Data Analyst Interview Questions (0-3 Years) 17-19 lpa

SQL Questions

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1. Write a query to find duplicate rows in a table.

To detect duplicates, identify columns that should be unique and group by them.

Example:

```
SELECT column1, column2, COUNT(*) AS count
FROM your_table
GROUP BY column1, column2
HAVING COUNT(*) > 1;
```

Explanation:

- GROUP BY combines rows with the same values in the specified columns.
- HAVING COUNT(*) > 1 filters those combinations that occur more than once, indicating duplicates.

Tip: Add ROW_NUMBER() or RANK() with CTE to highlight or delete duplicates if needed.

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2. Explain the difference between INNER JOIN and OUTER JOIN with examples.

🔹 **INNER JOIN:**

Returns only **matching** records from both tables.

```
SELECT e.name, d.department_name
FROM employees e
INNER JOIN departments d ON e.department_id = d.department_id;
```

- Output: Only employees who belong to a department.

🔹 **LEFT OUTER JOIN:**

Returns **all records from the left** table, and matching records from the right table. If no match, NULL is returned.

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

- Output: All employees, with department info where available.

🔹 **RIGHT OUTER JOIN:**

Returns **all records from the right** table, and matching records from the left.

🔹 **FULL OUTER JOIN:**

Returns **all records from both tables**, matching where possible.

Key Difference:

- INNER JOIN = intersection (matched data only)
- OUTER JOIN = union + NULLs (matched + unmatched data)

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3. Write a query to fetch the second-highest salary from an employee table.

Option 1: Using DISTINCT, ORDER BY, and LIMIT (MySQL/PostgreSQL)

```
SELECT DISTINCT salary
FROM employees
ORDER BY salary DESC
LIMIT 1 OFFSET 1;
```

Option 2: Using subquery (Generic SQL)

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

Explanation:

- The subquery fetches the highest salary.
- The outer query finds the maximum salary **less than** the highest — giving the second-highest.

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4. How do you use GROUP BY and HAVING together? Provide an example.

Use GROUP BY to group data and HAVING to filter **aggregated results** (unlike WHERE, which filters raw rows).

```
SELECT department_id, COUNT(*) AS emp_count
FROM employees
GROUP BY department_id
HAVING COUNT(*) > 5;
```

Explanation:

- Groups employees by department.
- Filters groups where the count of employees is **more than 5**.

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5. Write a query to find employees earning more than their managers.

Assume the table employees has:
emp_id, name, salary, manager_id

```
SELECT e.name AS employee_name, e.salary, m.name AS manager_name, m.salary AS manager_salary
FROM employees e
JOIN employees m ON e.manager_id = m.emp_id
WHERE e.salary > m.salary;
```

Explanation:

- Self-join: matches employees (e) with their managers (m).
- Filters those where employee's salary > manager's salary.

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6. What is a window function in SQL? Provide examples of ROW_NUMBER and RANK.

🔹 **Definition:**

A **window function** performs calculations **across a set of table rows** related to the current row — without collapsing rows like GROUP BY.

Syntax:

```
FUNCTION_NAME() OVER (PARTITION BY column ORDER BY column)
```

🔸 **Example: ROW_NUMBER()**

Assigns a unique sequential number to each row **within a partition**.

```
SELECT name, department, salary,
    ROW_NUMBER() OVER (PARTITION BY department ORDER BY salary DESC) AS row_num
FROM employees;
```

- Each employee within the same department gets a row number based on salary rank (highest first).

🔸 **Example: RANK()**

Assigns **the same rank** to rows with **equal values**, but skips the next rank(s).

```
SELECT name, department, salary,
    RANK() OVER (PARTITION BY department ORDER BY salary DESC) AS rank_num
FROM employees;
```

- If 2 employees have the same salary, both get rank 1, and the next gets rank 3.

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7. Write a query to fetch the top 3 performing products based on sales.

Assume table sales_data has:
product_id, product_name, total_sales

```
SELECT product_id, product_name, total_sales
FROM sales_data
ORDER BY total_sales DESC
LIMIT 3;
```

Alternate using RANK() (if ties matter):

```
SELECT product_id, product_name, total_sales
FROM (
  SELECT *, RANK() OVER (ORDER BY total_sales DESC) AS rank_num
  FROM sales_data
) ranked_sales
WHERE rank_num <= 3;
```

8. Explain the difference between UNION and UNION ALL.

Feature	UNION	UNION ALL
Duplicates	Removes duplicates	Keeps all rows, including duplicates
Performance	Slower (because of sorting)	Faster (no de-duplication)
Use case	When you want distinct rows	When duplicates are meaningful

Example:

```
SELECT city FROM customers
UNION
SELECT city FROM vendors;
```

→ Returns a unique list of cities.

```
SELECT city FROM customers
UNION ALL
SELECT city FROM vendors;
```

→ Returns **all cities**, including duplicates.

9. How do you use a CASE statement in SQL? Provide an example.

🔹 **CASE lets you write conditional logic in SQL (similar to IF/ELSE).**

```
SELECT name, salary,
      CASE
        WHEN salary >= 100000 THEN 'High'
        WHEN salary >= 50000 THEN 'Medium'
        ELSE 'Low'
      END AS salary_category
FROM employees;
```

Explanation:

- Assigns a category based on salary value.
- Works inside SELECT, WHERE, ORDER BY, etc.

10. Write a query to calculate the cumulative sum of sales.

Assume table sales has:
order_date, product_id, sales_amount

```
SELECT order_date, product_id, sales_amount,
      SUM(sales_amount) OVER (PARTITION BY product_id ORDER BY order_date) AS
cumulative_sales
FROM sales;
```

Explanation:

- SUM(...) OVER (...) calculates a **running total** per product based on order date.
- PARTITION BY groups by product, and ORDER BY ensures the accumulation follows chronological order.

11. What is a CTE (Common Table Expression), and how is it used?

🔹 **Definition:**

A **CTE (Common Table Expression)** is a temporary, named result set that you can reference within a SQL query.
It improves readability and simplifies complex subqueries or recursive logic.

🔹 **Syntax:**

```
WITH cte_name AS (
  SELECT ...
)
SELECT * FROM cte_name;
```

🟩 **Example – Filter top-paid employees using CTE:**

```
WITH HighEarners AS (
  SELECT emp_id, name, salary
  FROM employees
  WHERE salary > 100000
)
SELECT * FROM HighEarners;
```

Benefits:

- Reusable and readable
- Allows recursion (e.g., hierarchical data)
- Avoids repeating subqueries

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12. Write a query to identify customers who have made transactions above $5,000 multiple times.

Assume transactions table has:
customer_id, transaction_amount

```
SELECT customer_id, COUNT(*) AS high_value_txns
FROM transactions
WHERE transaction_amount > 5000
GROUP BY customer_id
HAVING COUNT(*) > 1;
```

Explanation:

- Filters high-value transactions (> $5000).
- Groups them by customer.
- Returns customers who've done this **more than once**.

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13. Explain the difference between DELETE and TRUNCATE commands.

Feature	DELETE	TRUNCATE
Removes rows	Yes (can use WHERE condition)	Yes (removes all rows)
WHERE supported?	✅ Yes	❌ No
Logging	Logs each deleted row (slower)	Minimal logging (faster)
Rollback	✅ Can be rolled back (if within transaction)	✅ Can be rolled back (in some RDBMS)
Identity reset	❌ Retains identity	✅ Resets identity (in most DBs)
Use case	Partial deletion or audit trail needed	Full data wipe without audit needed

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14. How do you optimize SQL queries for better performance?

Here are **key SQL optimization techniques**:

🔹 **1. Use SELECT only required columns**

```
-- Bad
SELECT * FROM orders;

-- Good
SELECT order_id, customer_id FROM orders;
```

🔹 **2. Create proper indexes**

- Index frequently used columns in JOIN, WHERE, ORDER BY.

🔹 **3. Avoid functions on indexed columns**

```
-- Slower (cannot use index)
WHERE YEAR(order_date) = 2024

-- Better
WHERE order_date BETWEEN '2024-01-01' AND '2024-12-31'
```

🔹 **4. Use EXISTS instead of IN (for subqueries)**

```
-- Prefer EXISTS (better for large datasets)
SELECT name FROM customers c
WHERE EXISTS (
  SELECT 1 FROM orders o WHERE o.customer_id = c.customer_id
);
```

🔹 **5. Avoid unnecessary joins or nested subqueries**

🔹 **6. Use appropriate data types and avoid implicit conversions**

🔹 **7. Analyze execution plans (EXPLAIN or EXPLAIN ANALYZE)**

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15. Write a query to find all customers who have not made

any purchases in the last 6 months.

Assume:

- customers(customer_id, name)
- transactions(customer_id, transaction_date)

```
SELECT c.customer_id, c.name
FROM customers c
LEFT JOIN transactions t
  ON c.customer_id = t.customer_id
     AND t.transaction_date >= CURRENT_DATE - INTERVAL '6 months'
WHERE t.customer_id IS NULL;
```

Explanation:

- LEFT JOIN includes all customers.
- WHERE t.customer_id IS NULL ensures the customer had **no purchase in the last 6 months**.

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16. How do you handle NULL values in SQL? Provide examples.

🔹 **NULL represents missing or unknown data.**

🟩 **1. Using IS NULL / IS NOT NULL:**

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

🟩 **2. Replace NULL using COALESCE() or IFNULL() (MySQL):**

```
SELECT name, COALESCE(phone_number, 'Not Provided') AS contact
FROM customers;
```

🟩 **3. Handling NULLs in aggregation (e.g., AVG, SUM):**

- These functions **ignore NULLs by default**.

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

🟩 **4. Conditional checks:**

```
SELECT name,
       CASE
         WHEN salary IS NULL THEN 'Unknown'
         ELSE 'Known'
       END AS salary_status
FROM employees;
```

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17. Write a query to transpose rows into columns.

Assume a table sales with:
region, month, sales_amount
We want to **pivot month values** into columns.

🟩 **Using CASE:**

```
SELECT region,
       SUM(CASE WHEN month = 'Jan' THEN sales_amount ELSE 0 END) AS Jan,
       SUM(CASE WHEN month = 'Feb' THEN sales_amount ELSE 0 END) AS Feb,
       SUM(CASE WHEN month = 'Mar' THEN sales_amount ELSE 0 END) AS Mar
FROM          sales
GROUP BY region;
```

■ Using PIVOT (SQL Server or Oracle syntax):

```
SELECT region, [Jan], [Feb], [Mar]
FROM (
  SELECT region, month, sales_amount
  FROM sales
) AS src
PIVOT (
  SUM(sales_amount)
  FOR month IN ([Jan], [Feb], [Mar])
) AS p;
```

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18. Explain indexing and how it improves query performance.

◆ What is an index?

An **index** is a data structure that improves the speed of data retrieval operations on a database table at the cost of additional space and write-time performance.

◆ How indexing helps:

Feature	With Index	Without Index
Search performance	Fast (uses binary/tree search)	Slow (scans every row — full scan)
Used in	WHERE, JOIN, ORDER BY, GROUP BY	Inefficient for large datasets
Types	B-tree (default), Bitmap, Hash, etc.	-

■ Example:

```
-- Creating index
CREATE INDEX idx_customer_id ON transactions(customer_id);
```

- This helps queries like:

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

ı Important notes:

- Too many indexes can slow down INSERT/UPDATE.
- Avoid indexing columns with **low cardinality** (e.g., gender).
- Use **composite indexes** when querying multiple columns together.

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19. Write a query to fetch the maximum transaction amount for each customer.

Assume a transactions table:

Column	Description
customer_id	ID of the customer
transaction_id	Unique transaction ID
amount	Transaction amount

Query:

```
SELECT customer_id, MAX(amount) AS max_transaction
FROM transactions
GROUP BY customer_id;
```

Explanation:

- GROUP BY groups all transactions by customer.
- MAX(amount) returns the highest transaction for each group (customer).

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20. What is a self-join, and how is it used?

Definition:

A **self-join** is a regular join where a table is joined with itself.
It is useful when rows in a table are related to other rows in the same table.

Example Use Case – Employees and Managers:

Assume:

emp_id	name	manager_id
1	Alice	NULL
2	Bob	1
3	Carol	1
4	David	2

Here, manager_id refers to emp_id of another employee.

Query: Get employee names along with their manager names

```
SELECT e.name AS employee_name, m.name AS manager_name
FROM employees e
LEFT JOIN employees m
  ON e.manager_id = m.emp_id;
```

Explanation:

- e is an alias for employees (as employee).
- m is another alias for the same table (as manager).
- The join links an employee to their manager using manager_id = emp_id.

Data Analysis/Scenario-Based Questions

21. How would you design a database to store credit card

transaction data?

To store credit card transaction data, we need to **normalize** the structure while keeping it **scalable**, **secure**, and **query-efficient**.

Suggested Schema Design:

1. Customers Table

customer_id (PK), name, email, phone, address

2. Cards Table

card_id (PK), customer_id (FK), card_number (masked), card_type, status, issued_date

3. Merchants Table

merchant_id (PK), name, category, location

4. Transactions Table

transaction_id (PK), card_id (FK), merchant_id (FK),
transaction_date, amount, currency, status, location

Best Practices:

- Mask sensitive fields (like card numbers).
- Store card_number as encrypted or tokenized.
- Use partitioning on date fields for faster querying.
- Add indexes on card_id, merchant_id, transaction_date.

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22. Write a query to identify the most profitable regions based on transaction data.

Assume a transactions table:
(transaction_id, customer_id, amount, region, transaction_date)

Query to find top 3 profitable regions:

```
SELECT region, SUM(amount) AS total_revenue
FROM transactions
GROUP BY region
ORDER BY total_revenue DESC
LIMIT 3;
```

Explanation:

- Aggregates transaction amounts per region.
- Orders regions by total revenue.
- Retrieves top 3 using LIMIT.

Optional: You could also calculate profit by subtracting costs (if a cost column is present).

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23. How would you analyze customer churn using SQL?

Step-by-step SQL approach:

Step 1: Define churn

Let's say a churned customer is one who hasn't transacted in the **last 6 months**.

Step 2: Sample schema

- customers(customer_id, name, signup_date)
- transactions(customer_id, transaction_date, amount)

🔹 **Step 3: Query to identify churned customers**

```
SELECT c.customer_id, c.name
FROM customers c
LEFT JOIN transactions t
  ON c.customer_id = t.customer_id
     AND t.transaction_date >= CURRENT_DATE - INTERVAL '6 months'
WHERE t.transaction_id IS NULL;
```

🔹 **Step 4: Analyze churn metrics**

You could extend this analysis by calculating:

- Churn rate = (Churned Customers / Total Customers) * 100
- Monthly churn trend
- Compare churned vs. active customers in terms of average spend

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24. Explain the difference between OLAP and OLTP databases.

Feature	OLTP (Online Transaction Processing)	OLAP (Online Analytical Processing)
Purpose	Handles real-time transactional queries	Used for analytical/reporting queries
Operations	INSERT, UPDATE, DELETE	SELECT (aggregate, group, slice, dice)
Data Structure	Highly normalized (3NF)	De-normalized (star/snowflake schema)
Speed	Fast for read/write of single rows	Fast for complex analytical queries
Examples	Banking systems, e-commerce order processing	Business intelligence, dashboards, sales trends
Users	Clerks, DBAs	Analysts, Data Scientists
Backup/Recovery	Essential and frequent	Less frequent

🟩 In short:

- **OLTP** = operational, fast, real-time transactions.
- **OLAP** = analytical, slow-changing, historical data.

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25. How would you determine the Average Revenue Per User (ARPU) from transaction data?

🔹 **ARPU = Total Revenue / Total Number of Users**

🟩 **Assume a transactions table:**

(transaction_id, customer_id, amount, transaction_date)

🟩 **SQL Query:**

```
SELECT
  SUM(amount) * 1.0 / COUNT(DISTINCT customer_id) AS ARPU
```

FROM transactions;

🔍 **Explanation:**

- SUM(amount) gets total revenue.
- COUNT(DISTINCT customer_id) counts unique users.
- Multiply by 1.0 to ensure float division.

You can also compute monthly ARPU by grouping by month.

```
SELECT
  DATE_TRUNC('month', transaction_date) AS month,
  SUM(amount) * 1.0 / COUNT(DISTINCT customer_id) AS monthly_arpu
FROM transactions
GROUP BY month
ORDER BY month;
```

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26. Describe a scenario where you would use a LEFT JOIN instead of an INNER JOIN.

🟩 **Use LEFT JOIN when:**

You want **all records from the left table**, even if there's **no matching record** in the right table.

🔷 **Real-life Scenario:**

Question: List all customers and their transactions — even if they haven't made any.

🟩 **Query:**

```
SELECT c.customer_id, c.name, t.transaction_id, t.amount
FROM customers c
LEFT JOIN transactions t
  ON c.customer_id = t.customer_id;
```

🔄 **Why LEFT JOIN?**

- Shows **all customers**, including those with **no transactions** (returns NULLs for those).
- Using INNER JOIN would exclude customers with zero activity.

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27. Write a query to calculate YoY (Year-over-Year) growth for a set of transactions.

Assume a table named transactions with:
(customer_id, transaction_date, amount)

🟩 **Step 1: Extract year-wise revenue**

```
SELECT
  EXTRACT(YEAR FROM transaction_date) AS year,
  SUM(amount) AS total_revenue
FROM transactions
GROUP BY EXTRACT(YEAR FROM transaction_date);
```

🟩 **Step 2: Calculate YoY Growth using a CTE and Self-Join**

```
WITH yearly_revenue AS (
```

```
  SELECT
    EXTRACT(YEAR FROM transaction_date) AS year,
    SUM(amount) AS total_revenue
  FROM transactions
  GROUP BY EXTRACT(YEAR FROM transaction_date)
)
SELECT
  curr.year AS current_year,
  curr.total_revenue,
  prev.total_revenue AS previous_year_revenue,
  ROUND(((curr.total_revenue - prev.total_revenue) / prev.total_revenue) * 100, 2) AS
yoy_growth_percent
FROM yearly_revenue curr
LEFT JOIN yearly_revenue prev
  ON curr.year = prev.year + 1;
```

Explanation:

- Joins each year to its previous year.
- Computes YoY growth as a percentage.

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28. How would you implement fraud detection using transactional data?

Fraud detection typically involves pattern recognition, anomaly detection, and rule-based filtering.

Possible SQL-Based Checks:

Type	Rule
Unusual Amounts	Flag transactions > 3x average amount of that user
Rapid Repeats	Detect multiple transactions from same user within seconds
Location Mismatch	Transactions from different countries within a short time
Card Sharing	Same card used by different customers or IPs

Example Query – Unusual high amount per user:

```
WITH avg_txn AS (
  SELECT customer_id, AVG(amount) AS avg_amount
  FROM transactions
  GROUP BY customer_id
)
SELECT t.*
FROM transactions t
JOIN avg_txn a
  ON t.customer_id = a.customer_id
WHERE t.amount > 3 * a.avg_amount;
```

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29. Write a query to find customers who have used more than 2 credit cards for transactions in a given month.

Assume a transactions table:
(customer_id, card_id, transaction_date)

Query:

```
SELECT customer_id,
       TO_CHAR(transaction_date, 'YYYY-MM') AS txn_month,
       COUNT(DISTINCT card_id) AS cards_used
FROM transactions
GROUP BY customer_id, TO_CHAR(transaction_date, 'YYYY-MM')
HAVING COUNT(DISTINCT card_id) > 2;
```

Explanation:

- Groups by customer_id and month.
- Counts distinct card_id used.
- Filters where more than 2 cards were used in a month.

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30. How would you approach a business problem where you need to analyze the spending patterns of premium customers?

Step-by-Step Structured Approach:

Step 1: Understand the Objective

- Clarify with stakeholders what **"spending pattern"** means.
  - Is it frequency, amount, category, channel, or timing?
- Define **"premium customer"**:
  - Based on credit score, card tier (e.g., Platinum, Centurion), monthly spend threshold, etc.

Step 2: Data Collection

- Gather relevant datasets:
  - Customer table (ID, tier, demographics)
  - Transactions table (amount, date, category, location)
  - Cards table (card_type, limits, activation)

Step 3: Data Cleaning & Preparation

- Handle missing values and outliers.
- Filter only **premium customers** using defined criteria.
- Enrich data (e.g., categorize merchant types or locations).

Step 4: Exploratory Data Analysis (EDA)

Use SQL/Python/Power BI to derive insights like:

Focus Area	Example Analysis
Spend Amount	Average monthly/yearly spend
Time Trends	Seasonality or weekly spending behavior
Categories	Where they spend most (Travel, Dining, Shopping)
Geography	City or region-wise behavior

Focus Area	Example Analysis
📈 Trends	Is their spend increasing/decreasing YoY?

🔹 Step 5: Segmentation

- Use clustering or thresholds to group premium customers into:
  - High spenders
  - Frequent spenders
  - Category loyalists (e.g., only travel)
- Identify anomalies or subgroups with unique patterns.

🔹 Step 6: Business Recommendations

- Personalize rewards or offers based on their dominant categories.
- Enhance retention strategies for segments showing decline.
- Promote premium card upgrades based on usage patterns.

🟩 Bonus: Sample SQL Query

Get top 3 spending categories of premium customers monthly:

```
SELECT customer_id,
       DATE_TRUNC('month', transaction_date) AS txn_month,
       category,
       SUM(amount) AS total_spend
FROM transactions
WHERE customer_id IN (
    SELECT customer_id FROM customers WHERE tier = 'Premium'
)
GROUP BY customer_id, txn_month, category
ORDER BY customer_id, txn_month, total_spend DESC;
```
