Week-8

Introduction to Database Systems

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Aggregate Functions
SUM, MIN, MAX
AVG, COUNT,DISTINCT
GROUP BY,

Relational Algebra

Introduction

- An aggregate function performs a calculation on a set of values of a column, and returns a single value

- Built-in aggregate functions

  COUNT, **SUM**, **MAX**, **MIN**, and **AVG**

- Functions can be used in the SELECT clause or in a HAVING clause

SUM, MAX, MIN, AVG

- Find the sum of the salaries of all employees, the maximum salary, the minimum salary, and the average salary.

```
SELECT SUM (Salary), MAX (Salary), MIN (Salary), AVG(Salary)
FROM  EMPLOYEE;
```

Sum (Salary)	Max(Salary)	Min (Salary)	Avg (Salary)
986550	55000	25000	55600

COUNT

Find the total number of employees.

```
SELECT count(ssn)
FROM EMPLOYEE;
```

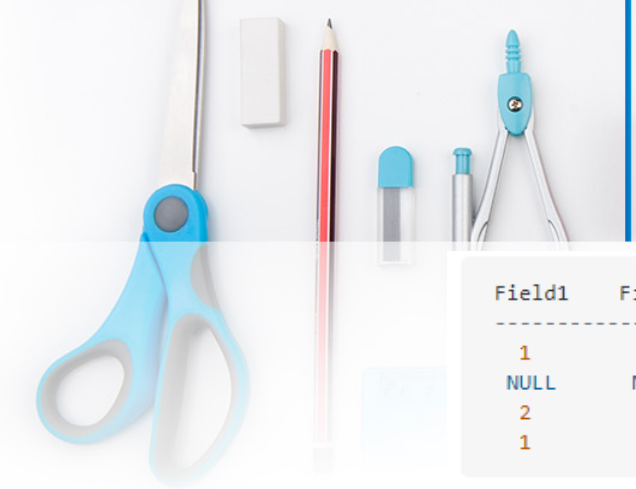
Count(ssn)
8

The above query will ignore nulls but not duplicates.

```
SELECT count(*)
FROM  EMPLOYEE;
```

Count(*)
10

The above query will not ignore nulls & duplicates. count(*) counts the rows.



How Count() handles null values?

```
Field1    Field2    Field3
---------------------------
  1         1         1
 NULL      NULL      NULL
  2         2         NULL
  1         3         1
```

Then

```
SELECT COUNT(*), COUNT(Field1), COUNT(Field2), COUNT(DISTINCT Field3)
FROM Table1
```

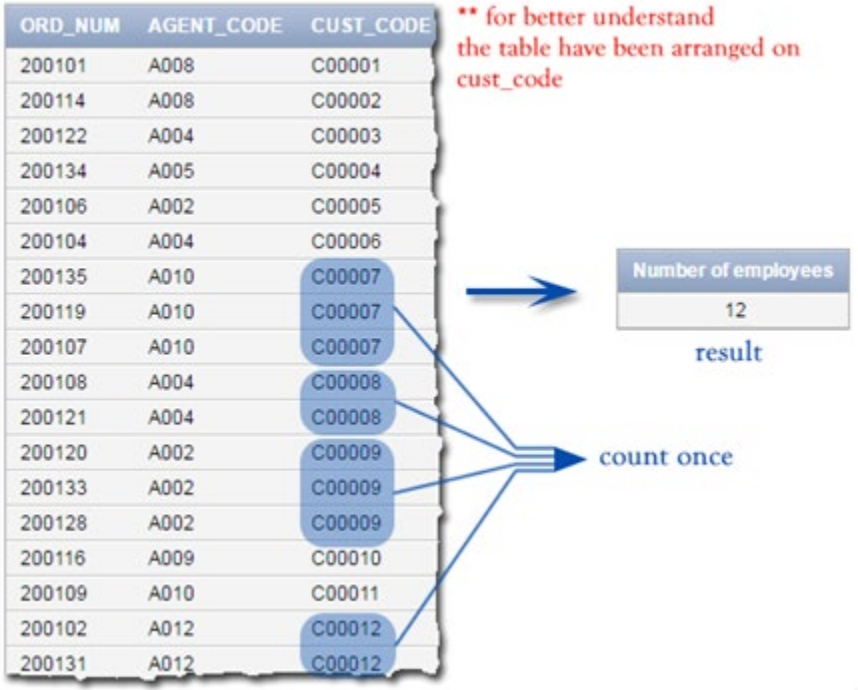
Output Is:

```
COUNT(*) = 4; -- count all rows, even null/duplicates

-- count only rows without null values on that field
COUNT(Field1) = COUNT(Field2) = 3

COUNT(Field3) = 2
COUNT(DISTINCT Field3) = 1 -- Ignore duplicates
```

DISTINCT

Count the number of distinct salary values in the database

```
SELECT      COUNT (DISTINCT CUST_CODE) AS
"Number of Employees"
FROM        ORDERS
Where Agent _code='A010' OR
Agent _code='A009';3
```

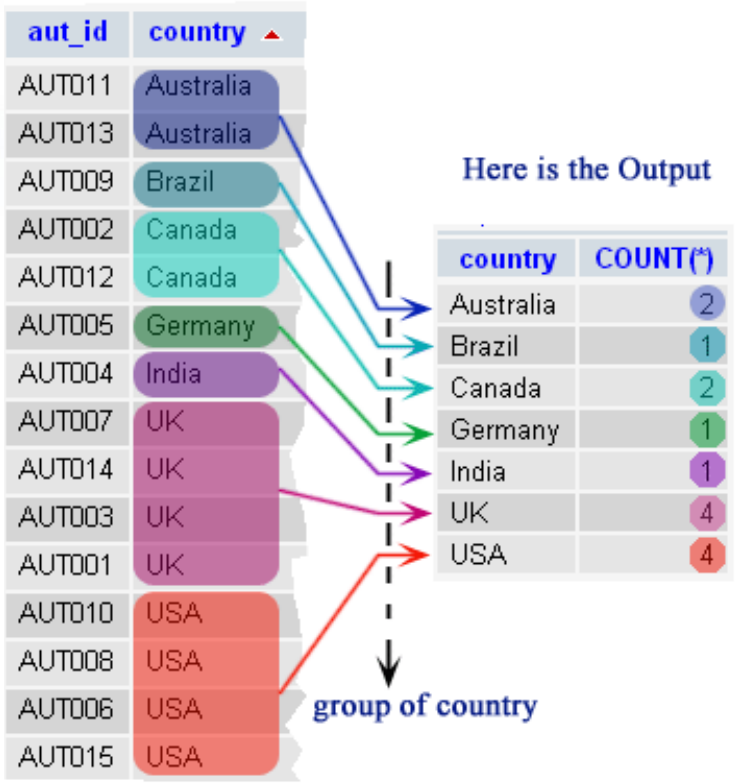


Group By

- Aggregate functions are often used with the GROUP BY clause
- GROUP BY Clause is used to collect data from multiple records and group the result by one or more column
- **Example:** "find the number of authors in each country".

```
SELECT column_name(s)
FROM table_name
WHERE condition
GROUP BY column_name(s)
ORDER BY column_name(s);
```

```
Select Country, count(*)
From Author
Group by country;
```



Example:

For each department, retrieve the department number, the number of employees in the department, and their average salary.

```
SELECT    Dno, COUNT (*), AVG (Salary)
FROM      EMPLOYEE
GROUP BY Dno;
```

Dno	Count(*)	Avg(Salary)
4	3	30000
5	4	31000
1	1	55000

Order of execution

ORDER	CLAUSE	FUNCTION
1	from	Choose and join tables to get base data.
2	where	Filters the base data.
3	group by	Aggregates the base data.
4	having	Filters the aggregated data.
5	select	Returns the final data.
6	order by	Sorts the final data.
7	limit	Limits the returned data to a row count.

Relational Algebra

γ (Aggregation)

- ***γ* (gamma) is** used for operations like SUM, AVG, COUNT, etc., often with grouping.
- It produces a relation where the result of the aggregation is stored as a new attribute.

Sum

Example:

SELECT SUM (Salary) As TotalSalary FROM EMPLOYEE;

In relational algebra, the expression for the above SQL query can be represented using the ***γ* (gamma)** operator to perform the summation:

***γ*SUM(Salary) AS TotalSalary (EMPLOYEE)**

Pronunciation: "Gamma: Sum of Salary as TotalSalary, applied to the EMPLOYEE relation."

Explanation:

- *γ* represents the Group By operation.
- "SUM(Salary) AS TotalSalary" inside *γ* indicates that we are performing the sum aggregation on the "Salary" attribute and renaming the result as "TotalSalary".
- The relation involved is "EMPLOYEE".

Max

Example:

SELECT MAX (Salary) As MaximumSalary FROM EMPLOYEE;

The relational algebra expression for the above SQL query can be represented using the γ (gamma) operator to perform the maximum aggregation:

γMAX(Salary) AS MaximumSalary(EMPLOYEE)

Pronounce: "Gamma: Maximum of Salary as MaximumSalary, applied to the EMPLOYEE relation."
Explanation:
•γ represents the Group By operation.
•"MAX(Salary) AS MaximumSalary" inside γ indicates that we are performing the maximum aggregation on the "Salary" attribute and renaming the result as "MaximumSalary".
•The relation involved is "EMPLOYEE".

Min

Example:

SELECT MIN (Salary) As MinimumSalary FROM EMPLOYEE;

The relational algebra expression for the above SQL query can be represented using the γ (gamma) operator to perform the maximum aggregation:

γMIN(Salary) AS MinimumSalary(EMPLOYEE)

Pronounce: "Gamma: Minimum of Salary as MinimumSalary, applied to the EMPLOYEE relation."
Explanation:
•γ represents the Group By operation.
•"MIN(Salary) AS MinimumSalary" inside γ indicates that we are performing the minimum aggregation on the "Salary" attribute and renaming the result as "MinimumSalary".
•The relation involved is "EMPLOYEE".

Avg

Example:

SELECT AVG (Salary) As AverageSalary FROM EMPLOYEE;

The relational algebra expression for the above SQL query can be represented using the γ (gamma) operator to perform the maximum aggregation:

γAVG(Salary) AS AverageSalary(EMPLOYEE)

Pronounce: "Gamma: Average of Salary as AverageSalary, applied to the EMPLOYEE relation."
Explanation:
•γ represents the Group By operation.
•"MIN(Salary) AS AverageSalary" inside γ indicates that we are performing the Average aggregation on the "Salary" attribute and renaming the result as “AverageSalary".
•The relation involved is "EMPLOYEE".

COUNT

SELECT COUNT (CUST_CODE) AS “Total_Customers”
FROM ORDERS;

γ COUNT (CUST_CODE) AS Total_Customers(ORDERS)

Pronunciation: Gamma count customer code as total customers from orders table.

Explanation:

- **γ**: Pronounced as "Gamma."
- **COUNT(CUST_CODE)**: Say "Count customer code."
- **AS Total_Customers**: Say "as total customers."
- **(ORDERS)**: Say "of orders."

COUNT - DISTINCT

```
SELECT COUNT (Distinct (CUST_CODE)) AS “Total_Customers”
FROM ORDERS;
```

R.A:

$$\gamma \text{ COUNT (DISTINCT CUST\_CODE) AS Total\_Customers(ORDERS)}$$

Pronunciation: " Gamma count distinct customer code as total customers from orders table"

Explanation:

- **γ**: Pronounced as "Gamma."
- **COUNT(DISTINCT CUST_CODE)**: Say "Count distinct customer code."
- **AS Total_Customers**: Say "as total customers."
- **(ORDERS)**: Say "of orders."

Group By

Example:

```
SELECT CustomerID, COUNT(*) AS TotalOrders
FROM Orders  GROUP BY CustomerID;
```

R.A:

$$\gamma_{\text{CustomerID, COUNT CustomerID AS TotalOrders}}(\text{Orders})$$

Pronunciation: "Projection of 'CustomerID' and 'OrderCount' from the result of grouping Orders by 'CustomerID' and applying the COUNT aggregate function, with the result aliased as 'OrderCount'."

Explanation:

- **γ**: Pronounced as "Gamma.“ represents the grouping and aggregation operation.
- **CustomerID:** Specifies that the grouping is done based on the CustomerID attribute.
- **COUNT(*) → OrderCount:** Applies the COUNT(*) aggregate function to count the number of orders for each group and names the result as OrderCount.
- **Orders:** Refers to the input relation (table).

Practice

Group By Subject count ?
Group By Year Count?

SUBJECT	YEAR	NAME
English	1	Harsh
English	1	Pratik
English	1	Ramesh
English	2	Ashish
English	2	Suresh
Mathematics	1	Deepak
Mathematics	1	Sayan

Practice:

- For each project, retrieve the project number, the project name, and the number of employees who work on that project.

```
SELECT
   p.project_number,
   p.project_name,
   COUNT(e.employee_id) AS num_employees
FROM
   projects p
JOIN
   employees e ON p.project_number = e.project_number
GROUP BY
   p.project_number, p.project_name;
```

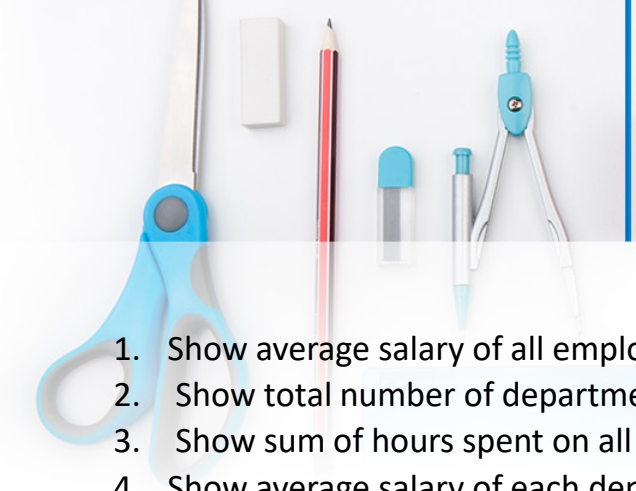
Practice:

- For each project, retrieve the project number, the project name, and the number of employees who work on that project.

- For each project, retrieve the project number, the project name, and the number of employees from department 5 who work on the project.

- For each project, retrieve the project number, the project name, and the number of employees from department 5 who work on the project.

```
Select pnumber, pname, count(essn)
From (project join workson on pno= pnumber) join employee on essn =ssn
Where dno = 5
 group by pnumber;
```



Practice Queries

1. Show average salary of all employees.
2. Show total number of departments.
3. Show sum of hours spent on all projects.
4. Show average salary of each department if average salary is greater than 40,000.
5. Show minimum salary of each department if minimum salary is less than 20,000.
6. Show total number of employees of each department with department name.
7. Show number of dependent of each employee.
8. Show count of projects of all departments in ascending order by department name.
9. Show count of total locations of each department which are located in Lahore.
10. For each project show project name and total number of employees working on it.

Thank You all!