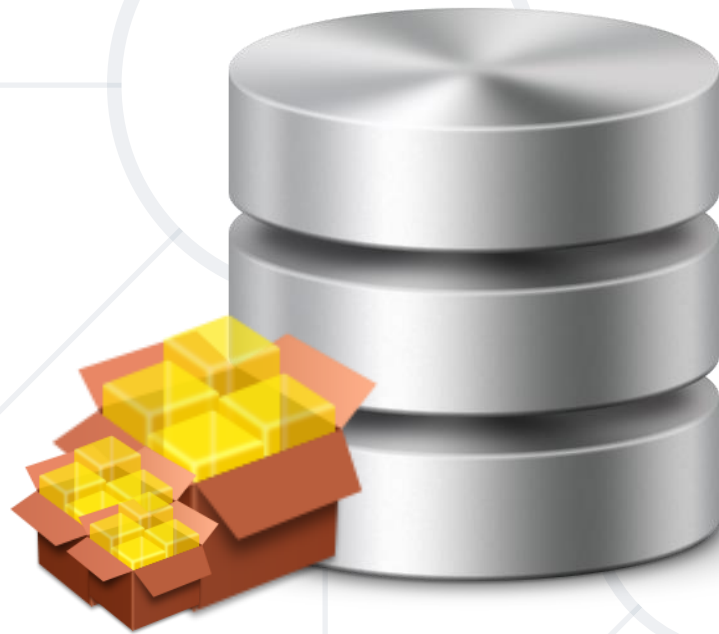


# Indices and Data Aggregation

## How to Get Data Insights?



**SoftUni Team**  
**Technical Trainers**



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**#csharp-db**

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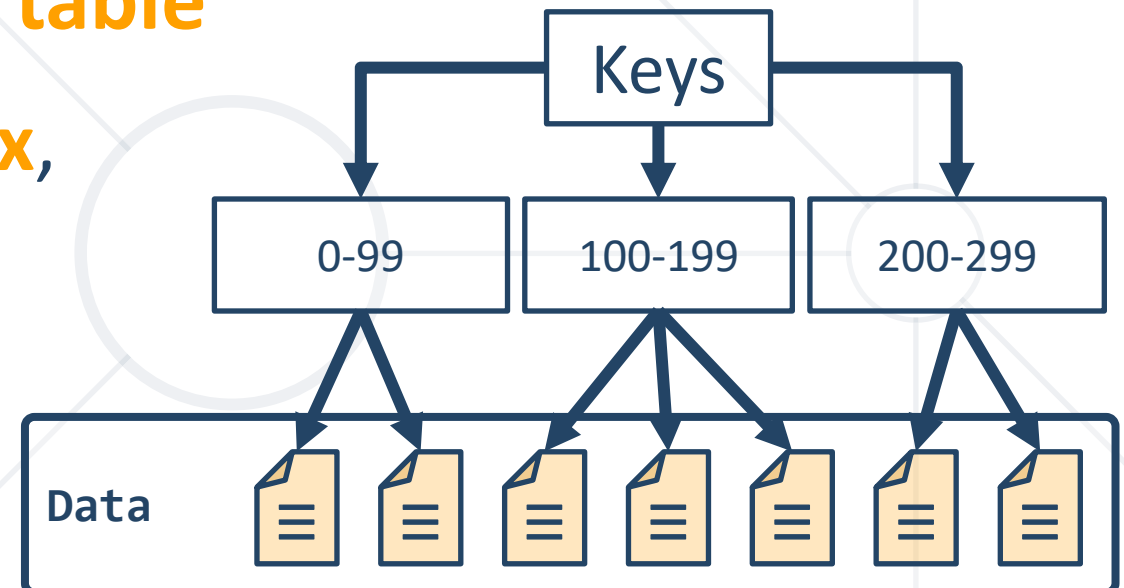


# Indices

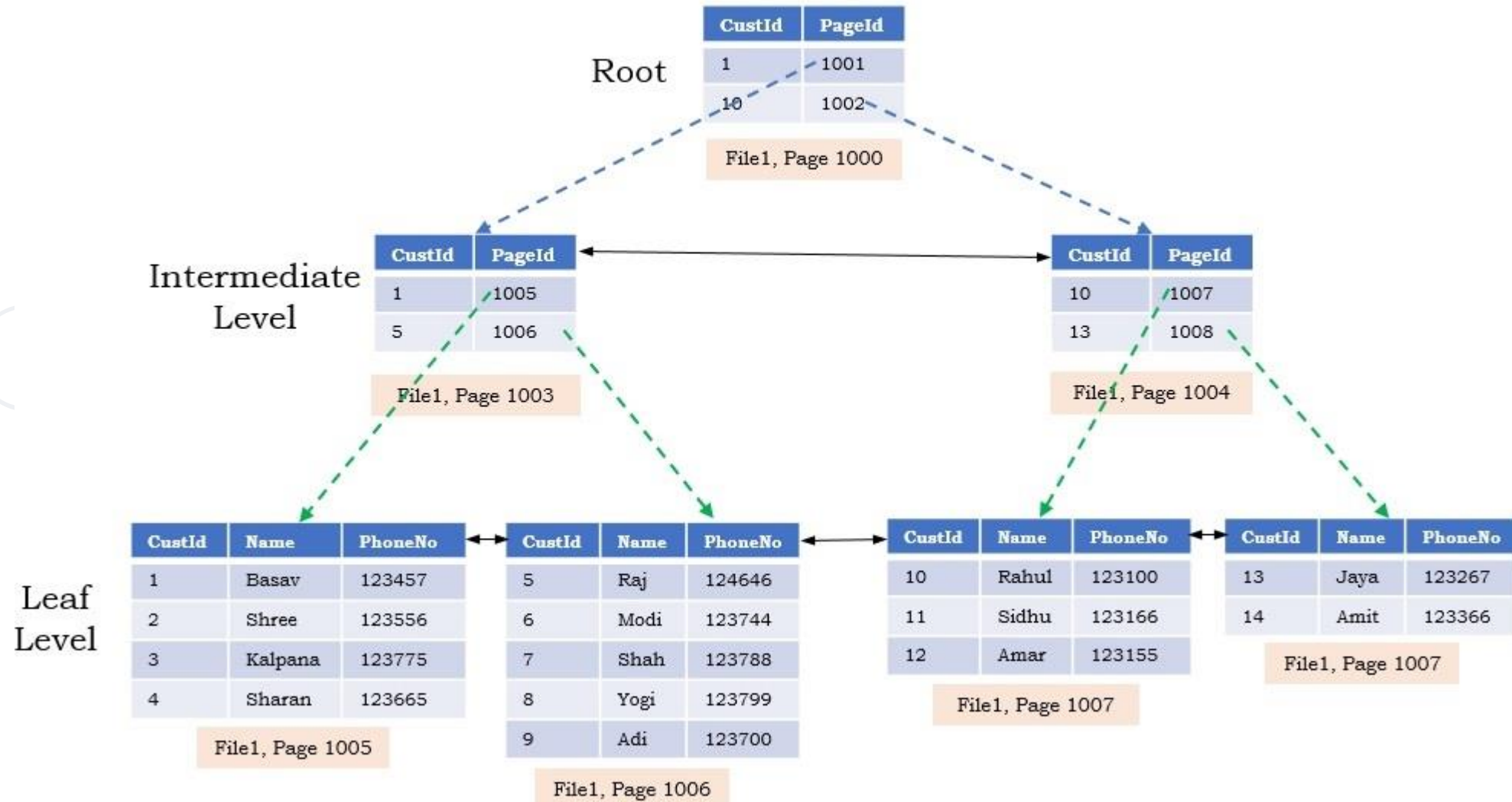
Clustered and Non-Clustered Indexes

- **Indices speed up the searching of values** in a certain column or group of columns
  - Usually implemented as **B-trees**
- Indices can be **built-in the table (clustered)** or **stored externally (non-clustered)**
- **Adding and deleting** records in indexed tables is **slower!**
  - Indices should be used **for big tables only** (e.g. 500 000 rows).

- **Clustered index** is actually **the data itself**
  - Very useful for **fast execution** of **WHERE**, **ORDER BY** and **GROUP BY** clauses
- Maximum **1** clustered index **per table**
  - If a table **has no clustered index**, its **data rows are stored in** an unordered structure (**heap**).



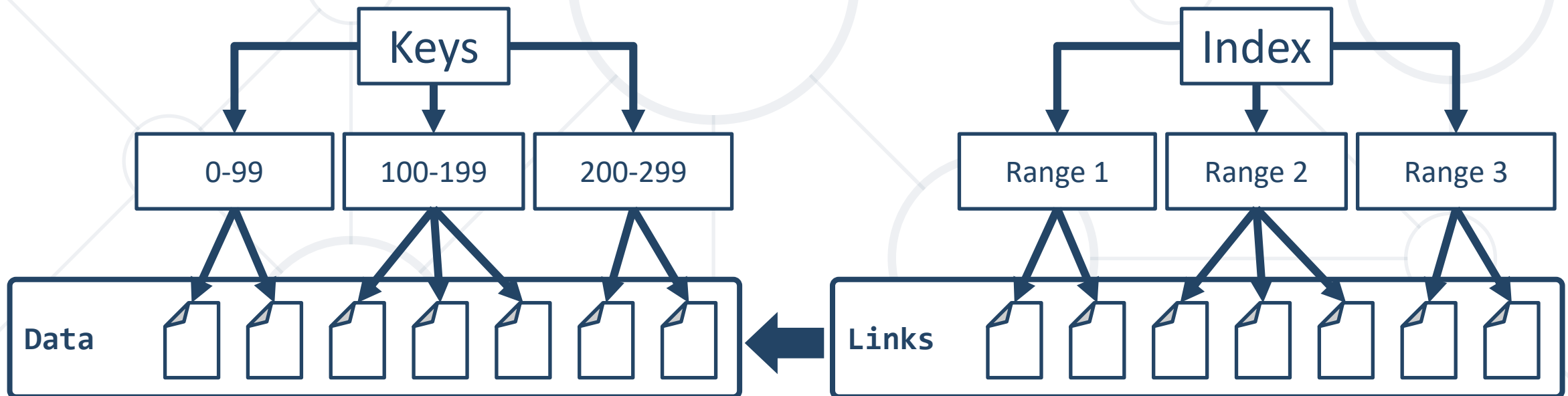
## B+ Tree Structure of a Clustered Index



- Useful for **fast retrieving** of a range of records
- Maintained in a **separate structure** in the DB
- Tend to be **much narrower** than the base table
  - Can **locate the exact record(s)** with **less I/O**
- Has **at least one more intermediate level** than the clustered index
  - Much **less valuable** if a table **doesn't have a clustered index**



- A non-clustered index **has pointers** to the **actual data rows** (pointers to the clustered index if there is one).



Index Type

```
CREATE NONCLUSTERED INDEX  
IX_Employees_FirstName_LastName  
ON Employees(FirstName, LastName)
```

Table Name

Columns



# Demo: Index Performance

Live Demo



# Grouping

Consolidating Data Based On Criteria

# Grouping

- **Grouping** allows receiving data into separate groups based on a common property



Single row

Employee	DepartmentName	Salary
Adam	Database Support	5,000
John	Database Support	15,000
Jane	Application Support	10,000
George	Application Support	15,000
Lila	Application Support	5,000
Fred	Software Support	15,000

Grouping column

Can be aggregated

- **GROUP BY** allows you to get each **separate group** and use an "**aggregate**" function over it (like **Average**, **Min** or **Max**):

```
SELECT e.DepartmentID  
FROM Employees AS e  
GROUP BY e.DepartmentID
```

Group Columns

- **DISTINCT** allows you to get **all unique** values:

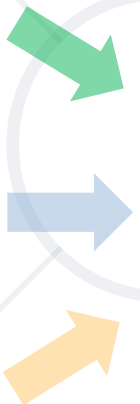
```
SELECT DISTINCT e.DepartmentID  
FROM Employees AS e
```

Unique  
Values

# Problem: Departments Total Salaries

- Use "**SoftUni**" **database** to create a query which prints the total sum of salaries for each department
  - Order them by **DepartmentID** (ascending)

Employee	DepartmentID	Salary
Adam	1	5,000
John	1	15,000
Jane	2	10,000
George	2	15,000
Lila	2	5,000
Fred	3	15,000



DepartmentID	TotalSalary
1	20,000
2	30,000
3	15,000

Check your solution here: <https://judge.softuni.org/Contests/Practice/Index/291#12>

# Solution: Departments Total Salaries

- After **grouping** every employee **by** its **department**, we can use an **aggregate function** to calculate the total amount of money per group

```
SELECT e.DepartmentID,  
       SUM(e.Salary) AS TotalSalary  
FROM Employees AS e  
GROUP BY e.DepartmentID  
ORDER BY e.DepartmentID
```

Column Alias

Table Alias

Group Columns

Check your solution here: <https://judge.softuni.org/Contests/Practice/Index/291#12>





# **Aggregate Functions**

COUNT, SUM, MAX, MIN, AVG...

- Operate over (**non-empty**) **groups**
- Perform **data analysis** on each one
  - **MIN, MAX, AVG, COUNT**, etc.

```
SELECT e.DepartmentID,  
       MIN(e.Salary) AS MinSalary  
FROM Employees AS e  
GROUP BY e.DepartmentID
```



DepartmentID	MinSalary
1	32700.00
2	25000.00
3	23100.00
4	13500.00
5	12800.00
6	40900.00
7	9500.00

- Aggregate functions usually **ignore NULL** values

# Aggregate Functions: COUNT

- **COUNT** - counts the values in one or more grouped columns
  - Ignores NULL values

Employee	DepartmentName	Salary
Adam	Database Support	5,000
John	Database Support	15,000
Jane	Application Support	10,000
George	Application Support	15,000
Lila	Application Support	5,000
Fred	Software Support	15,000



DepartmentName	SalaryCount
Database Support	2
Application Support	3
Software Support	1

- **COUNT**(ColumnName)

New Column Alias

```
SELECT e.DepartmentID,  
       COUNT(e.Salary) AS SalaryCount  
FROM Employees AS e  
GROUP BY e.DepartmentID
```


Group Columns

- Note: **COUNT** ignores any employee with **NULL** salary

# Aggregate Functions: SUM

- **SUM** - sums the values in a column

Employee	DepartmentName	Salary
Adam	Database Support	5,000
John	Database Support	15,000
Jane	Application Support	10,000
George	Application Support	15,000
Lila	Application Support	5,000
Fred	Software Support	15,000



DepartmentName	TotalSalary
Database Support	20,000
Application Support	30,000
Software Support	15,000

- If any department **has no salaries**, it **returns NULL**

Grouping  
Column

New Column Alias

```
SELECT e.DepartmentID,  
       SUM(e.Salary) AS TotalSalary  
FROM Employees AS e  
GROUP BY e.DepartmentID
```

# Aggregate Functions: MAX

- **MAX** - takes **the largest value** in a column

Employee	DepartmentName	Salary
Adam	Database Support	5,000
John	Database Support	15,000
Jane	Application Support	10,000
George	Application Support	15,000
Lila	Application Support	5,000
Fred	Software Support	15,000



DepartmentName	MaxSalary
Database Support	15,000
Application Support	15,000
Software Support	15,000

```
SELECT e.DepartmentID,  
       MAX(e.Salary) AS MaxSalary  
FROM Employees AS e  
GROUP BY e.DepartmentID
```

Grouping Column

New Column Alias

Group Columns



# Aggregate Functions: MIN

- **MIN** - takes **the smallest value** in a column

Employee	DepartmentName	Salary
Adam	Database Support	5,000
John	Database Support	15,000
Jane	Application Support	10,000
George	Application Support	15,000
Lila	Application Support	5,000
Fred	Software Support	15,000



DepartmentName	MinSalary
Database Support	5,000
Application Support	5,000
Software Support	15,000

```
SELECT e.DepartmentID,  
       MIN(e.Salary) AS MinSalary  
FROM Employees AS e  
GROUP BY e.DepartmentID
```

New Column Alias

Group Columns

# Aggregate Functions: AVG

- **AVG** - calculates the **average value** in a column

Employee	DepartmentName	Salary
Adam	Database Support	5,000
John	Database Support	15,000
Jane	Application Support	10,000
George	Application Support	15,000
Lila	Application Support	5,000
Fred	Software Support	15,000



DepartmentName	AvgSalary
Database Support	10,000
Application Support	10,000
Software Support	15,000

```
SELECT e.DepartmentID,  
       AVG(e.Salary) AS AvgSalary  
FROM Employees AS e  
GROUP BY e.DepartmentID
```

New Column Alias

Group Columns

- **STRING\_AGG** - Concatenates the values of string expressions and places separator values between them. The separator is not added at the end of string

Expressions are converted to **NVARCHAR** or **VARCHAR** types during concatenation. Non-string types are converted to **NVARCHAR** type

```
STRING_AGG ( expression, separator )  
[WITHIN GROUP ( ORDER BY expression [ ASC | DESC ] )]
```



# Having

Using Predicates While Grouping

# HAVING Clause

- The **HAVING clause** is used to **filter data** based on **aggregate values**
  - We **cannot** use it **without grouping** first
- **Aggregate functions** (MIN, MAX, SUM etc.) are **executed only once**
  - Unlike HAVING, **WHERE filters** rows **before aggregation**



# HAVING Clause: Example

- Filter departments having total salary more than or equal to 15,000

Aggregated value

Employee	DepartmentName	Salary	TotalSalary
Adam	Database Support	5,000	20,000
John	Database Support	15,000	
Jane	Application Support	1,000	11,000
George	Application Support	5,000	
Lila	Application Support	5,000	
Fred	Software Support	15,000	15,000

DepartmentName	TotalSalary
Database Support	20,000
Software Support	15,000



# HAVING Syntax

```
SELECT e.DepartmentID,  
       SUM(e.Salary) AS TotalSalary  
FROM Employees AS e  
GROUP BY e.DepartmentID  
HAVING SUM(e.Salary) >= 15000
```

Aggregate  
Function

Column Alias

Grouping Columns

Having Predicate

- **Grouping** by Shared Properties
- **Aggregate** Functions
- Having **Clause**

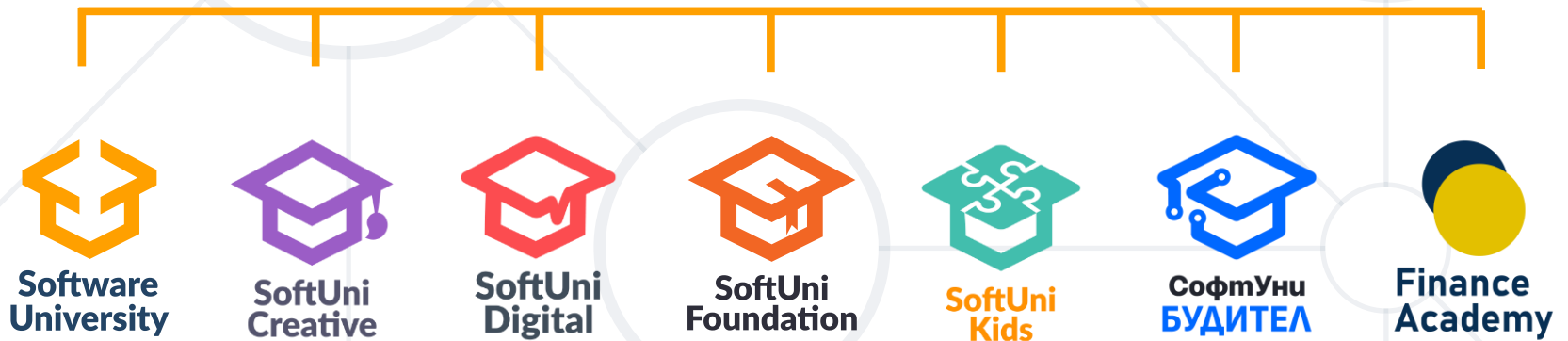
```
SELECT  
    SUM(e.Salary) AS 'TotalSalary'  
FROM Employees AS e  
GROUP BY e.DepartmentID  
HAVING SUM(e.Salary) >= 15_000
```



# Questions?



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