GROUP BY and Aggregation Functions in SQL: The Key to Data Summarization and Analysis

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GROUP BY and Aggregation Functions

In the world of data analysis, raw data is often too vast and scattered to derive meaningful insights directly. Whether you're analyzing customer transactions, tracking sales performance, or summarizing business metrics, the ability to group data and compute summaries is vital. This is where SQL's **GROUP BY clause** and **aggregation functions** come into play.

Imagine you're working with a dataset of thousands of sales records. How would you quickly find the total revenue generated by each region? Or determine the average price of products sold in each category? SQL provides a straightforward solution: **GROUP BY**, which helps you organize data into logical groups, and **aggregation functions**, which calculate meaningful summaries like totals, averages, counts, and more.

This guide will walk you through the fundamentals of **GROUP BY** and **aggregation functions**—their syntax, applications, and advanced use cases. With clear examples and relatable scenarios, you'll learn how to transform raw data into actionable insights, making your analyses faster, more precise, and impactful. By the end, you'll understand how to use these powerful SQL features and how they can make a difference in real-world decision-making.

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What is GROUP BY?

The GROUP BY clause groups rows that share the same value(s) in specified columns. Once grouped, you can apply aggregate functions to perform calculations for each group.

- **Why Use GROUP BY?**

  To analyze grouped data such as:

  - Total revenue by product category.
  - Average score by class.
  - Number of transactions by customer.

Common Aggregation Functions

Aggregation functions perform calculations on grouped data and return a single value for each group.

Function	Purpose
COUNT()	Counts rows in a group, including or excluding NULLs.
SUM()	Calculates the total of numeric values in a group.
AVG()	Returns the average of numeric values in a group.
MIN()	Returns the smallest value in a group.
MAX()	Returns the largest value in a group.
STRING_AGG()	Concatenates values from a group into a single string (available in modern SQL versions).

Syntax

Here's the syntax for the GROUP BY clause with aggregation functions:

```
SELECT column1, column2,
AGGREGATE_FUNCTION(column3)
FROM table_name
WHERE condition
GROUP BY column1, column2
HAVING condition;
```

Dataset for Examples

Table: Sales

SaleID	Region	Product	Quantity	Price	SaleDate
1	North	Laptop	10	500	2023-01-01
2	South	Desktop	5	300	2023-01-02
3	North	Laptop	15	500	2023-01-03
4	East	Smartphone	20	200	2023-01-04
5	West	Smartphone	25	200	2023-01-05
6	South	Laptop	5	500	2023-01-06

Examples of GROUP BY and Aggregation Functions

Example 1: COUNT()

Find the number of sales made in each region.

```sql
SELECT Region, COUNT(*) AS Sale_Count
FROM Sales
GROUP BY Region;
```

Explanation:

- Groups rows by the Region column.
- Counts the number of rows in each group.

Output:

Region	Sale_Count
North	2
South	2
East	1
West	1

Example 2: SUM()

Calculate the total quantity sold in each region.

```
SELECT Region, SUM(Quantity) AS Total_Quantity
FROM Sales
GROUP BY Region;
```

Explanation:

- Groups rows by Region.
- Computes the sum of the Quantity column for each region.

Output:

Region	Total_Quantity
North	25
South	10
East	20
West	25

Example 3: AVG()

Determine the average price of products sold in each region.

```
SELECT Region, AVG(Price) AS Avg_Price
FROM Sales
GROUP BY Region;
```

Output:

Region	Avg_Price
North	500
South	400
East	200
West	200

Example 4: MIN() and MAX()

Find the smallest and largest quantity sold for each product.

```
SELECT Product, MIN(Quantity) AS Min_Quantity,
MAX(Quantity) AS Max_Quantity
FROM Sales
GROUP BY Product;
```

Explanation:

- Groups rows by Product.
- Returns the minimum and maximum values of Quantity for each product.

Output:

Product	Min_Quantity	Max_Quantity
Laptop	5	15
Desktop	5	5
Smartphone	20	25

Example 5: Combining Aggregation Functions

Find the total revenue (Quantity * Price), average quantity, and the count of sales for each product.

```sql
SELECT Product,
       SUM(Quantity * Price) AS Total_Revenue,
       AVG(Quantity) AS Avg_Quantity,
       COUNT(*) AS Sale_Count
FROM Sales
GROUP BY Product;
```

Output:

Product	Total_Revenue	Avg_Quantity	Sale_Count
Laptop	15000	10	3
Desktop	1500	5	1
Smartphone	9000	22.5	2

Example 6: HAVING Clause

Filter groups based on aggregate values. Find regions where total quantity sold exceeds 20.

```sql
SELECT Region, SUM(Quantity) AS Total_Quantity
FROM Sales
GROUP BY Region
HAVING SUM(Quantity) > 20;
```

Output:

Region	Total_Quantity
North	25
West	25

Example 7: GROUP BY with Multiple Columns

Calculate total revenue for each region-product combination.

```sql
SELECT Region, Product, SUM(Quantity * Price) AS
Total_Revenue
FROM Sales
GROUP BY Region, Product;
```

Output:

Region	Product	Total_Revenue
North	Laptop	12500
South	Desktop	1500
South	Laptop	2500
East	Smartphone	4000
West	Smartphone	5000

6. Advanced Use Cases

Scenario 1: Percentage Contribution

Find each region's contribution to the total quantity sold.

```sql
SELECT Region,
       SUM(Quantity) AS Total_Quantity,
       SUM(Quantity) * 100.0 / (SELECT
SUM(Quantity) FROM Sales) AS
Percentage_Contribution
FROM Sales
GROUP BY Region;
```

Output:

Region	Total_Quantity	Percentage_Contribution
North	25	33.33
South	10	13.33
East	20	26.67
West	25	33.33

Scenario 2: Find Duplicate Records

Identify products with duplicate sales.

```sql
SELECT Product, COUNT(*) AS Sale_Count
FROM Sales
GROUP BY Product
HAVING COUNT(*) > 1;
```

Output:

Product	Sale_Count
Laptop	3
Smartphone	2

7. Key Takeaways

1. **GROUP BY with Aggregation**: Allows you to summarize data effectively.
2. **Use HAVING**: Filters groups based on conditions.
3. **Advanced Aggregations**: Combine multiple aggregations for richer insights.
4. **Multiple Columns**: Group by multiple columns for finer granularity.

Practice Questions

1. Write a query to find the average revenue per region.
2. Identify products with the highest total revenue in each region.
3. Find the total revenue and percentage contribution for each product category.