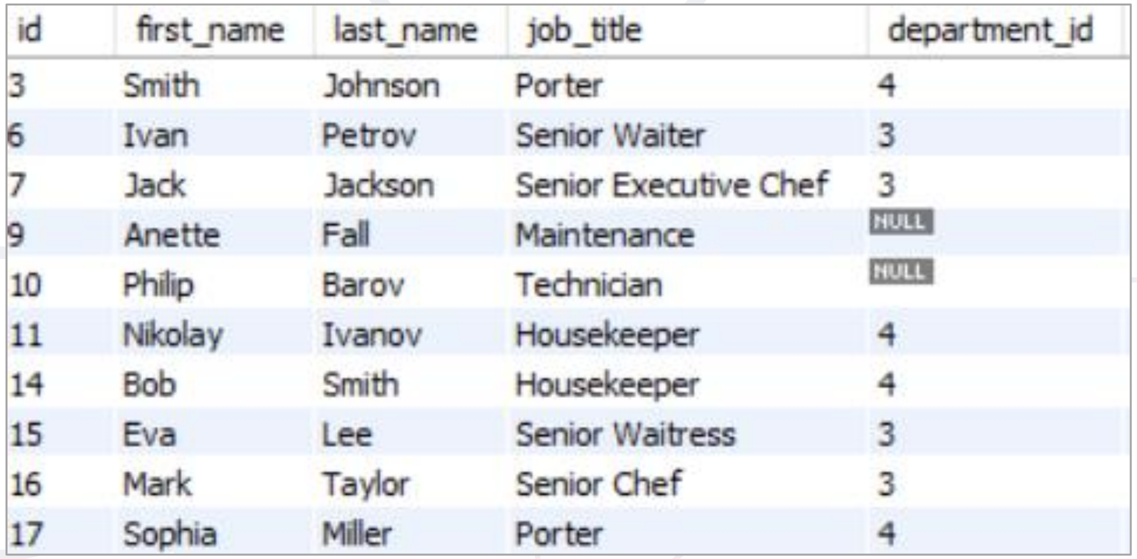
  - Note: Don't forget the **WHERE** clause!

- Delete all rows from a table (**TRUNCATE** works faster than **DELETE**)

```
TRUNCATE TABLE clients;
```

Problem: Delete from Table

- **Delete** all employees from the "**employees**" table who are in department **2 or 1**.
- **Order** the rest by id.



id	first_name	last_name	job_title	department_id
3	Smith	Johnson	Porter	4
6	Ivan	Petrov	Senior Waiter	3
7	Jack	Jackson	Senior Executive Chef	3
9	Anette	Fall	Maintenance	NULL
10	Philip	Barov	Technician	NULL
11	Nikolay	Ivanov	Housekeeper	4
14	Bob	Smith	Housekeeper	4
15	Eva	Lee	Senior Waitress	3
16	Mark	Taylor	Senior Chef	3
17	Sophia	Miller	Porter	4

Solution: Delete from Table

Delete Data

OR Condition

```
DELETE FROM employees
WHERE department_id = 1
OR department_id = 2;


SELECT * FROM employees;
```

SQL in Testing

Database Interaction for Effective Testing

Why SQL Is Important in Testing?

- **Central Role of Databases:** The backbone of virtually every system
- **Relational Database Management:** MySQL and Oracle are widely used for storing and organizing data
- **Standard Language for Data Processing:** SQL stands as the industry-standard computer language for relational database management and data processing
- **Accessing and Managing Data:** Crucial language for accessing and managing the data within the database
- **Data Manipulation and Retrieval:** Wide range of essential operations, including querying, inserting, updating, and modifying data

Must have knowledge for QAs

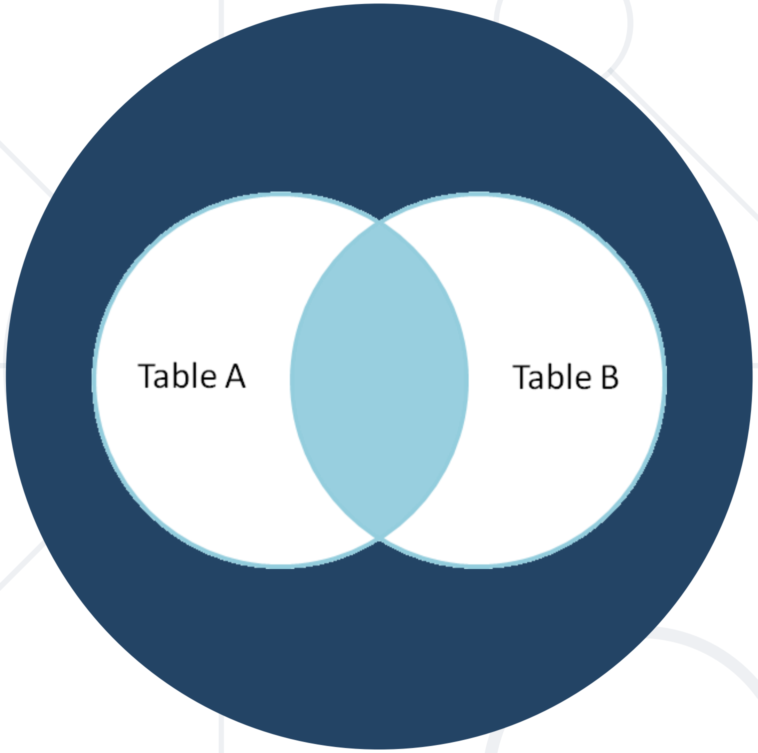
- Recognize **Various Types** of Databases
- Connect Using **Different SQL Clients**
- Comprehend Database **Relationships, Keys, and Indexes**
- Write **Simple and Complex** SQL Queries
- Perform **Data Validation** and Testing Techniques
- Test **Data Modifications** and Transactions
- **Explore** Database Schema
- **Interpret** Complex Queries

Really Complex Queries ;)

```
SELECT d.name AS department_name,
       COUNT(e.id) AS total_employees,
       AVG(e.salary) AS average_salary,
       MIN(e.salary) AS min_salary,
       MAX(e.salary) AS max_salary
FROM departments d
LEFT JOIN employees e ON d.id = e.department_id
GROUP BY d.name
HAVING total_employees >= 2
ORDER BY average_salary DESC;
```

Query Explanation:

- This SQL query performs the following tasks:
  - Retrieve **Department Information**
  - **Count Total Employees** per Department
  - **Calculate Average Salary** per Department
  - **Find Minimum** and **Maximum Salaries** per Department
  - **Group and Filter** the Results
  - The HAVING clause is used to **filter out departments** with fewer than two employees
  - **Sorts** the Results



SQL Practice

Master the Most Used SQL Statements!

Some of Most Used SQL Statements

- **CREATE** - Creates a new database, table, view, or other database objects
- **INSERT INTO** - Adds new rows (records) into a table to store data in the database
- **DROP** - Deletes an existing database object, such as a table, from the database
- **ALTER** - Modifies the structure of an existing database object, such as a table or column
- **UPDATE** – Updates specific records with new values
- **SELECT** - Specifies the database to be used for subsequent SQL statements

Some of Most Used SQL Statements

- **SELECT DISTINCT** - Extracts unique values from one or more fields in the result set, removing duplicates
- **WHERE** - Specifies which rows to retrieve based on specific conditions
- **IN** - Checks if a value matches any value in a specified list or subquery
- **BETWEEN** - Filters data within a specified range of values
- **LIKE** - Performs pattern matching to find specific values in the data
- **ORDER BY** - Sorts the result set in ascending or descending order based on specified columns
- **AND, OR** and **NOT** Operators

Some of Most Used SQL Statements

- **Aggregate Functions** - Perform calculations involving a range of values and returns a single value
  - MIN, MAX
  - AVG, SUM, COUNT
- HAVING - Added because the WHERE keyword cannot be used with aggregate functions
- INNER JOIN - Selects records that have matching values in both tables
- MySQL Operators – Arithmetic, Comparison, Compound, Logical
- Primary Key Constraint - uniquely identifies each record in a table
- Foreign Key Constraint - refers to the PRIMARY KEY in another table

Summary

- What are **Databases**?
- **SQL** and **MySQL** in short
- How to Retrieve Data – **SELECT**
- How to Write Data - **INSERT**
- How to Modify Data – **UPDATE, DELETE**
- Why SQL is **needed in Testing**?
- Further **Practice**

Questions?

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