UNIT IV

1. What is PL/SQL?
PL/SQL refers to Procedural Language/Structured Query Language. It is a programming language extension of SQL that allows you to write procedural code, such as loops, conditional statements, exception handling, and SQL statements. PL/SQL is mainly used for developing database applications and stored procedures within Oracle Database.
2. Compare SQL and PL/SQL.
SQL is a domain-specific language to manage and manipulate relational databases. It primarily deals with querying, inserting, updating, and deleting data in a database. On the other hand, PL/SQL is a procedural language that extends SQL by adding programming constructs like variables, loops, and exception handling. PL/SQL is used for writing stored procedures, functions, and triggers, allowing for more complex and reusable database logic.
3. Do you know the basic structure of PL/SQL?
Yes, the basic structure of a PL/SQL block includes:

- Declaration section: Where you define variables, constants, and cursors.
- Execution section: Where you write the actual PL/SQL code, including SQL statements and procedural logic.
- Exception handling section: Where you handle errors and exceptions that may occur during execution.

4. What Is a Trigger? How Do You Use It?
A trigger is a database object in PL/SQL that automatically executes actions in response to specific events, such as insertions, updates, or data deletions in a table. Triggers are typically used to enforce business rules, maintain data integrity, and automate tasks. You create and define triggers using PL/SQL code and attach them to database tables.
5. What data types does pl/SQL have?
PL/SQL supports various data types, including:

- Scalar data types like VARCHAR2, NUMBER, DATE, and BOOLEAN.
- Composite data types like RECORD and TABLE.
- Reference data types like REF CURSOR and PL/SQL TABLE.

6. Explain the PL/SQL compilation process.
The PL/SQL compilation process involves:

- Parsing: The PL/SQL code is checked for syntax errors.
- Compilation: The code is converted into a format the Oracle Database can execute.
- Storage: The compiled code is stored in the database.
- Execution: When the PL/SQL code is called, it is executed by the database engine.

7. Tell me what a package consists of.
A PL/SQL package contains related procedures, functions, variables, and other PL/SQL constructs. It consists of two main parts:

- Package Specification: This defines the public interface of the package, including procedures, functions, and global variables that other programs can access.
- Package Body: This contains the actual implementation of the functions and procedures defined in the specification.

8. What are the benefits of using PL/SQL packages?
Using PL/SQL packages offers several benefits, including:

- Encapsulation: You can encapsulate related code and data within a package, promoting modular and organized code.
- Reusability: Packages allow you to reuse code across multiple programs and reduce redundancy.
- Information Hiding: You can hide implementation details by exposing only the necessary interfaces in the package specification.
- Improved Performance: Packages are precompiled and stored in the database, which can enhance performance.

9. Do you understand the meaning of exception handling?
Yes, exception handling in PL/SQL is the process of handling errors or exceptional conditions that may occur during program execution. It allows you to gracefully handle errors by specifying actions to take when a particular exception occurs, such as logging the error, rolling back transactions, or raising custom exceptions.
10. Give me some examples of predefined exceptions.
Predefined exceptions in PL/SQL include:

- NO_DATA_FOUND: Raised when a SELECT statement returns no rows.
- TOO_MANY_ROWS: Raised when a SELECT INTO statement retrieves multiple rows.
- DUP_VAL_ON_INDEX: Raised when attempting to insert a duplicate value into a specific index.
- ZERO_DIVIDE: Raised when dividing by zero.

11. What do you understand by PL/SQL cursors?
PL/SQL cursors retrieve and manipulate data from a result set. They can be either explicit or implicit. The database automatically creates implicit cursors for DML statements (e.g., SELECT INTO), while the programmer defines and uses explicit cursors. Cursors help iterate through query results and process data row by row.
12. When do we use triggers?
Triggers are used when you want to automate actions or enforce rules based on changes in the database. Common use cases for triggers include auditing changes, maintaining data integrity, and implementing business rules.
13. What is a PL/SQL block?
A PL/SQL block is a self-contained unit of code that can include declarations, executable statements, and exception handlers. It is the fundamental structure for writing PL/SQL programs, procedures, functions, and anonymous blocks.
14. Name the differences between syntax and runtime errors.

- Syntax Error: These errors occur during compilation and are related to incorrect PL/SQL language syntax. They prevent the code from compiling successfully.
- Runtime Error: These errors occur during program execution and are caused by issues such as division by zero, data type mismatches, or other exceptional conditions. They can be handled with exception handling.

15. What are COMMIT, ROLLBACK, and SAVEPOINT?

- COMMIT: The SQL statement known as COMMIT is utilized to persistently store all modifications carried out within the ongoing transaction in the database, signifying the successful conclusion of said transaction.
- ROLLBACK: ROLLBACK in SQL is a command employed to reverse all modifications executed during the ongoing transaction and revert the database to its prior state.
- SAVEPOINT: SAVEPOINT sets a point within a transaction to which you can later roll back if needed. It allows you to undo parts of a transaction selectively.

1. What is SQL?

SQL (Structured Query Language) is a programming language used to manipulate and manage data in relational databases. SQL is used to communicate and connect with a database to create, modify, retrieve, and delete data.

Some everyday tasks performed using SQL include creating tables and views, inserting and updating data, selecting specific data from tables, and deleting data from tables.

2. What is a database?

A database is an organized collection of structured information or data, typically stored electronically in a computer system. It allows users to store, manage, retrieve, and update data efficiently through database management systems (DBMS).

3. What is a primary key, and why is it important in a database?

A primary key is a crucial component of a Database as it serves as a unique identifier in a table for each record. The primary key enables efficient data retrieval and manipulation while ensuring data integrity by preventing duplicate entries.

Using a primary key, a database management system can quickly locate and retrieve data from a table without scanning the entire table. This makes data retrieval more efficient, especially in large databases with many records. Additionally, primary keys allow for the easy creation of relationships between tables, simplifying complex queries and making database maintenance easier.

4. What is a foreign key, and how is it different from a primary key?

A foreign key is a database constraint that establishes a link between two tables in a relational database. It is used to maintain referential integrity. It is a field or set of fields in one table that also refers to the primary key of another table. It differs from a primary key in that it does not have to be unique and can be used to establish relationships between tables.

5. What is the difference between a LEFT JOIN and a RIGHT JOIN in SQL?

In SQL, a LEFT JOIN and a RIGHT JOIN are both types of outer join that can be used to combine data from two or more tables. The difference between them lies in which table's data is preserved if there is no matching data in the other table.

- In a LEFT JOIN, all the rows from the table on the left-hand side of the JOIN keyword (the "left table") are included in the result set, even if there is no matching data in the table on the right-hand side (the "right table").
- In the Right JOIN, all the rows from the table on the right-hand side of the JOIN keyword (the "right table") are included In the result set, even if there is no matching data in the left table.

In summary, the difference between a LEFT JOIN and a RIGHT JOIN is the table whose data is preserved when there is no match in the other table.

6. How would you retrieve all the records from a " customers " table in SQL?

Ans: To retrieve all the records from a table called "customers" in SQL, you would use the following query:

```
SELECT * FROM customers;
```

7. What is a subquery, and how is it used in SQL?

A subquery is a query that is embedded within another query. It retrieves data used in the main query as a filter or a condition.

Syntax:

```
SELECT column1, column2
FROM table1
WHERE column3 IN (SELECT column3 FROM table2 WHERE condition);
```

8. What is the difference between SQL's WHERE and HAVING clauses?

In SQL, the WHERE clause is used to filter rows based on a condition on a column, while the HAVING clause is used to filter groups based on an aggregate function.

The WHERE clause is applied before any grouping takes place and filters individual rows based on a condition. On the other hand, the HAVING clause is applied after the grouping and filter groups based on the results of aggregate functions such as COUNT, SUM, AVG, etc.

9. What is the difference between a function and a stored procedure in SQL?

In SQL, a function returns a value, while a stored procedure does not necessarily return a value and may execute a series of operations or tasks. Functions can be used as part of a SQL statement or expression to return a value. In contrast, stored procedures can be used to encapsulate a series of SQL statements and can be executed as a single unit. Additionally, functions can be used within stored procedures, but stored procedures cannot be used within functions.

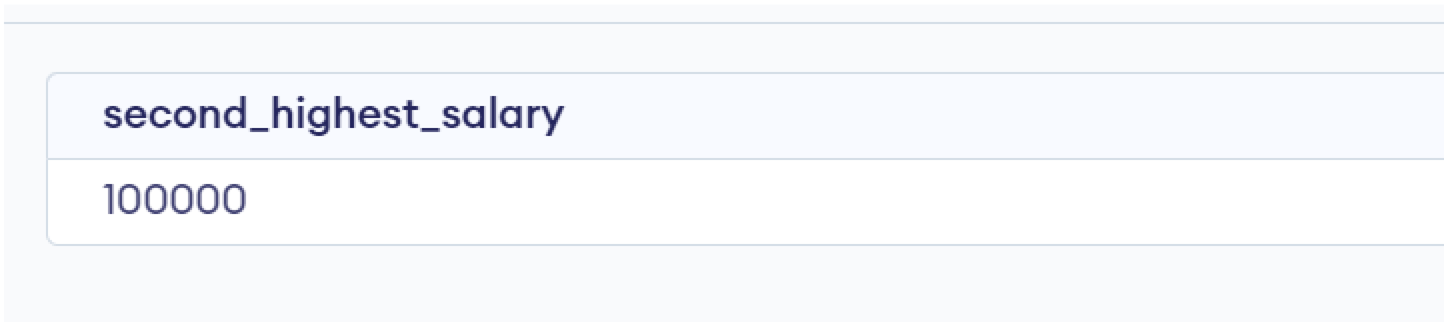
10. Write a SQL query to find the second-highest salary from an employee table.

Assuming we have the following "employees" table:

```
CREATE TABLE employees (
        id INT PRIMARY KEY,
        name VARCHAR(255) NOT NULL,
        salary INT
);

INSERT INTO employees (id, name, salary) VALUES (1, 'Sangeeta', 100000);
INSERT INTO employees (id, name, salary) VALUES (2, 'Ranjita', 150000);
INSERT INTO employees (id, name, salary) VALUES (3, 'Anita', 70000);
INSERT INTO employees (id, name, salary) VALUES (4, 'Sunita', 50000);
INSERT INTO employees (id, name, salary) VALUES (5, 'Anjeeta', 90000);
```

```
SELECT MAX(salary) as second_highest_salary
FROM employees
WHERE salary < (SELECT MAX(salary) FROM employees)
```

Output:



```
second_highest_salary
100000
```

11. What is the purpose of an index in SQL, and how does it work?

An index is used to improve the performance of queries by allowing for faster data retrieval. It creates a separate data structure that stores the values of one or more columns and allows faster access to the data based on those values.

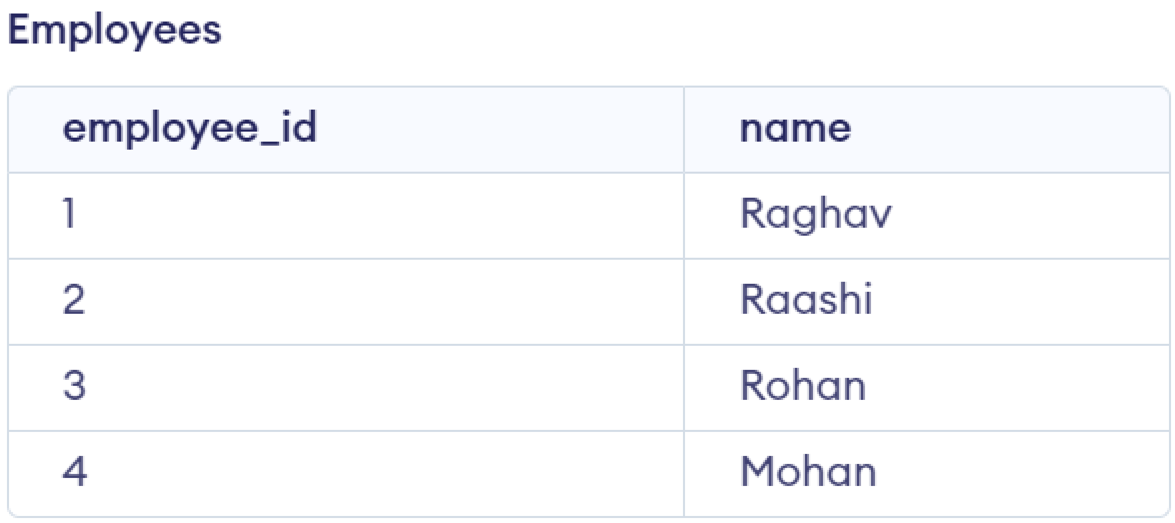
12. What is the difference between NOSQL and SQL?

SQL	NOSQL
It is a relational data model.	It is a non-relational data model.
Vertical scaling is more common.	Supports horizontal scaling.
Handles structured data.	Handles large and unstructured data.
Fixed schema structure.	Flexible structure.
Schema-based.	Schema-less.

13. Write a SQL query to find the names of employees who have not been assigned to any project.

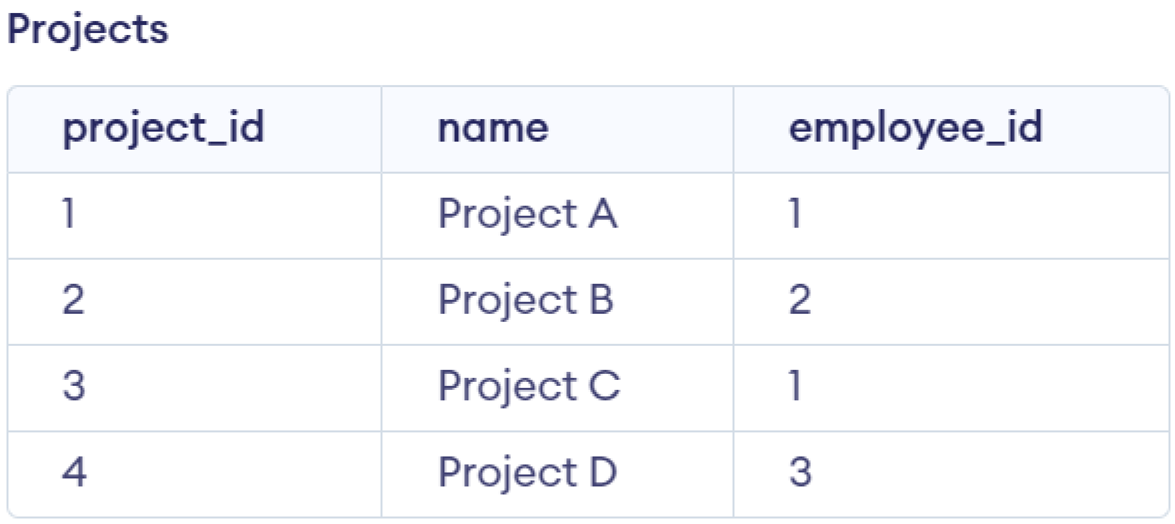
We have created an Employee table and a Project table

```
CREATE TABLE employees (
            employee_id INT PRIMARY KEY,
            name VARCHAR(50)
);

INSERT INTO employees (employee_id, name)
VALUES
            (1, 'Raghav'),
            (2, 'Raashi'),
            (3, 'Rohan'),
            (4, 'Mohan');
```


Employees

employee_id	name
1	Raghav
2	Raashi
3	Rohan
4	Mohan

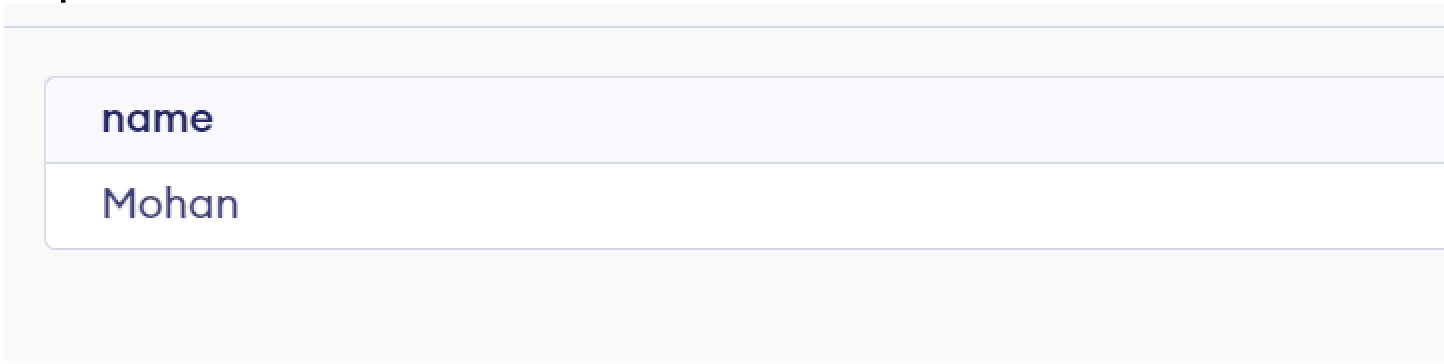
```
CREATE TABLE projects (
		project_id INT PRIMARY KEY,
		name VARCHAR(50),
		employee_id INT,
		FOREIGN KEY (employee_id) REFERENCES employees(employee_id)
);

INSERT INTO projects (project_id, name, employee_id)
VALUES
		(1, 'Project A', 1),
		(2, 'Project B', 2),
		(3, 'Project C', 1),
		(4, 'Project D', 3);
```


Projects

project_id	name	employee_id
1	Project A	1
2	Project B	2
3	Project C	1
4	Project D	3

```
SELECT employees.name
FROM employees
LEFT JOIN projects
ON employees.employee_id = projects.employee_id
WHERE projects.employee_id IS NULL;
```

Output:

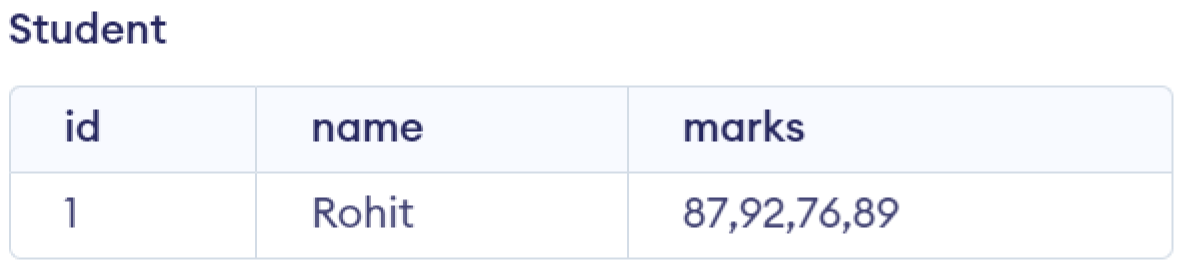


name
Mohan

Explanation:
This is because the employee Mohan has not been assigned to any project, as there are no corresponding rows in the **"projects"** table with their respective employee IDs. The rest have been assigned to at least one project, so they are not included in the output.

14. In the Student table, the marks column contains a list of values separated by commas. How can you determine the number of values in this comma-separated list?

```
CREATE TABLE Student (
            id INT NOT NULL,
            name VARCHAR(50) NOT NULL,
            marks VARCHAR(255) NOT NULL,
            PRIMARY KEY (id)
);
INSERT INTO Student (id, name, marks)
VALUES (1, 'Rohit', '87,92,76,89');
```



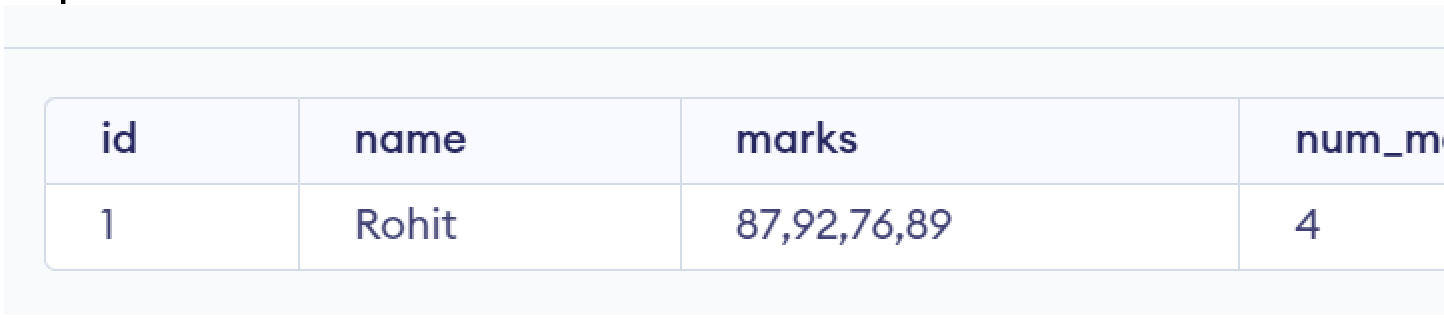
Student

id	name	marks
1	Rohit	87,92,76,89

```
SELECT id, name, marks, LENGTH(marks) - LENGTH(REPLACE(marks, ',', '')) + 1 AS num_
marks
FROM Student
```

```
WHERE id = 1;
```

Output:



id	name	marks	num_m
1	Rohit	87,92,76,89	4

15. State the difference between cross-join and natural join.

Features	CROSS JOIN	NATURAL JOIN
Definition	Returns the Cartesian product of the two tables, meaning every row from the first table is combined with every row from the second table.	Joins two tables based on columns with the same name, producing a result set with only one column for each pair of same-named columns.
Syntax	SELECT * FROM table1 CROSS JOIN table2;	SELECT * FROM table1 NATURAL JOIN table2;
Join Condition	Joins every row of the first table to every row of the second table.	Joins the two tables based on columns with the same name.
Resulting Rows	Total rows in table1 multiplied by total rows in table2.	Rows where the values in columns with the same name are equal.
Performance	It can be slow for large tables, generates Cartesian product.	More efficient than CROSS JOIN but may require specifying columns explicitly.
Usage	Used when no columns exist to join tables or when you want all possible combinations of rows from the two tables.	Used when two tables have at least one column with the same name, and you want to join them based on that column.

16. List the different types of relationships in SQL.

In SQL, there are four main types of relationships:

- **One-to-One (1:1) Relationship**: In this type of relationship, each record in the first table is associated with only one record in the second table, and vice versa. This is typically used when the two tables have a common attribute or key, and the second table contains additional information about the first table.

- **One-to-Many (1:N) Relationship**: In this type of relationship, each record in the first table can be associated with multiple records in the second table, but each record in the second table is associated with only one record in the first table. This is used when one record in the first table can have multiple related records in the second table.

- **Many-to-One (N:1) Relationship**: This is the inverse of the one-to-many relationship. In this type of relationship, each record in the second table can be associated with multiple records in the first table, but each record in the first table is associated with only one record in the second table. This is used when multiple records in the second table are related to one record in the first table.

- **Many-to-Many (N:N) Relationship**: In this type of relationship, each record in the first table can be associated with multiple records in the second table and vice versa. This requires the use of an intermediary table, often called a junction table, which contains foreign keys to both the first and second tables. This is used when multiple records in each table can be related to multiple records in the other table.

17. What are Tables and Fields?
In a relational database, a table is a collection of data organized in rows and columns. Tables are used to store and manage data in a structured way, with each row representing a unique record and each column representing specific information about the record. Tables are often named according to the type of data they contain, such as "customers", "orders", or "employees".
A **field**, also known as a column or an attribute, is a single information stored in a table. Each field is named and has a specific data type, such as text, number, date, or Boolean, that determines the type of data that can be stored in the field. For example, a "customers" table might have fields for the customer's name, address, phone number, and email address.

Fields can also have other properties, such as a maximum length or a default value, that define how the data is stored and how it can be used. In addition, fields can be used to define relationships between tables by referencing the primary key of another table or by creating foreign keys that link related records across different tables.

Tables	Fields

Tables	Fields
customer's	customer_id, name, email, phone, and address.
orders	order_id, customer_id, order_date, total_amount.
products	product_id, name, description, price, quantity.
employees	employee_id, first_name, last_name, job_title, hire_date.

Together, tables and fields form the basic building blocks of a relational database, providing a flexible and powerful way to store, manage, and query large amounts of data in a structured and organized way.

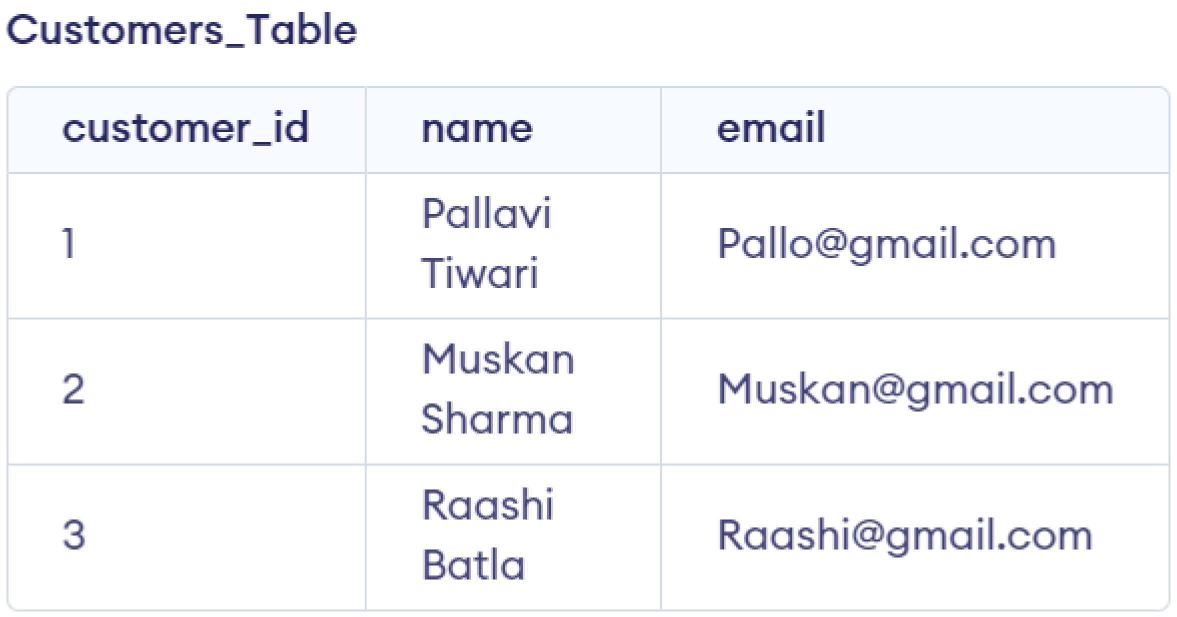
18. What is the difference between the SQL statements DELETE and TRUNCATE?

Statement	DELETE	TRUNCATE
Syntax	DELETE FROM table_name WHERE condition;	TRUNCATE TABLE table_name;
Functionality	Deletes specific rows that match the WHERE condition.	Removes all rows from the table.
Auto-increment	Does not reset auto-increment values.	Resets auto-increment values to their starting value.
Transaction	It can be rolled back within a transaction.	It cannot be rolled back within a transaction.
Logging	Logs, each row deletion, can be slower for large tables.	It does not log individual row deletions but can be faster for large tables.
Access	Requires to DELETE privileges on the table.	Requires to DROP and CREATE privileges on the table.

19. How should data be structured to support Join Operations in a one-to-many relationship?

In a one-to-many relationship, where one record in the primary table is related to many records in the related table, the data should be structured in a way that supports efficient join operations.
A practical method to establish a relationship between two tables is to utilize a foreign key column within the related table that points to the primary key column in the primary table. This allows the database to quickly locate all the related records for a given primary record.
Consider two tables

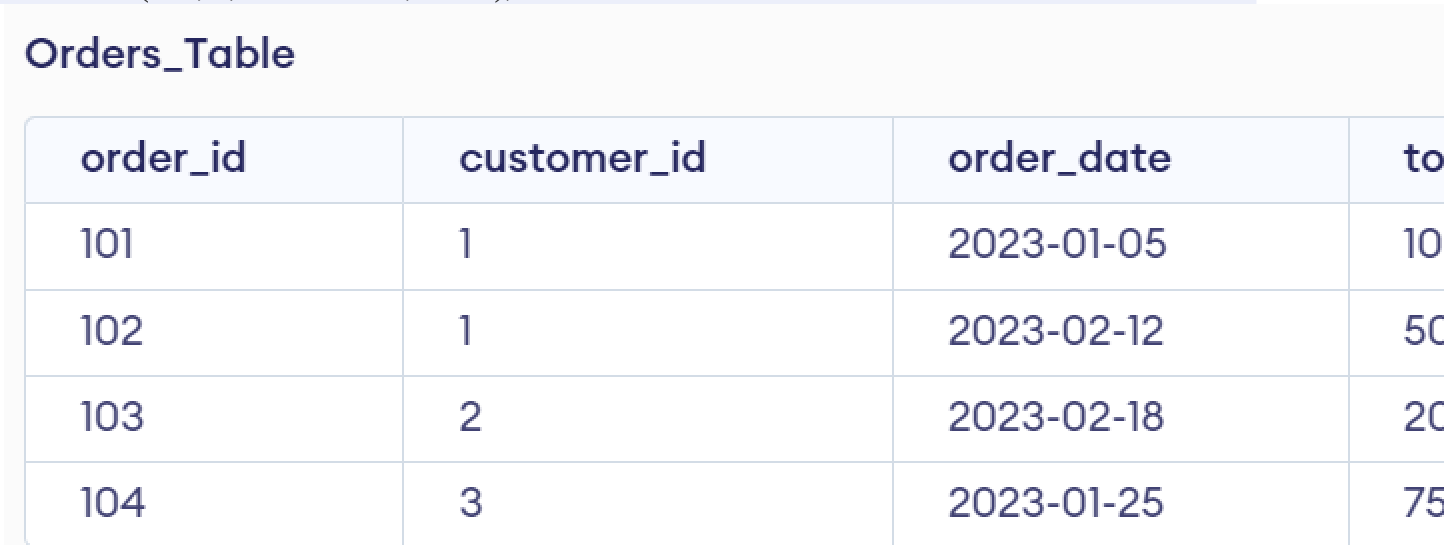
```
CREATE TABLE customers_Table (
            customer_id INT PRIMARY KEY,
            name VARCHAR(50),
            email VARCHAR(100)
);
INSERT INTO customers_Table (customer_id, name, email)
VALUES (1, 'Pallavi Tiwari', 'Pallo@gmail.com');

INSERT INTO customers_Table (customer_id, name, email)
VALUES (2, 'Muskan Sharma', 'Muskan@gmail.com');

INSERT INTO customers_Table (customer_id, name, email)
VALUES (3, 'Raashi Batla', 'Raashi@gmail.com');
```



Customers_Table

customer_id	name	email
1	Pallavi Tiwari	Pallo@gmail.com
2	Muskan Sharma	Muskan@gmail.com
3	Raashi Batla	Raashi@gmail.com

```
CREATE TABLE orders_Table (
            order_id INT PRIMARY KEY,
            customer_id INT,
            order_date DATE,
            total_amount DECIMAL(10, 2),
            FOREIGN KEY (customer_id) REFERENCES customers(customer_id)
);
INSERT INTO orders_Table(order_id, customer_id, order_date, total_amount)
VALUES (101, 1, '2023-01-05', 100.00);

INSERT INTO orders_Table (order_id, customer_id, order_date, total_amount)
VALUES (102, 1, '2023-02-12', 50.00);

INSERT INTO orders_Table (order_id, customer_id, order_date, total_amount)
VALUES (103, 2, '2023-02-18', 200.00);

INSERT INTO orders_Table (order_id, customer_id, order_date, total_amount)
VALUES (104, 3, '2023-01-25', 75.00);
```



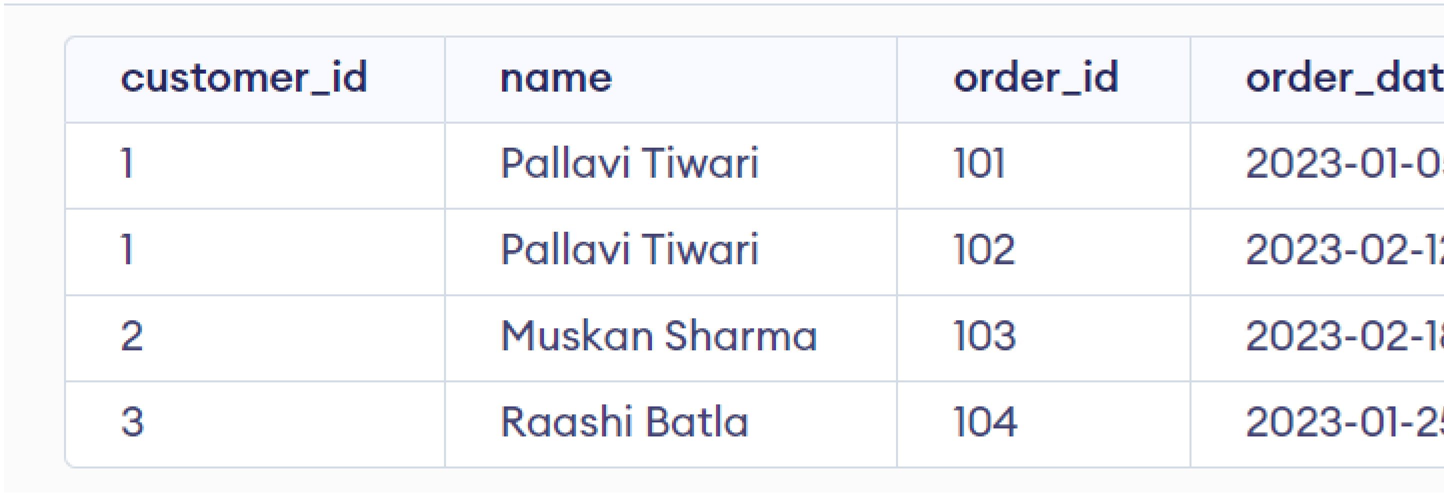
Orders_Table

order_id	customer_id	order_date	to
101	1	2023-01-05	10
102	1	2023-02-12	50
103	2	2023-02-18	20
104	3	2023-01-25	75

In this example, the table name customer_Table has a primary key column called "customer_id", a unique identifier for each customer. The orders_Table has a foreign key column called "customer_id", which references the customer_id column in the customers_Table. This establishes a one-to-many relationship between customers and orders: each can have multiple orders, but each order is associated with a single customer.
To retrieve a list of all customers and their associated orders, you could use a SQL statement like this:

```
SELECT customers_Table.customer_id, customers_Table.name, orders_Table.order_id, orders_
Table.order_date, orders_Table.total_amount
FROM customers_Table
LEFT JOIN orders_Table ON customers_Table.customer_id = orders_Table.customer_id;
```

This statement uses a LEFT JOIN operation to include all records from the customers_Table, and any matching records from the orders_Table. The ON clause specifies the join condition, which matches records in the orders table with the corresponding customer records based on the customer_id column.
Output:



customer_id	name	order_id	order_dat
1	Pallavi Tiwari	101	2023-01-0
1	Pallavi Tiwari	102	2023-02-1
2	Muskan Sharma	103	2023-02-1
3	Raashi Batla	104	2023-01-2

As you can see, this query combines the data from both tables, showing the customer and order information together in a single result set.

20. What is a transaction in SQL, and why is it important?

In SQL, a transaction is a logical unit of work consisting of one or more SQL statements executed as a single atomic operation. The primary purpose of a transaction is to ensure that a group of SQL statements is executed as a single, consistent, and reliable unit.

When a transaction is initiated, a set of SQL statements are executed, and the changes made to the database are temporarily stored in a buffer area called a transaction log. If all the SQL statements in the transaction are executed successfully, the changes made to the database are committed, which means they are made permanent.

- If any error occurs during the transaction, all changes made to the database are rolled back, and the database is restored to its original state before the transaction starts.

- The importance of transactions in SQL is maintaining the consistency, reliability, and integrity of the data in the database. Transactions help to ensure that the database is always in a valid state and that data is not lost or corrupted due to errors or system failures.

- Transactions also provide a mechanism for concurrent access to the database, allowing multiple users to access the database simultaneously without interfering with each other's work.

- Transactions form the backbone of many business-critical applications and systems by ensuring that database changes are processed reliably and consistently.

21. What is the difference between CHAR and VARCHAR in SQL?

CHAR is a fixed-length data type in SQL, meaning it will always occupy the exact number of characters specified, even if the actual value is shorter. Padding with spaces is done to meet the required length. On the other hand, VARCHAR is a variable-length data type. It stores only the number of characters that are used, without extra padding, making it more efficient for storing variable-length strings. However, CHAR can be faster for fixed-length data as there is no length checking involved.

22. What is the use of the GROUP BY clause in SQL?

The GROUP BY clause in SQL is used to group rows that share the same values in specified columns into summary rows. It is typically used with aggregate functions like COUNT(), SUM(), AVG(), etc., to perform operations on these grouped data. For instance, you can use GROUP BY to find the total sales for each product in a sales table. It helps in producing summary reports and is commonly used for analytical queries.

23. What is the default sorting order in SQL?

The default sorting order in SQL is ascending. When you run a query with the ORDER BY clause, it automatically sorts the results in ascending order unless explicitly specified as DESC (for descending order). For example, in a list of numbers or dates, sorting in ascending order will arrange them from smallest to largest or from oldest to newest, respectively. Ascending sorting can be done by simply using the ORDER BY clause without specifying ASC.

24. What is the difference between UNION and UNION ALL in SQL?

UNION and UNION ALL are both used to combine the result sets of two or more SELECT statements. The key difference is that UNION removes duplicate rows, ensuring that each row in the final result set is unique. In contrast, UNION ALL includes all rows from each query, including duplicates. While UNION is helpful when you need to eliminate duplicates, UNION ALL is faster since it does not perform the duplicate check and simply appends the results.

25. How do you use the DISTINCT keyword in SQL?

The DISTINCT keyword is used in SQL to remove duplicate values from the result set of a SELECT query. It ensures that only unique records are returned. For instance, when retrieving data from a column with repeating values, using DISTINCT will return each unique value only once. This is useful when you want to know distinct categories, items, or identifiers in a table. For example, SELECT DISTINCT department FROM employees; will give a list of unique departments.

Intermediate SQL Interview Questions

26. What is ETL in SQL?

ETL (Extract, Transform, Load) is a common process used in data warehousing and business intelligence to move data from various sources into a data warehouse or database. The process involves three steps:

- **Extract**: In this step, data is extracted from various sources such as databases, files, or web services. This may involve using SQL queries to extract data from databases, APIs, or web scraping tools to extract data from web services or files.

- **Transform:** Once the data has been extracted, it is transformed or cleaned to make it suitable for storage and analysis. This may involve applying filters, aggregating data, or converting data types. SQL is commonly used to transform data as part of the ETL process.

- **Load:** The final step is to load the transformed data into a data warehouse or database. This may involve loading data into tables, creating indexes, or performing other database operations.

The ETL process is critical for data integration, as it allows organizations to collect data from various sources, transform it into a consistent format, and store it in a central location for analysis and reporting. ETL tools such as Microsoft SQL **Server Integration Services (SSIS)** or Talend can automate much of the ETL process and provide a visual interface for designing and managing data flows.

27. What are the types of SQL JOINS?

In SQL, there are four types of JOINs:

- **INNER JOIN:** It returns only the matching rows between two tables. It combines rows from two or more tables where the values in the common columns match.

- **LEFT JOIN:** It returns all the left and the matching rows from the right table. The result will contain null values for the right table's columns if there are no matches.

- **RIGHT JOIN:** It returns all the rows from the right table and the matching ones from the left table. The result will contain null values for the left table's columns if there are no matches.

- **FULL OUTER JOIN:** It returns all the rows from both tables, including unmatched ones. If there are no matches, the result will contain null values for the table's columns that don't have a matching row.

There is also a CROSS JOIN, which returns the Cartesian product of the two tables, which combines every row from the first table with all rows from the second table. However, unlike the other JOIN types, it doesn't use a join condition to match the rows between the tables.

28. What are Aggregate and Scalar functions?

In database management systems, there are two main types of functions used to manipulate data: **aggregate functions and scalar functions**.

Aggregate functions perform calculations on a set of values and return a single value representing a summary of that set. These functions are typically used with a GROUP BY clause to group data by one or more columns and then perform calculations on each group. Examples of aggregate functions include SUM, AVG, COUNT, MAX, and MIN.

Scalar functions, on the other hand, operate on a single value and also return a single value. They can manipulate data in various ways, such as performing string operations, date calculations, or mathematical computations. Examples of scalar functions include CONCAT (to concatenate two strings), DATEADD (to add a specified amount of time to date), and ABS (to return the absolute value of a number).

Aggregate functions are used to perform calculations on data sets and return a single value representing some summary of that set. In contrast, scalar functions operate on a single value and return a single value. Both functions are commonly used in database management systems to manipulate and analyze data.

29. List different Types of Index in SQL?

In SQL, different indexes can be created to improve query performance. Here are some of the most common types of indexes:

- **Clustered Index:** A clustered index in SQL organizes and stores the data rows in a table based on the values of one or more columns. This index determines the physical order of the data within the table, making it highly efficient for range queries and sorting operations. By sorting and storing the data in the table based on the values of the clustered index, queries that filter or sort by those columns can be performed faster since they can utilize the physical order of the data.

- **Non-Clustered Index:** A non-clustered index creates a separate structure that stores a copy of the indexed columns and a pointer to the corresponding data row in the table. It allows for faster retrieval of specific rows or ranges of rows but can be less efficient than a clustered index for sorting operations.

- **Unique Index:** A unique index enforces the constraint that the values in the indexed column(s) must be unique across all rows in the table. Depending on the table's primary key, it can be either a clustered or non-clustered index.

- **Composite Index:** A composite index is an index that is created on two or more columns in a table. It can improve the performance of queries that filter on multiple columns, allowing more efficient sorting and matching of the indexed values.

- **Full-Text Index:** A full-text index searches for text-based data in a table, such as articles, documents, or web pages. It allows for fast and efficient searching of large amounts of text using algorithms that analyze the data's words, phrases, and context.

- **Spatial Index:** A spatial index is used to optimize the querying of geographic or location-based data in a table, such as maps, GPS coordinates, or boundaries. It uses specialized data structures and algorithms to store and search for spatial data efficiently.

30. What is the difference between a clustered and a non-clustered index in SQL?

Features	Clustered Index	Non-Clustered Index
Definition	Determines the physical order of the data.	A separate structure that contains the index key and a pointer to the data.
Implementation	Only one clustered index per table.	Multiple non-clustered indexes per table are possible.

Features	Clustered Index	Non-Clustered Index
Data Retrieval	Faster data retrieval for large data sets.	Slower data retrieval for large data sets.
Storage	Contains the actual data.	Does not contain the actual data.
Key	Determines the order of data on the table.	It helps in searching for the data.
Unique Index	Clustered indexes are unique by default.	Non-clustered indexes can be unique or non-unique.
Data Modification	This may cause more overhead for updates.	It May cause less overhead for updates.
Tables with Clustered Index	It may require defragmentation.	Does not require defragmentation.

31. What are the different types of normalizations?

In database design, several types of normalization are used to reduce data redundancy, improve data integrity, and ensure efficient data retrieval. The different types of normalizations are

- **First Normal Form (1NF):** This normalization ensures that the data in each table's column is atomic, meaning that it cannot be further broken down into smaller pieces. It also eliminates duplicate rows from the table.

- **Second Normal Form (2NF):** This normalization eliminates partial dependencies by ensuring that each non-key column in a table is dependent on the entire primary key rather than on its part of it.

- **Third Normal Form (3NF):** This normalization eliminates transitive dependencies by ensuring that each non-key column in a table is dependent only on the primary key and not on any other non-key columns.

- **Boyce-Codd Normal Form (BCNF):** This normalization is an extension of 3NF and ensures that each determinant in a table is a candidate key.

- **Fourth Normal Form (4NF):** This normalization eliminates multivalued dependencies by ensuring that each non-key column in a table is dependent on the entire primary key and not on any subsets.

- **Fifth Normal Form (5NF):** This normalization is known as the Project-Join Normal Form and ensures that each table in a database has a single theme or topic.

The normalization process is iterative, and it may be necessary to apply multiple normalizations to achieve the desired data organization and efficiency level.

32. Explain Boyce-Codd Normal Form (BCNF).

Boyce-Codd Normal Form (BCNF) is a normalization technique used in database design to eliminate redundancy and improve data integrity. In BCNF, each determinant (i.e., attribute or set of attributes that uniquely determine another attribute) in a table must be a candidate key (i.e., a unique identifier for each row).

In simpler terms, BCNF ensures that each attribute in a table depends on the entire primary key rather than on just a part of it. This helps to reduce data redundancy and improve data integrity by ensuring that each piece of data in the table is only stored once and can be accessed efficiently.

BCNF is an extension of the Third Normal Form (3NF) and is helpful in situations where 3NF is insufficient to eliminate all forms of redundancy in a table.

However, it is essential to note that achieving BCNF can sometimes result in a higher number of tables and more complex relationships between them. Hence, it is important to balance the benefits of normalization with the practical considerations of database design.

33. What is the difference between a join and a subquery in SQL?

Here's a table format to help illustrate the differences between a join and a subquery in SQL:

Features	Join	Subquery
Syntax	SELECT ... FROM table1 JOIN table2 ...	SELECT ... FROM table1 WHERE condition IN (...)
Purpose	Combine columns from multiple tables.	Retrieve data to use as a condition in the query.
Usage	When querying data from multiple tables.	When querying data based on a condition.
Performance	Typically faster than a subquery.	It can be slower than a join for large datasets.
Result set	Returns columns from multiple tables.	Returns a result set for a single table.

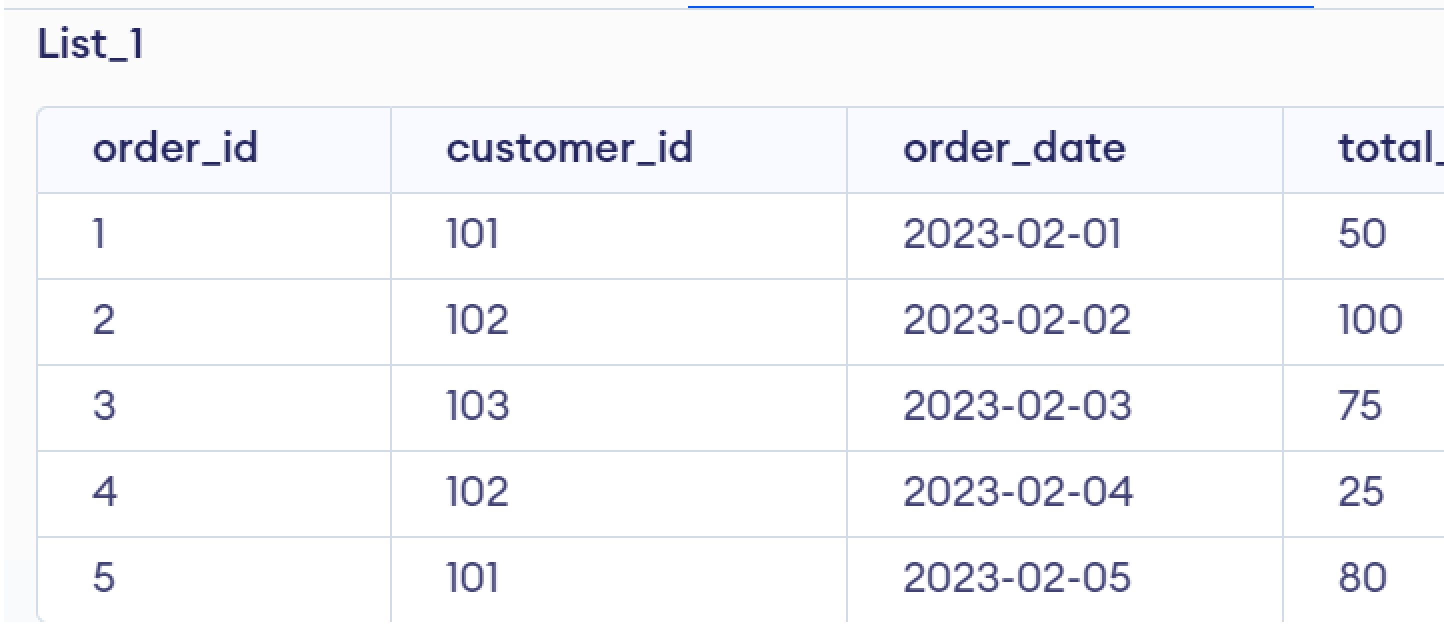
Features	Join	Subquery
Complexity	More complex syntax and usage.	Less complex syntax and usage
Flexibility	It can be used with various types of joins.	It can be used with various types of subqueries.
Code readability	It can be less readable for complex joins	It can be easier to read for simple queries

34. What are some standard clauses used with SELECT queries in SQL?

In SQL, the SELECT statement retrieves data from a database. Along with the introductory SELECT statement, you can use clauses to specify additional details about how the data should be retrieved. Here are some standard clauses used with the SELECT statement example:

Here, we consider a table name List_1 and perform the following SELECT queries.

```
CREATE TABLE `List_1` (
            order_id int(11) NOT NULL,
            customer_id int(11) NOT NULL,
            order_date date NOT NULL,
            total_amount decimal(10,2) NOT NULL,
            PRIMARY KEY (`order_id`)
);

INSERT INTO `List_1` (`order_id`, `customer_id`, `order_date`, `total_amount`) VALUES
(1, 101, '2022-01-01', 50.00),
(2, 102, '2022-01-02', 100.00),
(3, 103, '2022-01-03', 75.00),
(4, 102, '2022-01-04', 25.00),
(5, 101, '2022-01-05', 80.00);
```



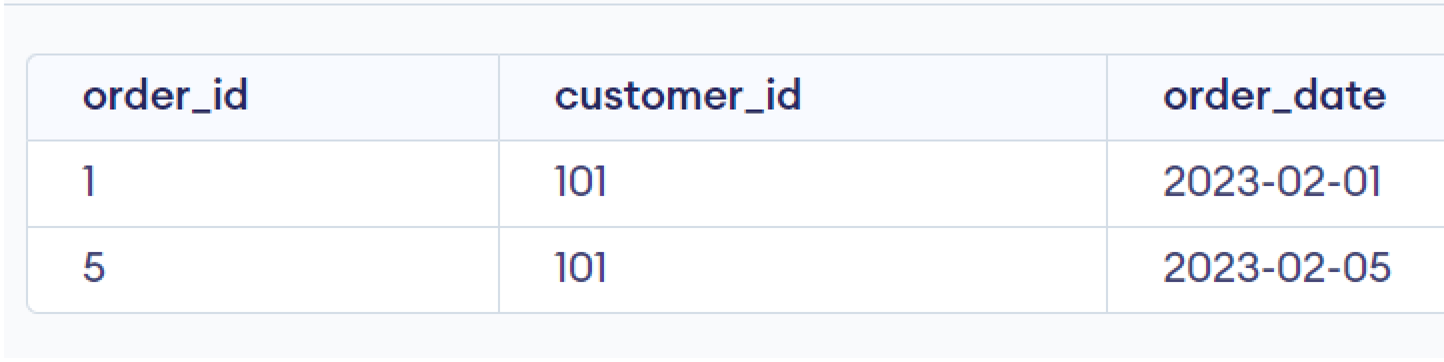
List_1

order_id	customer_id	order_date	total_
1	101	2023-02-01	50
2	102	2023-02-02	100
3	103	2023-02-03	75
4	102	2023-02-04	25
5	101	2023-02-05	80

- **WHERE:** This clause filters data based on a specific condition. For example, you can use WHERE to retrieve all records where a particular column is equal to a specific value.

```
SELECT * FROM List_1
WHERE customer_id = 101;
```

Output:

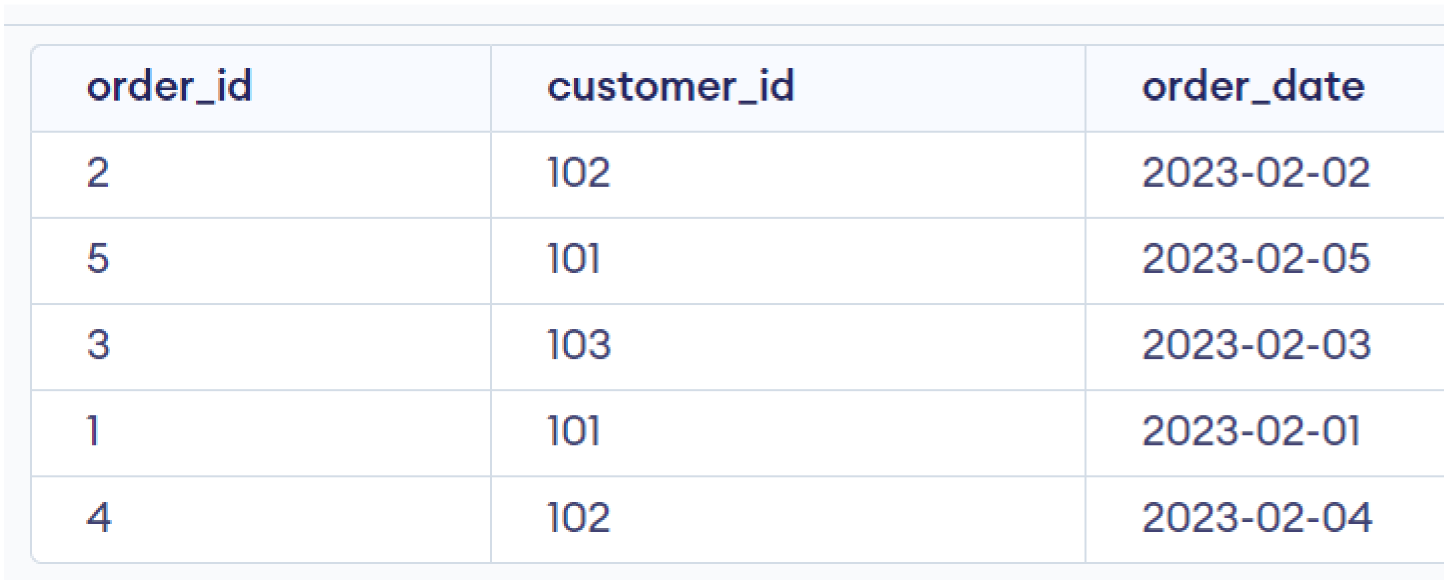


order_id	customer_id	order_date
1	101	2023-02-01
5	101	2023-02-05

- **ORDER BY:** This clause is used to sort the results in descending or ascending order based on one or more columns. For example, you can use ORDER BY to sort a list of customers by their last name.

```
SELECT * FROM List_1
ORDER BY total_amount DESC;
```

Output:

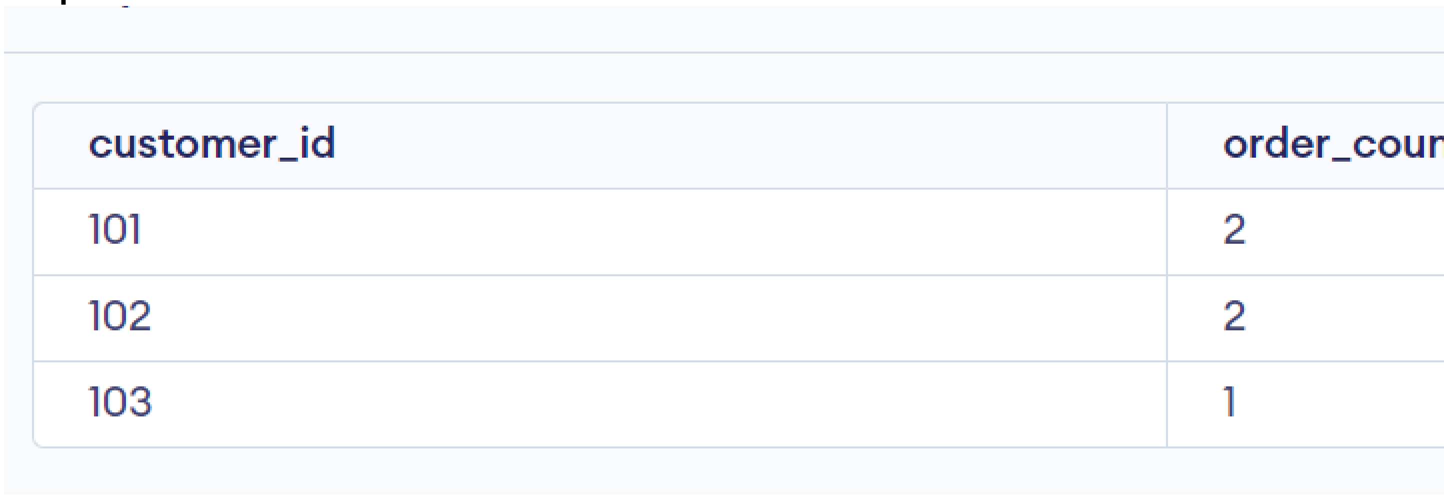


order_id	customer_id	order_date
2	102	2023-02-02
5	101	2023-02-05
3	103	2023-02-03
1	101	2023-02-01
4	102	2023-02-04

- **GROUP BY:** This clause group the results by one or more columns. For example, you can use GROUP BY to group a list of sales by month or by product.

```
SELECT customer_id, COUNT(*) as order_count
FROM List_1
GROUP BY customer_id;
```

Output:



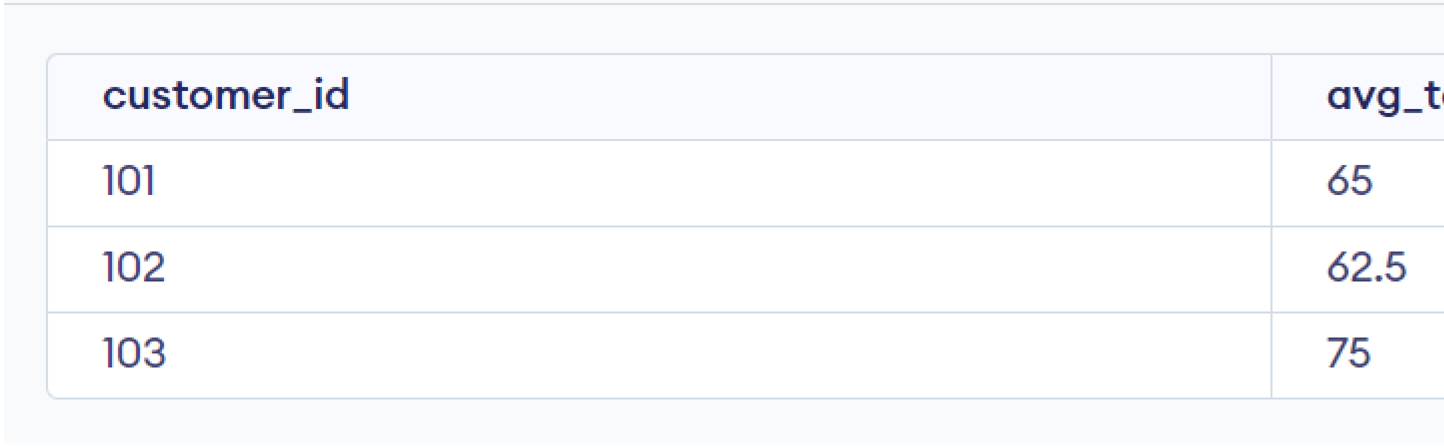
customer_id	order_coun
101	2
102	2
103	1

- **HAVING:** It filters the groups created by the GROUP BY clause based on a specific condition. For example, you can use HAVING to retrieve only those groups where the total sales are greater than a certain amount.

```
SELECT customer_id, AVG(total_amount) as avg_total
FROM List_1
```

```
GROUP BY customer_id
HAVING AVG(total_amount) > 60;
```

Output:

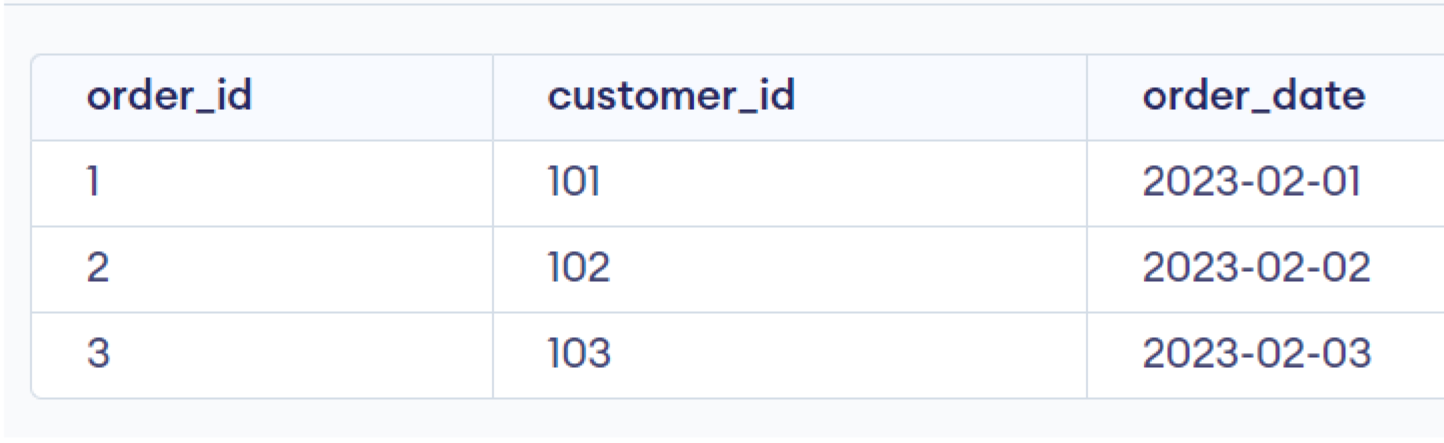


customer_id	avg_t
101	65
102	62.5
103	75

- **LIMIT:** This clause limits the number of rows returned by the query. For example, you can use LIMIT to retrieve the top 10 customers based on their sales.

```
SELECT * FROM List_1
LIMIT 3;
```

Output:

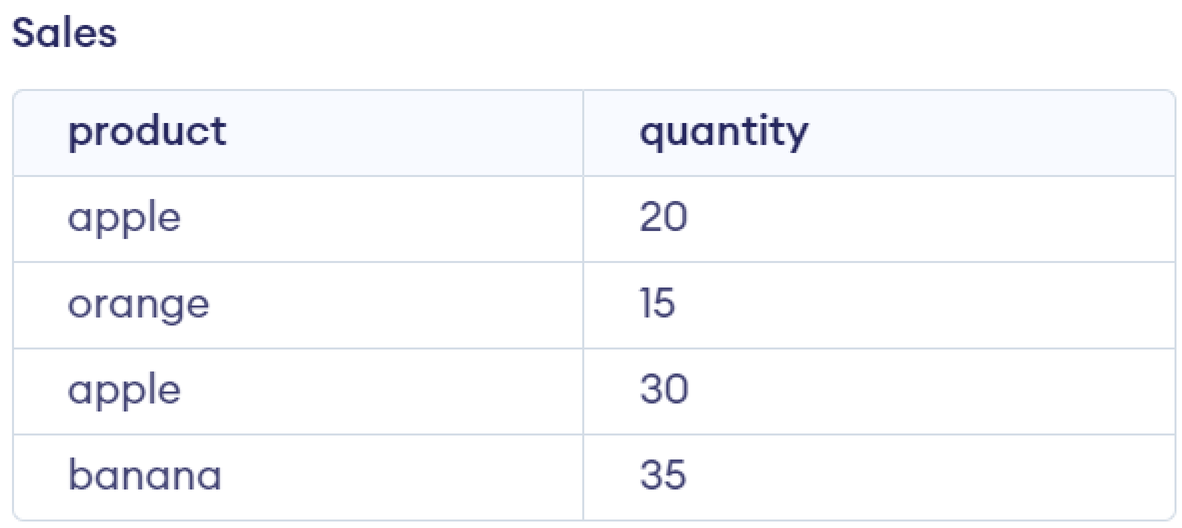


order_id	customer_id	order_date
1	101	2023-02-01
2	102	2023-02-02
3	103	2023-02-03

35. How to get unique records from the table without using distinct keywords.
To get unique records from a table without using the DISTINCT keyword in SQL, you can use the GROUP BY clause with aggregate functions like COUNT, SUM, or AVG.
Create a Table Sales

```
CREATE TABLE sales (
            product VARCHAR(50),
            quantity INT
);
```

```
INSERT INTO sales (product, quantity) VALUES ('apple', 20);
INSERT INTO sales (product, quantity) VALUES ('orange', 15);
INSERT INTO sales (product, quantity) VALUES ('apple', 30);
INSERT INTO sales (product, quantity) VALUES ('banana', 35);
```



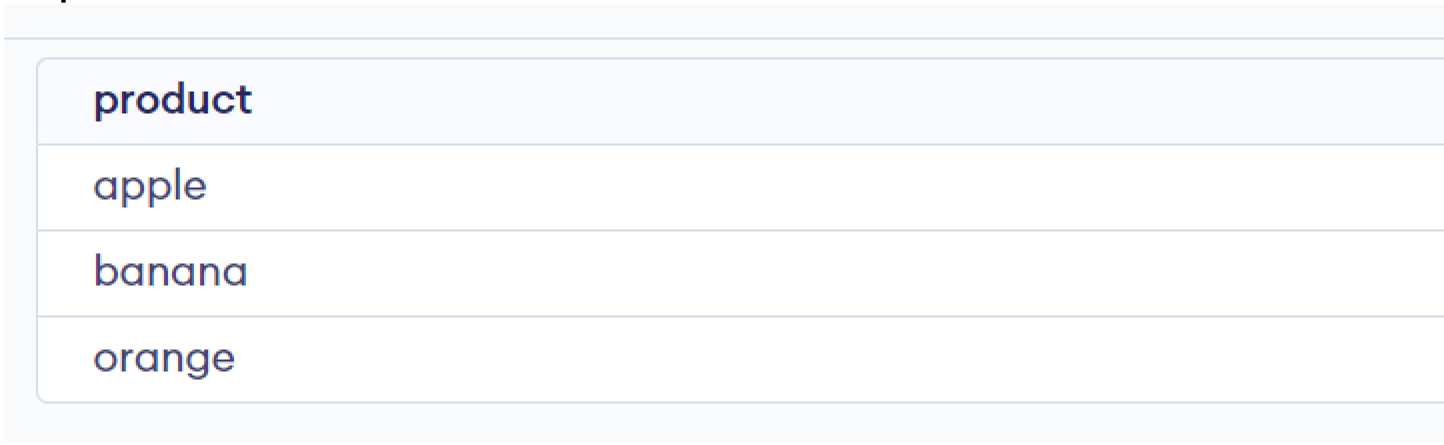
Sales

product	quantity
apple	20
orange	15
apple	30
banana	35

To get unique products from the sales table, you can group the rows by the product column and use the COUNT aggregate function to count the number of occurrences of each product:

```
SELECT product
FROM sales
GROUP BY product;
```

Output:



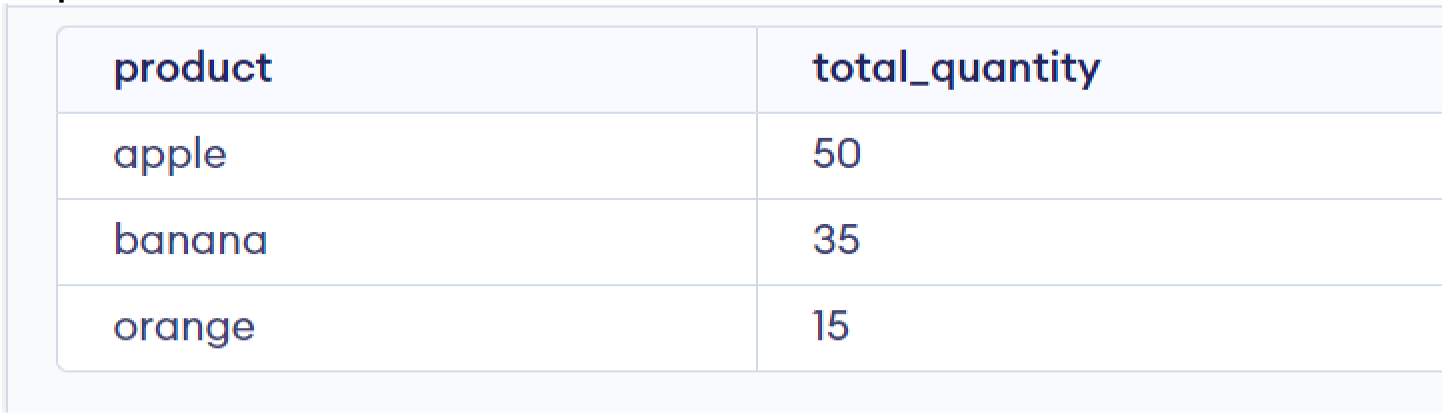
product
apple
banana
orange

If you want to include additional columns in the output, you can also use aggregate functions for those columns. For example, to get the sum of quantities sold for each product, you can use the SUM aggregate function:

```
SELECT product, SUM(quantity) as total_quantity
FROM sales
```

```
GROUP BY product;
```

Output:

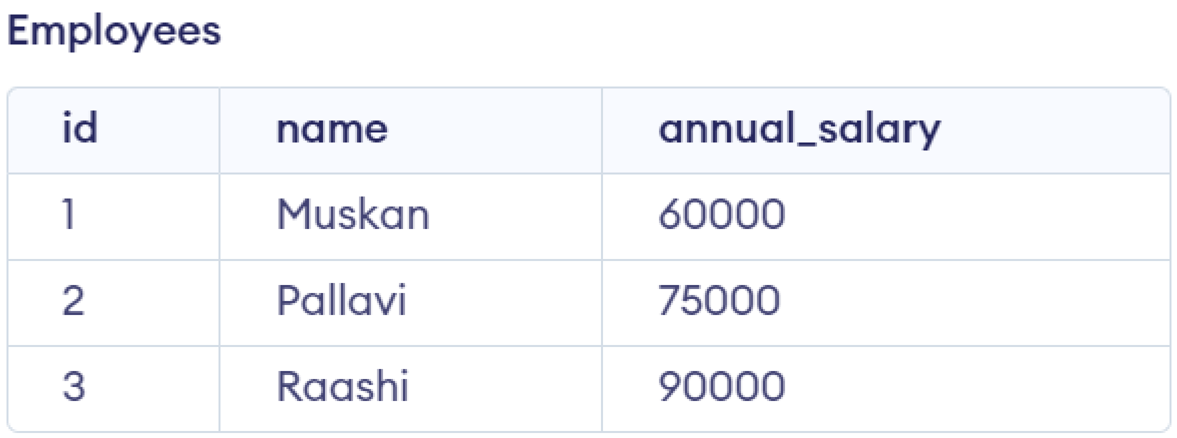


product	total_quantity
apple	50
banana	35
orange	15

By grouping the rows by the product column and using the aggregate functions, you can effectively get unique records from the table without using the DISTINCT keyword.

36. Display the monthly Salary of Employees given annual salary.

```
CREATE TABLE employees (
            id INT NOT NULL,
            name VARCHAR(50) NOT NULL,
            annual_salary DECIMAL(10, 2) NOT NULL,
            PRIMARY KEY (id)
);
INSERT INTO employees (id, name, annual_salary)
VALUES (1, 'Muskan', 60000);

INSERT INTO employees (id, name, annual_salary)
VALUES (2, 'Pallavi', 75000);

INSERT INTO employees (id, name, annual_salary)
VALUES (3, 'Raashi', 90000);
```

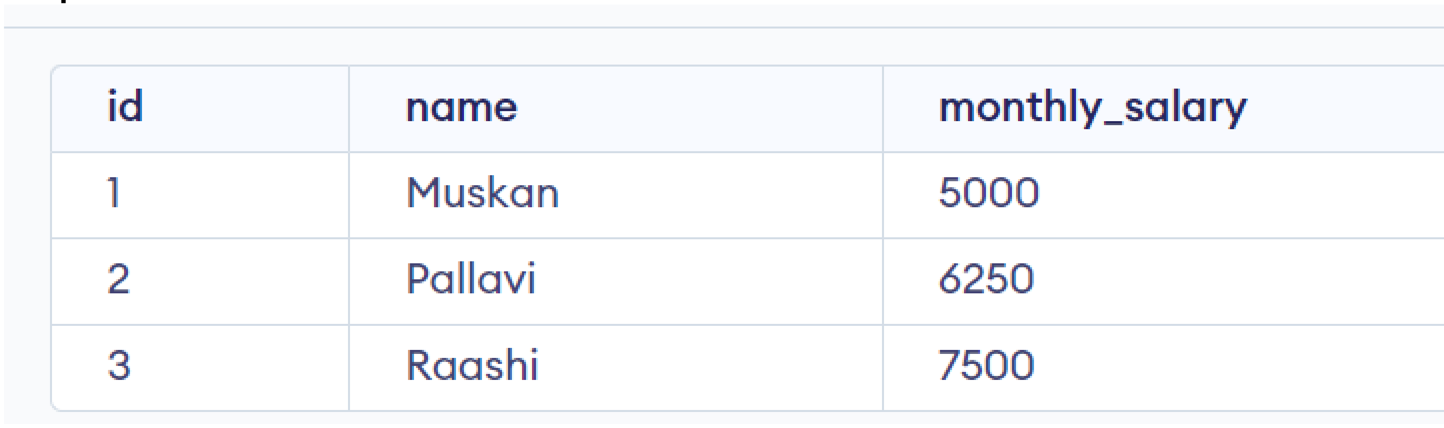


Employees

id	name	annual_salary
1	Muskan	60000
2	Pallavi	75000
3	Raashi	90000

```
SELECT id, name, annual_salary / 12 as monthly_salary
FROM employees;
```

Output:

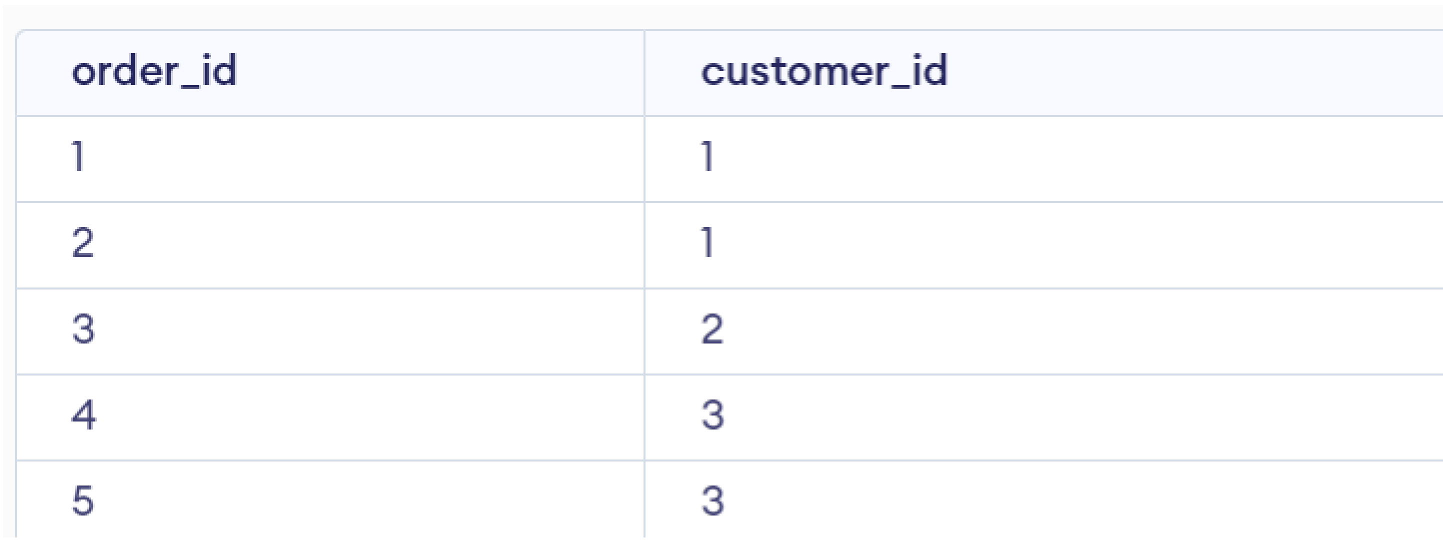


id	name	monthly_salary
1	Muskan	5000
2	Pallavi	6250
3	Raashi	7500

37. Distinguish between nested subquery, correlated subquery, and join operation.

For distinguishing between these three, we have taken some example through which it would be better for you to understand the terms.

```
CREATE TABLE customerss (
            customer_id INT,
            customer_name VARCHAR(50),
            customer_location VARCHAR(50)
);

INSERT INTO customerss (customer_id, customer_name, customer_location)
VALUES
            (1, 'Shila', 'New York'),
            (2, 'Palak', 'India'),
            (3, 'Rajesh', 'New York');


CREATE TABLE orderss (
            order_id INT,
            customer_id INT,
            total_amount INT
);

INSERT INTO orderss (order_id, customer_id, total_amount)
VALUES
            (1, 1, 100),
            (2, 1, 150),
            (3, 2, 75),
            (4, 3, 200),
            (5, 3, 175);
```

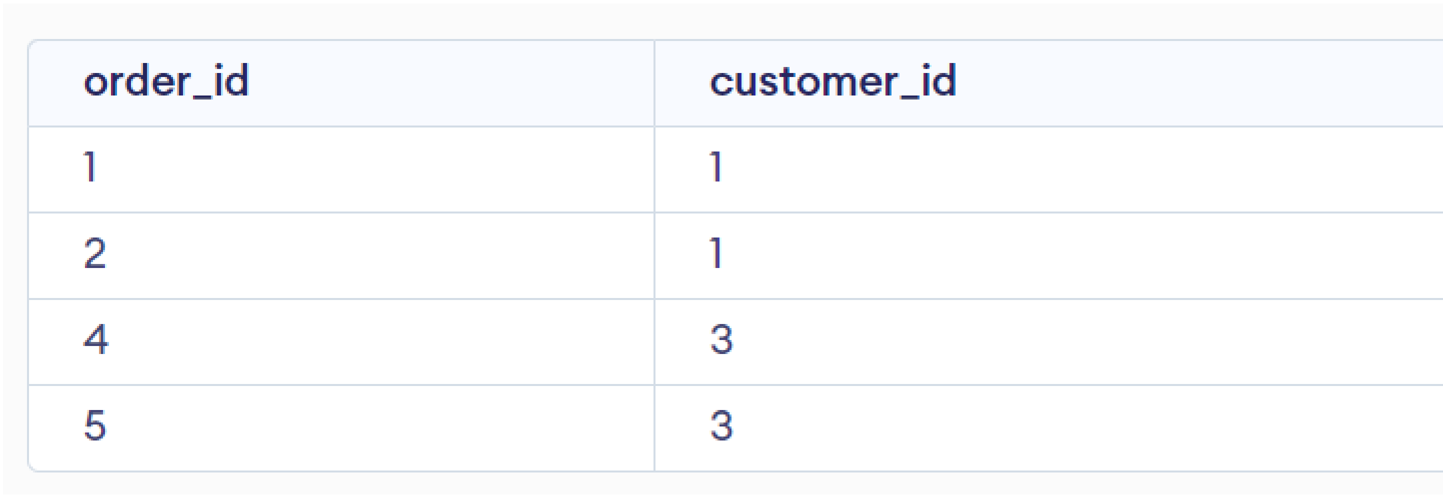


order_id	customer_id
1	1
2	1
3	2
4	3
5	3

Nested Subquery:
A nested subquery is a query that is embedded within another query. The inner query is performed first, and the outer query uses its results. The inner query is enclosed within parentheses and is usually placed in the WHERE or HAVING clause of the outer query. A nested subquery returns a single value or a list of values.
Example:

```
SELECT order_id, customer_id, total_amount
FROM orderss
WHERE customer_id IN (
            SELECT customer_id
            FROM customerss
            WHERE customer_location = 'New York'
);
```

Output:

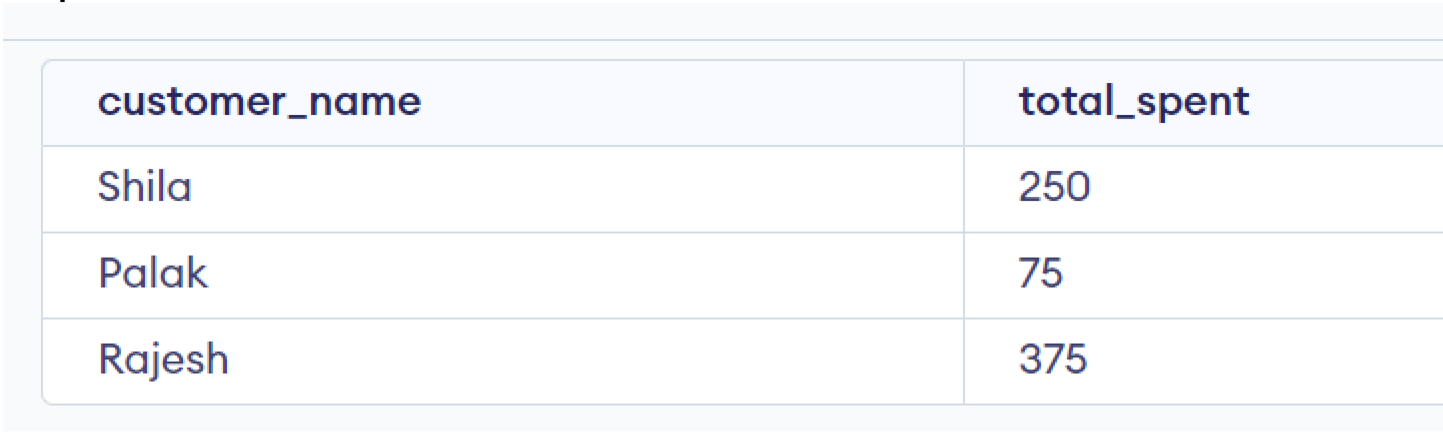


order_id	customer_id
1	1
2	1
4	3
5	3

Correlated Subquery:
It uses a value from the outer query. The inner query is performed once for each row of the outer query, and the result depends on the outer query's current row. A correlated subquery filters or joins data from two or more tables.
Example:

```
SELECT customer_name, (
            SELECT SUM(total_amount)
            FROM orderss
            WHERE orderss.customer_id = customerss.customer_id
) AS total_spent
FROM customerss;
```

Output:

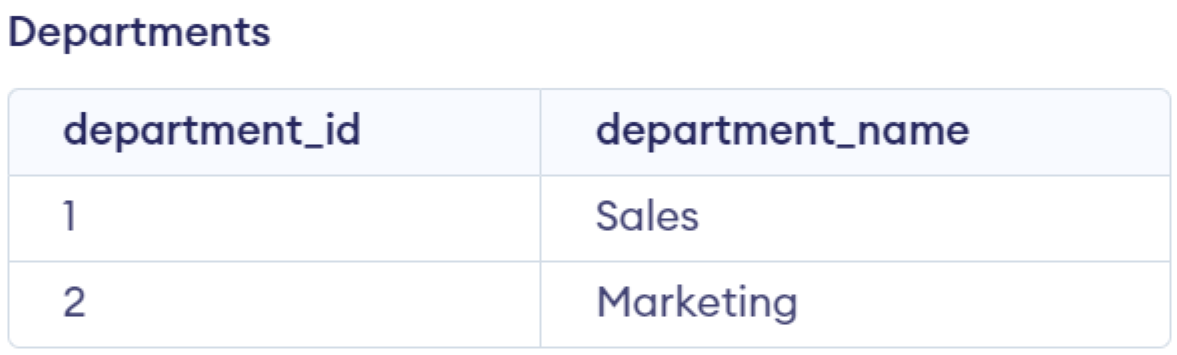


customer_name	total_spent
Shila	250
Palak	75
Rajesh	375

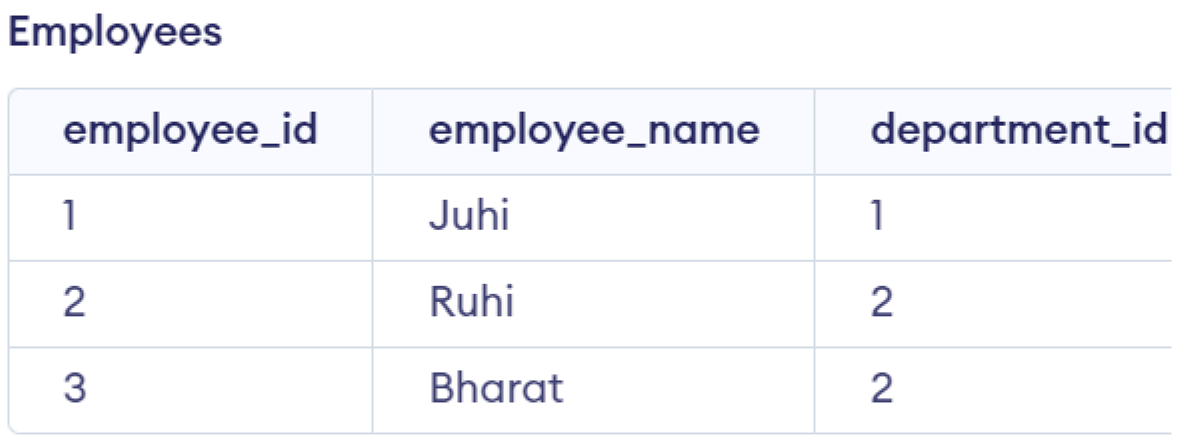
Join Operation:
When you have information about a single object or entity spread across multiple tables, you can use a join operation to combine this information into a single table. Join operations work by matching the data in a specific column between two or more tables and then combining the rows from these tables into a new table. Different types of join operations determine how data is matched and combined. You can retrieve a piece of complete information about an object or entity using join operations from multiple tables.

Example:

```
CREATE TABLE employees (
        employee_id INT,
        employee_name VARCHAR(50),
        department_id INT
);

INSERT INTO employees (employee_id, employee_name, department_id)
VALUES
        (1, 'Juhi', 1),
        (2, 'Ruhi', 2),
        (3, 'Bharat', 2);

CREATE TABLE departments (
        department_id INT,
        department_name VARCHAR(50)
);

INSERT INTO departments (department_id, department_name)
VALUES
        (1, 'Sales'),
        (2, 'Marketing');
```


Departments

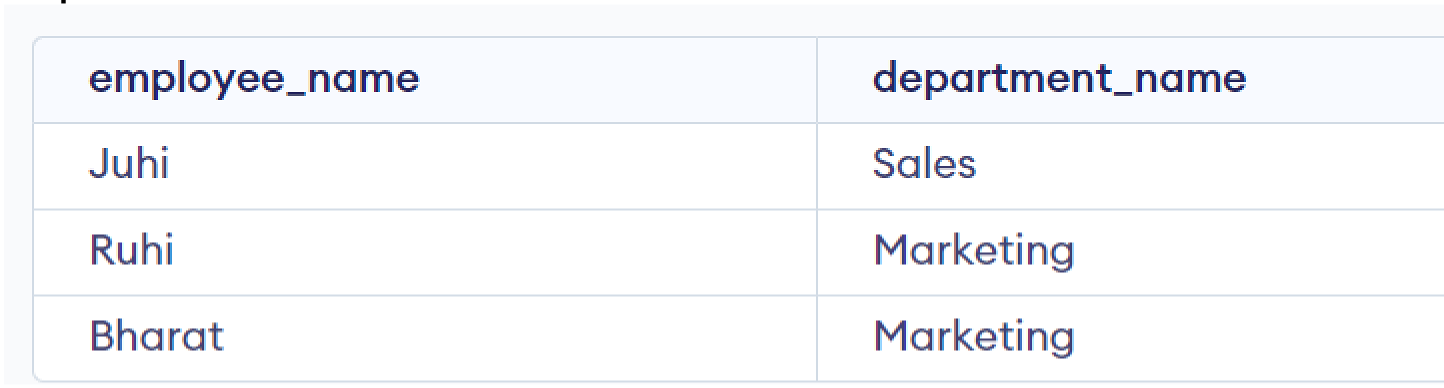
department_id	department_name
1	Sales
2	Marketing


Employees

employee_id	employee_name	department_id
1	Juhi	1
2	Ruhi	2
3	Bharat	2

```
SELECT employees.employee_name, departments.department_name
FROM employees
INNER JOIN departments
ON employees.department_id = departments.department_id;
```

Output:



employee_name	department_name
Juhi	Sales
Ruhi	Marketing
Bharat	Marketing

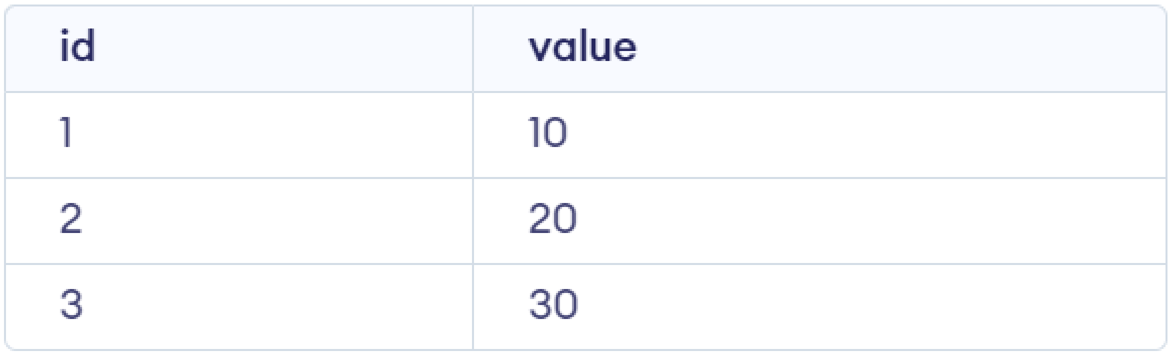
38. What is a Non-Equi Join?

A non-equi join is a type of join operation in SQL where the join condition is based on a comparison operator other than equality, such as '>' (greater than), '>=' (greater than or equal to), '<' (less than), '<=' (less than or equal to), or '<>' (not equal to).

Example:

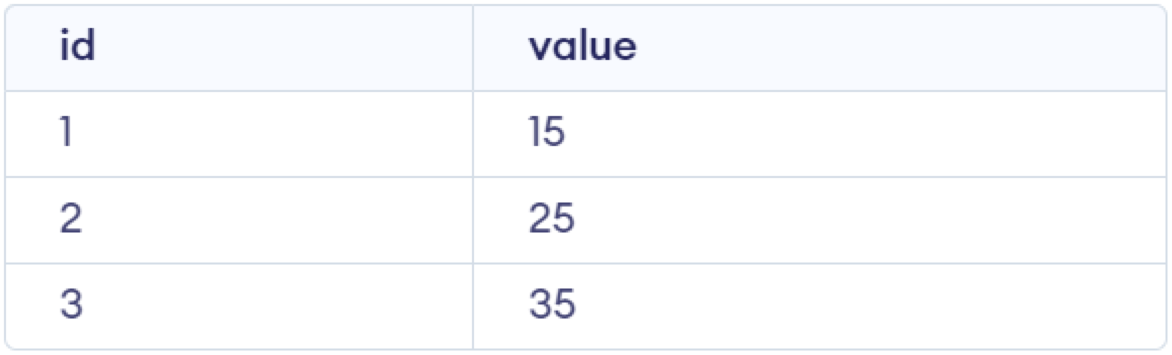
```
CREATE TABLE table1 (
        id INT,
        value INT
);

INSERT INTO table1 (id, value) VALUES (1, 10);
INSERT INTO table1 (id, value) VALUES (2, 20);
INSERT INTO table1 (id, value) VALUES (3, 30);

CREATE TABLE table2 (
        id INT,
        value INT
);

INSERT INTO table2 (id, value) VALUES (1, 15);
INSERT INTO table2 (id, value) VALUES (2, 25);
INSERT INTO table2 (id, value) VALUES (3, 35);
```

Table1



id	value
1	10
2	20
3	30

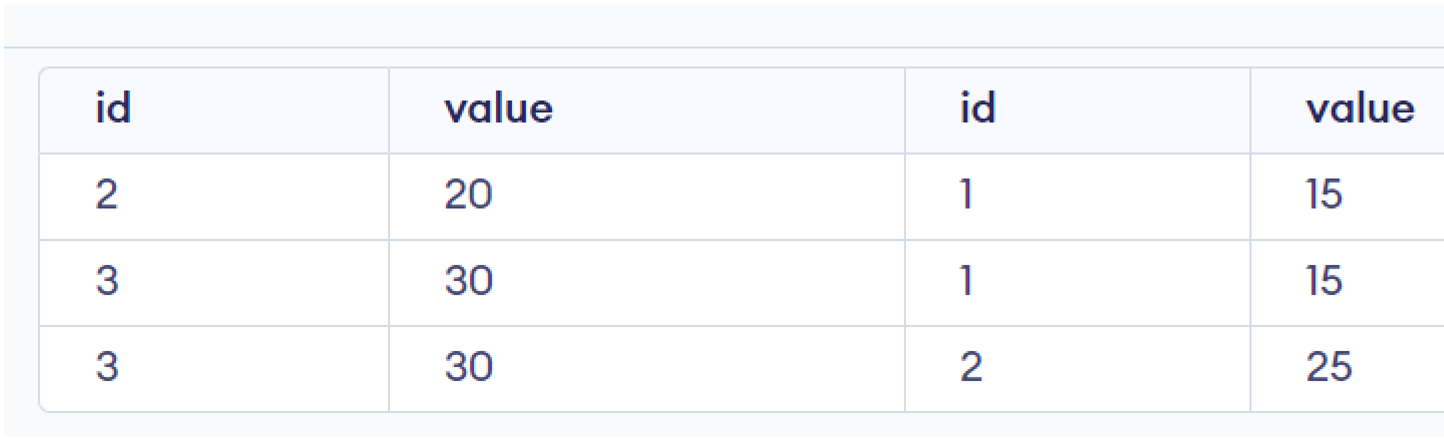
Table2



id	value
1	15
2	25
3	35

```
SELECT *
FROM table1
JOIN table2
ON table1.value > table2.value;
```

Output:



id	value	id	value
2	20	1	15
3	30	1	15
3	30	2	25

As you can see, this query returns all possible combinations of rows where the value in table1 is greater than the corresponding value in table2.

39. What are OLAP and OLTP?

OLAP(Online analytical processing) and OLTP(Online Transaction Processing) are two different types of database systems that are used for different purposes in the data processing. OLTP systems are mainly used for recording and processing transactions in real-time. These transactions are usually brief and involve updating, inserting, or deleting data in the database. OLTP systems are built to handle a high volume of concurrent transactions while ensuring data consistency, accuracy, and availability.

In contrast, OLAP systems are used for analytical processing, which involves complex queries and data aggregation for decision-making and business intelligence. OLAP systems typically store a large amount of historical data and allow for sophisticated data analysis, such as trend analysis, forecasting, and data mining. OLAP systems are designed for quick query performance and data retrieval, even when handling large amounts of data.

To sum up, OLTP systems are primarily used for real-time transaction processing, while OLAP systems are used for complex analysis of historical data to support decision-making and business intelligence.

40. What is a Self Join in SQL?

A self-join in SQL occurs when a table is joined with itself. This is typically used when a relationship exists within the same table and you need to compare rows within that table. For instance, if you have an employee table where each employee has a manager, you can use a self-join to find all employees with the same manager.

A self-join uses table aliases to distinguish between the original table and the copy of the table:

```
SELECT A.employee_name, B.employee_name AS manager_name
FROM employees A
JOIN employees B ON A.manager_id = B.employee_id;
```

Here, the table employees is joined with itself, and we can see which employee is managed by whom. The aliases A and B help identify the same table being used in different contexts.

41. Explain the use of the COALESCE function in SQL.

The **COALESCE** function in SQL is used to return the first non-null value in a list of expressions. It evaluates each expression one by one and returns the first expression that is not NULL. If all expressions evaluate to NULL, the COALESCE function returns NULL.
The function is particularly useful when dealing with nullable columns in databases where you want to substitute a default value if a NULL is encountered. For instance, you may want to return a default message if a user's name is not available:

```
SELECT COALESCE(first_name, 'Unknown') AS display_name
FROM users;
```

In this example, if the first_name is NULL, the query will return 'Unknown'. The COALESCE function can accept multiple arguments, making it more versatile than ISNULL, which can only evaluate two arguments.

42. How do you delete duplicate rows in SQL?

To delete duplicate rows in SQL, you can use the **ROW_NUMBER()** function in a Common Table Expression (CTE) or subquery to assign unique row numbers to rows with duplicate values. Then, you can delete rows that have duplicate row numbers, keeping only one instance.
Here's a step-by-step approach using a CTE in SQL Server:

```
WITH CTE AS (
  SELECT column_name,
  ROW_NUMBER() OVER (PARTITION BY column_name ORDER BY column_name) AS ro
w_num
  FROM table_name
)
DELETE FROM CTE WHERE row_num > 1;
```

Explanation:

- The ROW_NUMBER() function assigns a unique number to each row within a partition (in this case, for each unique column_name).
- The PARTITION BY clause specifies the column that contains duplicate values, and the ORDER BY clause determines how the rows should be numbered within each partition.
- Rows where row_num > 1 are considered duplicates and are deleted.

In MySQL, you can achieve the same by using a DELETE JOIN:

```
DELETE t1 FROM table_name t1
JOIN table_name t2
ON t1.id > t2.id AND t1.column_name = t2.column_name;
```

This approach deletes rows from t1 where the value of column_name matches another row in t2 but with a larger id, ensuring only one unique row is left.

43. What is a CTE (Common Table Expression) in SQL?

A **Common Table Expression (CTE)** is a temporary result set in SQL that is defined using the WITH keyword and can be referenced within a SELECT, INSERT, UPDATE, or DELETE query. CTEs make queries easier to read and maintain, especially when working with complex joins, recursive queries, or hierarchical data.

A CTE is particularly useful for breaking down complicated queries into simpler steps or reusing a common subquery in multiple parts of the main query. For example:

```
WITH CTE AS (
  SELECT employee_id, manager_id, salary
  FROM employees
  WHERE salary > 50000
)
SELECT * FROM CTE WHERE manager_id IS NOT NULL;
```

Here, the CTE named CTE filters employees who earn more than $50,000. This result set is then queried in the main SELECT statement.
CTEs can also be recursive, meaning that the CTE can call itself to handle hierarchical data structures like organizational charts or tree-like data models.

44. Explain how to perform pagination in SQL.

Answer:
Pagination in SQL refers to the process of dividing large sets of data into smaller chunks or pages to improve performance and provide easier data navigation.
Pagination is commonly used in web applications to display data in a user-friendly way across multiple pages.
In SQL, you can perform pagination using the LIMIT and OFFSET clauses (in MySQL and PostgreSQL), or with ROW_NUMBER() in SQL Server.
MySQL/PostgreSQL Example:

```
SELECT * FROM table_name
ORDER BY column_name
LIMIT 10 OFFSET 20;
```

Explanation:
- LIMIT 10 specifies the number of rows to return (10 rows per page).
- OFFSET 20 specifies the starting point for fetching records (skips the first 20 rows, i.e., starts from the 21st row).

SQL Server Example:

```
SELECT * FROM (
  SELECT *, ROW_NUMBER() OVER (ORDER BY column_name) AS row_num
  FROM table_name
) AS T
WHERE row_num BETWEEN 21 AND 30;
```

Explanation:
- ROW_NUMBER() assigns a unique row number to each row based on the specified ordering.
- The outer query selects rows where row_num falls within the specified range (in this case, rows 21 to 30).

Pagination is essential for handling large datasets and improving query performance, especially in applications where users need to navigate through many records.

45. How do you handle NULL values in SQL?

Handling NULL values in SQL is crucial because NULL represents missing, undefined, or unknown data. Operations involving NULL values can lead to unexpected results if not handled properly.
Here are a few common methods to handle NULL values in SQL:
IS NULL / IS NOT NULL: You can use the IS NULL or IS NOT NULL operators to filter records that have NULL values.

```
SELECT * FROM employees WHERE department IS NULL;
```

COALESCE Function: The COALESCE() function returns the first non-NULL value in a list of expressions.

```
SELECT COALESCE(phone_number, 'Not Available') FROM contacts;
```

IFNULL() or ISNULL(): These functions can be used to replace NULL values with a specified value.

```
SELECT ISNULL(salary, 0) FROM employees;
```

NULL-safe Comparisons: Comparing NULL values with the equality (=) operator will always return FALSE. Use IS NULL or IS NOT NULL to safely check for NULL values in conditions.
Handling NULL values ensures that your queries are more robust and return meaningful results, especially when performing calculations or aggregations.

46. What is the difference between IN and EXISTS in SQL?

Both IN and EXISTS are used in SQL to filter data based on the results of a subquery, but they differ in terms of execution and performance.
IN is used to compare a column to a set of values or the result of a subquery, and it returns TRUE if the column value matches any value in the list.

```
SELECT * FROM employees WHERE department_id IN (SELECT id FROM departments);
```

EXISTS is used to check whether a subquery returns any rows. It returns TRUE if the subquery returns at least one row.

```
SELECT * FROM employees WHERE EXISTS (SELECT 1 FROM departments WHERE
departments.id = employees.department_id);
```

Differences:

- **Performance:** EXISTS is often faster than IN for large datasets because EXISTS stops executing as soon as it finds a match, whereas IN checks every value in the subquery result.
- **Data Handling:** IN compares values, whereas EXISTS checks for the existence of rows in the subquery.

Use EXISTS when the subquery involves checking for the existence of data, and use IN when dealing with a small set of specific values.

47. How can you improve the performance of SQL queries?

Improving the performance of SQL queries is critical for optimizing database operations. Here are several techniques to enhance query performance:

Use Indexes: Indexing key columns speeds up query execution by reducing the amount of data the database engine needs to scan. However, avoid over-indexing as it can slow down insert, update, and delete operations.
Optimize Joins: Use the most efficient join type for your query (INNER JOIN, LEFT JOIN, etc.). Ensure that join conditions are indexed to avoid full table scans.
Avoid SELECT *: Instead of selecting all columns, specify only the columns you need. This reduces the amount of data transferred and processed by the database.

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

Use WHERE Clauses Effectively: Ensure that filters in WHERE clauses use indexed columns. Avoid applying functions directly to columns in the WHERE clause as this can prevent the use of indexes.

```
SELECT * FROM orders WHERE order_date >= '2023-01-01';
```

Limit Results with LIMIT or TOP: When querying large tables, use LIMIT or TOP to fetch only the required number of rows, especially in paginated queries.
Use Query Caching: In databases that support caching, enable query caching for frequently executed queries to avoid running the same query multiple times.
Analyze Execution Plans: Use the EXPLAIN or EXPLAIN ANALYZE command to review the query execution plan and identify performance bottlenecks.
By applying these techniques, you can significantly reduce query execution time and improve overall database performance.

48. What is the difference between RANK() and DENSE_RANK() in SQL?

Both RANK() and DENSE_RANK() are window functions in SQL that assign ranks to rows within a partition based on a specified ordering. However, they handle ties (rows with the same rank) differently:

RANK():

Assigns the same rank to tied rows, but the rank of the next row is incremented by the number of tied rows. In other words, there can be gaps in the ranks.
Example:

```
Row 1:  RANK = 1
Row 2:  RANK = 2
Row 3:  RANK = 2  (Tie)
Row 4:  RANK = 4
```

DENSE_RANK():

Assigns the same rank to tied rows but ensures the next rank is consecutive (no gaps).
Example:

```
Row 1:  DENSE_RANK = 1
Row 2:  DENSE_RANK = 2
Row 3:  DENSE_RANK = 2  (Tie)
Row 4:  DENSE_RANK = 3
Row 1:  RANK = 1
Row 2:  RANK = 2
Row 3:  RANK = 2  (Tie)
Row 4:  RANK = 4
```

Both functions are useful when ranking rows based on some criteria, but DENSE_RANK() is typically used when you want continuous ranking without gaps.

49. What is a View in SQL, and why is it used?

A **View** in SQL is a virtual table that is the result of a pre-defined SQL query. It doesn't store data physically but provides a way to present data from one or more tables in a structured format. Views are primarily used to simplify complex queries, enforce security by restricting access to specific data, and provide a layer of abstraction to hide the complexity of the underlying table structures.

For example, you can create a view to display only the relevant columns and rows from a table:

```
CREATE VIEW employee_view AS
SELECT employee_name, department_name
FROM employees
JOIN departments ON employees.department_id = departments.id;
```

Benefits of using views:

- **Simplified Querying:** A view allows users to query complex joins or aggregations as if they were simple tables.
- **Security:** Views can restrict access to sensitive columns or rows, ensuring users see only what is necessary.
- **Data Abstraction:** Views hide the underlying table structure and any changes to it, simplifying data presentation.

50. What are Aggregate Functions in SQL? Provide examples.

Aggregate functions in SQL perform a calculation on a set of values and return a single value. They are often used with GROUP BY to summarize data. Common aggregate functions include:

COUNT(): Returns the number of rows in a result set.

```
SELECT COUNT(*) FROM employees;
```

SUM(): Returns the sum of numeric values in a column.

```
SELECT SUM(salary) FROM employees;
```

AVG(): Returns the average of numeric values in a column.

```
SELECT AVG(salary) FROM employees;
```

MAX(): Returns the maximum value in a column.

```
SELECT MAX(salary) FROM employees;
```

MIN(): Returns the minimum value in a column.

```
SELECT MIN(salary) FROM employees;
```

Aggregate functions are essential for reporting and analyzing data, such as calculating totals, averages, and counts across large datasets. They can be combined with GROUP BY to calculate aggregated values for each group of rows.

Advanced SQL Interview Questions and Answers

51. What is a CTE (Common Table Expression) in SQL?

A **CTE (Common Table Expression)** is a temporary result set that can be referred to within a SELECT, INSERT, UPDATE, or DELETE statement. It is defined using the WITH clause and provides better readability for complex queries.
Example of CTE:

```
WITH EmployeeCTE AS (
    SELECT employee_id, first_name, salary
    FROM employees
    WHERE salary > 50000
)
SELECT * FROM EmployeeCTE;
```

CTEs improve query structure, making it easier to break down complex operations.

52. How does the MERGE statement work in SQL?

The **MERGE** statement in SQL allows you to perform INSERT, UPDATE, or DELETE operations in a single statement based on conditions. It is typically used for merging records from a source table into a target table.
Example:

```
MERGE INTO target_table AS T
USING source_table AS S
ON T.id = S.id
WHEN MATCHED THEN
    UPDATE SET T.name = S.name
WHEN NOT MATCHED THEN
    INSERT (id, name) VALUES (S.id, S.name);
```

This simplifies operations that would otherwise require multiple separate SQL statements.

53. What are Window Functions in SQL?

Window functions perform calculations across a set of table rows related to the current row. Unlike aggregate functions, they do not group the result into a single row but keep the row structure intact.
Example of ROW_NUMBER() as a window function:

```
SELECT employee_name, salary, ROW_NUMBER() OVER (PARTITION BY department OR
DER BY salary DESC) AS rank
FROM employees;
```

Window functions are often used in ranking, aggregating, and calculating running totals without affecting the row-level granularity of the result.

54. What is the difference between ROW_NUMBER(), RANK(), and DENSE_RANK() in SQL?

These are all **ranking window functions**, but they behave differently in handling ties:

- **ROW_NUMBER()**: Assigns a unique number to each row, regardless of ties.
- **RANK()**: Assigns the same rank to tied rows but leaves a gap in the ranking.
- **DENSE_RANK()**: Assigns the same rank to tied rows but does not leave any gaps.

Example:

```
SELECT employee_name, salary,
ROW_NUMBER() OVER (ORDER BY salary DESC) AS row_num,
RANK() OVER (ORDER BY salary DESC) AS rank,
DENSE_RANK() OVER (ORDER BY salary DESC) AS dense_rank
FROM employees;
```

55. Explain Recursive CTE in SQL.

A **Recursive CTE** allows a CTE to reference itself. This is useful for hierarchical or tree-like data structures, such as organizational charts or recursive relationships.

Example:

```
WITH RecursiveCTE (employee_id, manager_id, level) AS (
    SELECT employee_id, manager_id, 1
    FROM employees
    WHERE manager_id IS NULL
    UNION ALL
    SELECT e.employee_id, e.manager_id, level + 1
    FROM employees e
    INNER JOIN RecursiveCTE r ON e.manager_id = r.employee_id
)
SELECT * FROM RecursiveCTE;
```

This CTE recursively retrieves hierarchical data, such as employees reporting to their managers.

56. What is the difference between UNION and UNION ALL?

- **UNION**: Combines the result sets of two or more SELECT statements but removes duplicates.
- **UNION ALL**: Combines the result sets of two or more SELECT statements without removing duplicates.

Example:

```
SELECT name FROM customers
UNION
SELECT name FROM suppliers;
```

UNION is slower due to the extra step of removing duplicates, while UNION ALL is faster because it includes all rows.

57. How do you optimize a SQL query with GROUP BY?

To optimize a GROUP BY query:

1. **Index the columns** used in the GROUP BY and WHERE clauses.
2. Use **aggregated columns** selectively.
3. Avoid using functions on columns in the GROUP BY clause.
4. If possible, filter data before using GROUP BY.

Example:

```
SELECT department, AVG(salary)
FROM employees
WHERE department IS NOT NULL
GROUP BY department;
```

Indexes on department improve performance by allowing the query to access pre-sorted data.

58. What is a Cross Join in SQL?

A **Cross Join** returns the Cartesian product of two tables. This means every row from the first table is combined with every row from the second table.

```
SELECT *
FROM products
CROSS JOIN categories;
```

If the first table has 3 rows and the second has 4 rows, the result will contain 12 rows (3x4).

59. What is a Partitioned Table in SQL?

A **Partitioned Table** splits a large table into smaller, more manageable pieces while maintaining a logical single table view. It improves query performance and simplifies data management.

```
CREATE TABLE orders (
    order_id INT,
    order_date DATE,
    amount DECIMAL(10, 2)
)
PARTITION BY RANGE (YEAR(order_date)) (
    PARTITION p2019 VALUES LESS THAN (2020),
    PARTITION p2020 VALUES LESS THAN (2021)
);
```

Partitioning makes it easier to query large datasets by accessing only relevant partitions.

60. How do you handle NULL values in SQL joins?

To handle NULL values in joins, you can:

- Use LEFT JOIN or RIGHT JOIN to include rows with NULL values from one table.
- Use COALESCE() or ISNULL() to replace NULL values with a default value in the result set.

Example:

```
SELECT e.employee_name, d.department_name
FROM employees e
LEFT JOIN departments d ON e.department_id = d.department_id;
```

Here, LEFT JOIN includes employees with NULL department IDs in the result.

61. What is an Index in SQL, and how does it improve performance?

An **Index** is a data structure that improves the speed of data retrieval operations on a table. Indexes are created on one or more columns of a table and allow the database to locate data without scanning the entire table.

Example:

```
CREATE INDEX idx_employee_name ON employees(employee_name);
```

Indexes improve the performance of SELECT queries but may slow down INSERT, UPDATE, and DELETE operations due to the overhead of maintaining the index.

62. What is a Covering Index?

A **Covering Index** is an index that contains all the columns needed to satisfy a query. If a query can be executed using only the index, without accessing the table, it is said to be "covered" by the index.

Example:

```
CREATE INDEX idx_covering ON employees (first_name, last_name, salary);
```

Here, the index covers queries that select only first_name, last_name, and salary from the employees table.

63. What is the difference between HAVING and WHERE in SQL?

- **WHERE**: Filters rows before aggregation. It cannot be used with aggregate functions like COUNT(), SUM(), etc.
- **HAVING**: Filters rows after aggregation. It is typically used with GROUP BY to filter aggregated data.

Example:

```
SELECT department, COUNT(*)
FROM employees
GROUP BY department
HAVING COUNT(*) > 10;
```

HAVING allows you to filter results based on the aggregate COUNT() function, whereas WHERE filters individual rows before the GROUP BY clause.

64. Explain the concept of Transaction Isolation Levels.

Transaction isolation levels determine how and when the changes made by one transaction become visible to other transactions. The SQL standard defines four levels of isolation:

1. **Read Uncommitted**: Lowest isolation level; allows dirty reads (reads uncommitted data).

2. **Read Committed**: Prevents dirty reads, but non-repeatable reads can still occur.

3. **Repeatable Read**: Prevents dirty and non-repeatable reads, but phantom reads can occur.

4. **Serializable**: Highest isolation level; prevents all types of inconsistencies, including phantom reads.

The higher the isolation level, the more consistent the data but at the cost of performance due to locking mechanisms.

65. What is the purpose of a WITH clause in SQL?

The **WITH** clause, also known as **CTE (Common Table Expression)**, is used to define a temporary result set that can be referenced within a SELECT, INSERT, UPDATE, or DELETE statement.

Example:
```
WITH EmployeeCTE AS (
  SELECT employee_id, first_name, salary
  FROM employees
)
SELECT * FROM EmployeeCTE WHERE salary > 50000;
```

The WITH clause improves query readability, especially for complex operations that involve subqueries.

66. What is a Composite Index in SQL?

A **Composite Index** is an index that is created on two or more columns of a table. It improves the performance of queries that filter data based on those multiple columns.

Example:
```
CREATE INDEX idx_emp_name_salary ON employees (first_name, last_name, salary);
```

This index will optimize queries that search or sort based on the combination of first_name, last_name, and salary. However, the order of columns in a composite index matters, as it can affect performance if not used in the right sequence.

67. How can you optimize a SQL query that uses JOIN operations?

To optimize a SQL query with JOIN:

1. **Index the columns** used in the JOIN condition.

2. Use **INNER JOIN** instead of **LEFT JOIN** when you don't need null records.

3. **Minimize the dataset** using the WHERE clause before applying JOIN.

4. Consider **partitioning large tables** to improve the performance of join operations.

Example:
```
SELECT e.first_name, d.department_name
FROM employees e
INNER JOIN departments d ON e.department_id = d.department_id
WHERE e.salary > 50000;
```

Indexes on employee_id and department_id will improve query performance.

68. What is a Trigger in SQL and how is it used?

A **Trigger** is a database object that automatically executes a specified SQL code in response to certain events, such as INSERT, UPDATE, or DELETE. Triggers help enforce data integrity and business rules.

Example:
```
CREATE TRIGGER salary_update_trigger
AFTER UPDATE ON employees
FOR EACH ROW
BEGIN
  IF NEW.salary < OLD.salary THEN
     SIGNAL SQLSTATE '45000' SET MESSAGE_TEXT = 'Salary cannot be reduced!';
  END IF;
```

```
END;
```

This trigger ensures that an employee's salary cannot be reduced during an update.

69. What are Materialized Views, and how do they differ from regular Views?

A **Materialized View** is a database object that stores the result of a query physically. Unlike a regular view, which is a virtual table that is generated dynamically upon query execution, a materialized view stores data to improve performance, especially for complex queries.

Example:

```
CREATE MATERIALIZED VIEW emp_dept_view AS
SELECT e.first_name, d.department_name
FROM employees e
JOIN departments d ON e.department_id = d.department_id;
```

Materialized views are useful for improving performance but require periodic refreshing to keep the data current.

70. What is the difference between EXISTS and IN in SQL?

Both **EXISTS** and **IN** are used to filter data based on subqueries, but they operate differently:

- **EXISTS**: Checks if the subquery returns any rows. It is efficient when the subquery result set is large.
- **IN**: Compares values from the outer query with a list of values returned by the subquery. It performs better when the subquery returns a smaller result set.

Example:

```
-- Using EXISTS
SELECT e.first_name
FROM employees e
WHERE EXISTS (SELECT 1 FROM departments d WHERE e.department_id = d.department_id);

-- Using IN
SELECT e.first_name
FROM employees e
WHERE e.department_id IN (SELECT department_id FROM departments);
```

71. What is Database Normalization and why is it important?

Database Normalization is the process of organizing a database to reduce redundancy and improve data integrity. It involves dividing large tables into smaller, related tables and defining relationships between them. The key goals of normalization are:

1. Eliminate redundancy.
2. Ensure data consistency.
3. Facilitate easier maintenance.

The main normal forms include:

- **1NF**: Ensures that each column contains atomic values.
- **2NF**: Requires 1NF compliance and removes partial dependencies.
- **3NF**: Requires 2NF compliance and eliminates transitive dependencies.

Normalization optimizes database structure but may introduce performance issues with excessive joins.

72. What are Stored Procedures and why are they useful?

A **Stored Procedure** is a compiled group of SQL statements that can be executed as a single unit. Stored procedures are useful for:

1. **Code reusability**.
2. **Improved performance**, as they are precompiled.
3. **Security** by controlling access to data.

Example:

```
CREATE PROCEDURE UpdateSalary(IN emp_id INT, IN new_salary DECIMAL)
BEGIN
   UPDATE employees SET salary = new_salary WHERE employee_id = emp_id;
END;
```

Stored procedures can accept input parameters and return output values, making them a powerful tool for automating tasks in SQL.

73. Explain the concept of Database Denormalization.

Denormalization is the process of combining tables or adding redundant data to a database to improve query performance. While normalization reduces redundancy, denormalization may reintroduce it to reduce the complexity of joins and speed up read queries.

Example: Instead of keeping employee and department data in separate tables, denormalization might store department information directly within the employee table.

Denormalization trades data redundancy for query performance, particularly in systems where read performance is more critical than storage efficiency.

74. What is the difference between Clustered and Non-Clustered Indexes?

- **Clustered Index**: Determines the physical order of data in a table. A table can only have one clustered index, and the data is stored based on this index.
- **Non-Clustered Index**: Does not affect the physical order of the data. A table can have multiple non-clustered indexes, and these indexes contain pointers to the actual data.

Example:

```
CREATE CLUSTERED INDEX idx_employee_id ON employees(employee_id);
CREATE NONCLUSTERED INDEX idx_employee_name ON employees(first_name, last_name);
```

Clustered indexes improve the performance of range queries, while non-clustered indexes optimize individual lookups.

75. How do you handle Deadlocks in SQL?

A **deadlock** occurs when two or more transactions hold locks on resources and each is waiting for the other to release the lock, causing a cycle. To handle deadlocks:

1. **Minimize locking time** by keeping transactions short.
2. **Use consistent locking order** in your application.
3. **Set proper isolation levels** to avoid unnecessary locking.

SQL Server automatically detects deadlocks and resolves them by rolling back one of the transactions. You can also manually resolve deadlocks by catching the error and retrying the transaction.

76. What is the purpose of the EXPLAIN command in SQL?

The **EXPLAIN** command is used to analyze and display the execution plan of a SQL query. It shows how the query optimizer plans to execute the query, including details like table scans, index usage, join operations, and cost estimates.
Example:

```
EXPLAIN SELECT * FROM employees WHERE salary > 50000;
```

By reviewing the execution plan, you can identify performance bottlenecks, such as full table scans, and take steps to optimize the query.

77. What are SQL Subqueries, and how are they used?

A **subquery** is a query nested inside another query. Subqueries can be used to return results that are used by the outer query. Subqueries can appear in SELECT, FROM, WHERE, or HAVING clauses.
Example:

```
SELECT first_name
FROM employees
WHERE salary > (SELECT AVG(salary) FROM employees);
```

This query returns employees whose salary is higher than the average salary, which is calculated by the subquery.

78. What are SQL Transactions and their properties?

A **Transaction** in SQL is a sequence of operations performed as a single logical unit. It ensures data integrity through **ACID properties**:

1. **Atomicity**: Ensures all operations in a transaction are completed or none are.
2. **Consistency**: Guarantees that the database remains in a consistent state after the transaction.
3. **Isolation**: Prevents concurrent transactions from interfering with each other.
4. **Durability**: Ensures that once a transaction is committed, it remains so, even in the event of a system failure.

Example:

```
BEGIN TRANSACTION;
UPDATE employees SET salary = salary * 1.1 WHERE department_id = 1;
COMMIT;
```

If any part of the transaction fails, you can use ROLLBACK to revert all changes.

79. How do you create and use a Pivot Table in SQL?

A **Pivot Table** in SQL allows you to transform data from rows into columns. This is useful for generating cross-tab reports.
Example:

```
SELECT department,
   SUM(CASE WHEN gender = 'Male' THEN 1 ELSE 0 END) AS male_count,
   SUM(CASE WHEN gender = 'Female' THEN 1 ELSE 0 END) AS female_count
FROM employees
GROUP BY department;
```

This query counts the number of males and females in each department, pivoting the gender data into separate columns.

80. What is the difference between DELETE and TRUNCATE in SQL?

- **DELETE**: Removes rows from a table one by one, and each row deletion is logged. It can be rolled back using a transaction.
- **TRUNCATE**: Removes all rows from a table quickly by deallocating the data pages. It is faster but cannot be rolled back in most databases.

Example:

```
DELETE FROM employees WHERE employee_id = 1001;
TRUNCATE TABLE employees;
```

DELETE is more flexible, while TRUNCATE is faster for large datasets.

PostgreSQL Interview Questions

81. What is PostgreSQL?

PostgreSQL is an open-source, object-relational database management system (ORDBMS) that emphasizes extensibility and compliance with SQL standards. It supports both SQL and JSON for relational and non-relational queries. PostgreSQL is widely known for its robustness, performance, and advanced features like complex queries, foreign keys, triggers, updatable views, and transaction integrity.

82. What is the difference between PostgreSQL and MySQL?

- **PostgreSQL** is an object-relational database management system (ORDBMS), whereas **MySQL** is a purely relational database management system (RDBMS).

- PostgreSQL supports advanced features like custom data types, table inheritance, and function overloading, making it highly extensible.

- MySQL has a simpler system architecture and is more focused on read-heavy applications, while PostgreSQL is designed for complex, write-heavy operations.

- PostgreSQL follows SQL standards more strictly than MySQL.

83. How do you create a new database in PostgreSQL?

To create a new database in PostgreSQL, you use the CREATE DATABASE command. For example:

```
CREATE DATABASE testdb;
```

This command will create a new database named testdb. You can connect to this database using the \c testdb command in the PostgreSQL command-line interface.

84. What is a CTE (Common Table Expression) in PostgreSQL?

A **Common Table Expression (CTE)** in PostgreSQL is a temporary result set defined within a SQL query. It is typically used to make queries more readable by breaking them into smaller parts. CTEs are created using the WITH clause. Example:

```
WITH sales_summary AS (
   SELECT department, SUM(sales) AS total_sales
   FROM sales
   GROUP BY department
)
SELECT * FROM sales_summary WHERE total_sales > 10000;
```

85. How does PostgreSQL handle indexing?

PostgreSQL supports various types of indexes, including **B-tree**, **Hash**, **GIN** (Generalized Inverted Index), and **GiST** (Generalized Search Tree). Indexes in PostgreSQL are automatically used by the query planner to optimize query performance. They help in speeding up the retrieval of rows from a database at the cost of additional storage space and slower inserts/updates. Example of creating an index:

```
CREATE INDEX idx_employee_id ON employees(employee_id);
```

86. What are TOAST tables in PostgreSQL?

TOAST (The Oversized-Attribute Storage Technique) is a mechanism in PostgreSQL for storing large data, such as big text or binary objects. PostgreSQL stores data in tuples, and if a tuple exceeds a certain size limit (usually 8KB), TOAST will automatically compress and store it in an external storage space to avoid performance issues.

87. What are the advantages of using JSONB in PostgreSQL?

JSONB is a binary representation of JSON data in PostgreSQL. It is optimized for efficient storage and faster query performance when working with JSON data. The advantages of JSONB over plain JSON include:

- Faster access and retrieval of JSON data.
- JSONB is stored in a decomposed binary format, allowing efficient indexing.
- Supports operators like @>, <@, and ? for advanced querying of JSON data.

88. How do you perform replication in PostgreSQL?

PostgreSQL supports multiple replication methods, including **Streaming Replication**, **Logical Replication**, and **Synchronous Replication**.

- **Streaming Replication**: Sends real-time changes from the primary server to a standby server.
- **Logical Replication**: Allows selective data replication (row-level) between databases.
- **Synchronous Replication**: Ensures that each transaction is confirmed on both primary and standby servers before committing.

Example of setting up streaming replication:

- Configure the primary server to enable wal_level to replica.
- Set up a standby server and configure the recovery.conf file.

89. How can you perform full-text search in PostgreSQL?

PostgreSQL offers built-in support for **full-text search** through the tsvector and tsquery data types. Full-text search is used to search for words and phrases within text fields, enabling more complex querying options. Example:

```
SELECT * FROM documents
WHERE to_tsvector('english', content) @@ to_tsquery('PostgreSQL & Database');
```

This query searches for documents containing both "PostgreSQL" and "Database" in their content.

90. What is the VACUUM command in PostgreSQL?

The **VACUUM** command in PostgreSQL reclaims storage occupied by dead tuples that result from UPDATE or DELETE operations. Without periodic vacuuming, PostgreSQL tables would bloat, leading to reduced performance. Example:

```
VACUUM FULL employees;
```

This command reclaims storage and optimizes the performance of the employees table.

Ref: https://www.naukri.com/code360/library/sql-interview-questions