

National University of Computer and Emerging Sciences



Lab Manual 4

“Data Retrieval Select-from-where, Joins, Order by, Aggregate functions, Group by”

Database Systems Lab

Spring 2023

Department of Computer Science
FAST-NU, Lahore, Pakistan



1. Contents

2. Objective	2
3. Pre-requisites	2
4. SELECT-FROM-WHERE	3
Most Basic Select:	3
Retrieving certain Columns from Select	4
Retrieving certain Rows from Select- WHERE CLAUSE	4
Renaming Resulting Column	5
5. Order by Clause	5
TOP Clause	6
6. Join Operation	6
Inner Join:	6
Left/Right/Full Outer Join	7
Cross Join	8
Joining More than two tables	8
7. Aggregation-Grouping	9
Grouping	11
Having Clause	12
8. Set operations	13



2. Objective

- The purpose of this manual is to get started with data retrieval queries, starting from Simple Select-From-Where, going towards Join operation, covering Order by clause and Aggregate functions, Group by.

3. Pre-requisites

- Lab 3 manual, on how to get started with MS-SQL server
- How Select from Where clause work
- How Joining and all its type work
- How Order by clause works
- Aggregate functions, Group by

Task Distribution

Total Time	170 Minutes
Select from where	15 Minutes
Order by	15 Minutes
Joining	15 Minutes
Group by	15 Minutes
Exercise	90 Minutes
Evaluation	Last 20 Minutes



4. SELECT-FROM-WHERE

Select from where is equivalent to projection and selection in Relational Algebra, it will give output in form of a table.

The most basic select statement includes Select and from clause, and it will retrieve all columns and rows from the table.

We will use the following schema and database for the examples. Script to create this schema is given in Lab4Manual.sql file

Students	StudentID	StudentName	StudentBatch	CGPA
	1	Ali	2013	3.3
	2	Aysha	2013	4
	3	Ahmed	2013	2.2
Instructors	InstructorID	InstructorsName		
	1	Zafar		
	2	Sadia		
	3	Saima		
Courses	CourseID	CourseName	CourseCreditHours	InstructorID
	1	Computer Programming	3	1
	2	Computer Organization	3	2
	3	Computer Programmi...	1	NULL
Registration	StudentID	CourseID	GPA	
	1	1	3	
	1	3	3	
	2	2	0	

Most Basic Select:

```
SELECT *
FROM <tableName>
```

* after select means that all columns will be retrieved

Try this

```
select * from students
```

Results

	StudentID	StudentName	StudentBatch	CGPA
1	1	Ali	2013	3.3
2	2	Aysha	2013	4
3	3	Ahmed	2013	2.2



Retrieving certain Columns from Select

To retrieve only certain columns give a comma separated list of those columns after Select keyword

```
SELECT ColumnX, ColumnY, ColumnZ  
FROM <tableName>
```

Try this

```
Select Course Name, CourseCreditHours  
from courses
```

Results

	CourseName	CourseCreditHours
1	Computer Programming	3
2	Computer Organization	3
3	Computer Programming Lab	1

Retrieving certain Rows from Select- WHERE CLAUSE

Like Selection in RA, rows are filter in SQL using WHERE clause, rows that fulfill where clause conditions will be projected in result. Where clause can put condition on original columns of tables mentioned on from clause, or derived columns.

```
SELECT *  
FROM <tableName>  
where <conditions>
```

Try this

```
Select CourseName, CourseCreditHours  
from courses  
where CourseName like '%Programming%' and CourseCreditHours >= 1
```

Results

	CourseName	CourseCreditHours
1	Computer Programming	3
2	Computer Programming Lab	1



Renaming Resulting Column

You can rename a column in result by using AS keyword also called Alias. The scope of this renaming is only to that select query, this is useful in joining where more than one table have same column names.

```
SELECT ColumnX as X , ColumnY as Y, ColumnZ  
FROM <tableName> as Table1
```

Try this

```
select StudentName AS StudentFirstName  
, CGPA AS [Cumulative CGPA]  
from students AS StudentsTable
```

Results

	StudentFirstName	Cumulative CGPA
1	Ali	3.3
2	Aysha	4
3	Ahmed	2.2

5. Order by Clause

Order by clause is used to arrange the rows in ascending or descending order of one or more columns

```
SELECT ColumnX as X , ColumnY as Y, ColumnZ  
FROM <tableName> as Table1  
ORDER BY ColumnX asc/desc, ColumnZ asc/desc
```

Try this

```
select StudentName AS StudentFirstName  
, CGPA AS [Cumulative CGPA]  
from students AS StudentsTable  
order by CGPA desc
```

Results

	StudentFirstName	Cumulative CGPA
1	Aysha	4
2	Ali	3.3
3	Ahmed	2.2

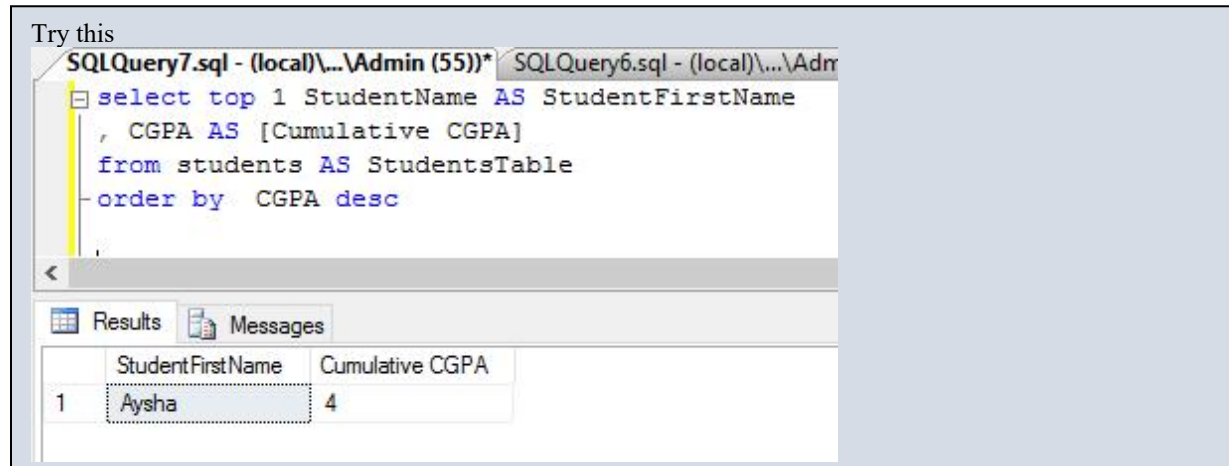


TOP Clause

Top n clause will give you first n rows from result instead of all the rows.

```
SELECT TOP <n> *  
FROM <tableName>  
where <conditions>  
Order by <column Name> asc/desc
```

Try this



The screenshot shows a SQL query window with the following text:

```
select top 1 StudentName AS StudentFirstName  
, CGPA AS [Cumulative CGPA]  
from students AS StudentsTable  
order by CGPA desc
```

Below the query window, the 'Results' tab is active, displaying a table with two columns: 'StudentFirstName' and 'Cumulative CGPA'. The first row shows 'Aysha' and '4'.

	StudentFirstName	Cumulative CGPA
1	Aysha	4

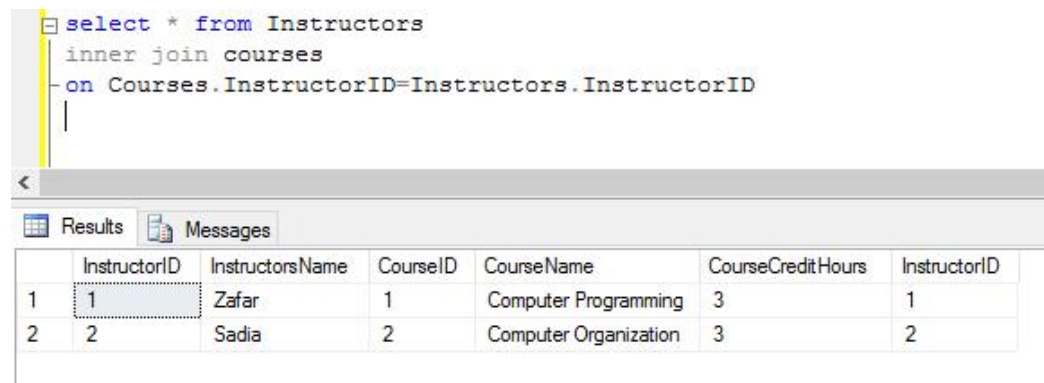
6. Join Operation

We will use the following tables in examples

Inner Join:

Returns only those rows that match in both tables.

```
SELECT *  
FROM <table1> inner join <table2>  
ON <Joining Condition>
```



The screenshot shows a SQL query window with the following text:

```
select * from Instructors  
inner join courses  
on Courses.InstructorID=Instructors.InstructorID
```

Below the query window, the 'Results' tab is active, displaying a table with seven columns: 'InstructorID', 'InstructorsName', 'CourseID', 'CourseName', 'CourseCreditHours', and 'InstructorID'. The first two rows are shown.

	InstructorID	InstructorsName	CourseID	CourseName	CourseCreditHours	InstructorID
1	1	Zafar	1	Computer Programming	3	1
2	2	Sadia	2	Computer Organization	3	2



Left/Right/Full Outer Join

Left Join: Returns all the rows of Left table with corresponding row or null row of right table

Right Join: Returns all the rows of Right table with corresponding row or null row of Left table

Full Join: Union of Left and Right Outer join

SELECT * FROM <table1> Left/Right/Full join <table2> ON <Joining Condition>

Try these

```
select * from Instructors  
left join courses  
on Courses.InstructorID=Instructors.InstructorID
```

	InstructorID	InstructorsName	CourseID	CourseName	CourseCreditHours	InstructorID
1	1	Zafar	1	Computer Programming	3	1
2	2	Sadia	2	Computer Organization	3	2
3	3	Saima	NULL	NULL	NULL	NULL

```
select * from Instructors  
right join courses  
on Courses.InstructorID=Instructors.InstructorID
```

	InstructorID	InstructorsName	CourseID	CourseName	CourseCreditHours	InstructorID
1	1	Zafar	1	Computer Programming	3	1
2	2	Sadia	2	Computer Organization	3	2
	NULL	NULL	3	Computer Programming Lab	1	NULL

```
select * from Instructors  
full join courses  
on Courses.InstructorID=Instructors.InstructorID
```

	InstructorID	InstructorsName	CourseID	CourseName	CourseCreditHours	InstructorID
1	1	Zafar	1	Computer Programming	3	1
2	2	Sadia	2	Computer Organization	3	2
3	3	Saima	NULL	NULL	NULL	NULL
4	NULL	NULL	3	Computer Programming Lab	1	NULL



Cross Join

It's a cross product of two tables, no ON condition is required here

```
SELECT * FROM <table1> cross Join <table2>
```

Try this

```
select * from Instructors  
cross join Courses
```

	InstructorID	InstructorsName	CourseID	CourseName	CourseCreditHours	InstructorID
1	1	Zafar	1	Computer Programming	3	1
2	2	Sadia	1	Computer Programming	3	1
3	3	Saima	1	Computer Programming	3	1
4	1	Zafar	2	Computer Organization	3	2
5	2	Sadia	2	Computer Organization	3	2
6	3	Saima	2	Computer Organization	3	2
7	1	Zafar	3	Computer Programming Lab	1	NULL
8	2	Sadia	3	Computer Programming Lab	1	NULL
9	3	Saima	3	Computer Programming Lab	1	NULL

Joining More than two tables

```
SELECT *  
FROM <table1>  
Left/Right/Full/Inner join <table2> ON <Joining Condition>  
Left/Right/Full/Inner join <table3> ON <Joining Condition>  
Left/Right/Full/Inner join <table4> ON <Joining Condition>
```

Try this

```
select studentName, courseName, instructorsName  
from students S  
join Registration R on R.studentID=S.studentID  
join Courses c on R.courseID=c.courseID  
join Instructors i on i.InstructorID=c.InstructorID
```

	studentName	courseName	instructorsName
1	Ali	Computer Programming	Zafar
2	Aysha	Computer Organization	Sadia



7. Aggregation-Grouping

Aggregation allows you to apply calculation on values of column, and it will return a scalar value. Adding the GROUP BY Clause allows you to aggregate on groups of data, a scalar value will be returned for each group of data. Some examples of Aggregate functions are given below.

Aggregation Function Key work	How it works	No of Column Function can work on
AVG()	Returns the average of the values in a group. Null values are ignored.	Single column
COUNT()	Returns the number of items in a group. This function always returns an int data type value	Single Column or List of Columns or *
MAX()	Returns the maximum value in the expression.	Single column
MIN()	Returns the minimum value in the expression.	Single column
SUM()	Returns the sum of all the values in the expression. SUM can be used on numeric columns only and it ignores all the NULL values.	Single column

Figure 1 Aggregation Functions

Following is the syntax of Aggregation without grouping.

```
Select <AggregationFunction> (COLUMNs/Column) AS <AliasName>
From <TableName>
```

Use the script (Lab4TryManual.sql Figure 1) to create database to try the following queries.

Students	StudentID	StudentName	StudentBatch	CGPA
	1	Ali	2013	2.625
	2	Aysha	2013	4
	3	Ahmed	2013	2.2
	4	Bilal	2012	2.5
	5	Zafar	2012	3.5
Instructors	InstructorID	InstructorsName		
	1	Zafar		
	2	Sadia		
	3	Saima		
Courses	CourseID	CourseName	CourseCreditHours	InstructorID
	1	Computer Programming	3	1
	2	Computer Organization	3	2
	3	Computer Programmi...	1	NULL
	4	Database	3	2
	5	Database Lab	1	1
Registrations	StudentID	CourseID	GPA	
	1	1	3	
	1	3	3	
	1	4	2	
	1	5	3	
	2	1	2.5	
	2	2	0	
	2	4	3	

Figure 2 University Database



TRY THIS (Aggregation with Grouping)

```
--Count total Number of Instructors  
select COUNT(*) AS [Total Instructors]  
from dbo.Instructors
```

Results Messages

Total Instructors
3

```
--Count total Number of Instructors that are taking some course  
select COUNT(Distinct InstructorID) AS [Total Instructors]  
from dbo.Courses
```

Results Messages

Total Instructors
2

****NOTE THE DISTINCT KEY WORD. WHAT DOES IT DO?**

YOU CAN USE AGGREGATION AND JOINING TOGETHER

```
--Calculate CGPA of Student with ID 1. CGPA = Sum(Course CRHr* Course GPA)/ sum(Course CRHr)  
select SUM(C.CourseCreditHours* R.GPA)/ SUM(C.CourseCreditHours) AS [CGPA]  
from Registration R inner join Courses C on R.CourseID=C.CourseID  
where R.StudentID = 1
```

Results Messages

CGPA
2.625

USE MORE THAN ONE AGGREGATION FUNCTION IN SAME SELECT

```
--Find out average credit hours of course and total number of course that are offered  
Select AVG(C.CourseCreditHours) AS [Average CrdHrs], COUNT(C.CourseID) AS [Course Offered]  
from Courses C
```

Results Messages

Average CrdHrs	Course Offered
2	5



Grouping:

Syntax:

```
Select T.ColumnX, T.ColumnY Aggreation Function(Column/Columns) AS [Alias]
from TableName T
Group by T.ColumnX, T.ColumnY --comma seperated list of all the column of
which
--groping is to be done
```

NOTE: ONLY THE COLUMNS THAT ARE USED IN GROUPING CAN BE USED IN SELECT CLAUSE

TRY THIS (Aggregate with grouping)

```
--Give Batch and total number of students for each batch
Select S.StudentBatch AS [Batch], COUNT(*) AS [# of Students]
from Students S
Group by S.StudentBatch
```

Results Messages

Batch	# of Students
2012	2
2013	3

```
--Give Student Name, Roll Number and His CGPA (calcualte CGPA using Aggregation)
Select S.StudentName,S.StudentID , SUM(C.CourseCreditHours* R.GPA)/ SUM(C.CourseCreditHours) AS [CGPA]
From Students S inner join Registration R on R.StudentID=S.StudentID
inner join Courses C on C.CourseID=R.CourseID
Group by S.StudentName,S.StudentID
```

Results Messages

StudentName	StudentID	CGPA
Ali	1	2.625
Aysha	2	1.83333333333333

```
--THIS QUERY WILL GIVE ERROR AS STUDENT BATCH IS NOT IN GROPUING COLUMNS SO IT CANNOT BE IN
--COLUMN LIST
Select S.StudentBatch , SUM(C.CourseCreditHours* R.GPA)/ SUM(C.CourseCreditHours) AS [CGPA]
From Students S inner join Registration R on R.StudentID=S.StudentID
inner join Courses C on C.CourseID=R.CourseID
Group by S.StudentName,S.StudentID
```

Messages

Msg 8120, Level 16, State 1, Line 3
Column 'Students.StudentBatch' is invalid in the select list because it is not contained in either an aggregate function or the GROUP BY clause.



Having Clause

Having Clause allows us to filter the data based on the result of aggregation function, it's the same as where clause except that we cannot use aggregate functions in where clause and we cannot use simple columns having clause.

Try this (aggregate group having)

```
--Give All the Batches wheretotal number of students are greater than 2
Select S.StudentBatch AS [Batch], COUNT(*) AS [# of Students]
from Students S
Group by S.StudentBatch
Having COUNT(*)>2
```

Results Messages

Batch	# of Students
2013	3

```
--Give Name of all the students in batch 2013 with CGPA less than 2
Select S.StudentName,S.StudentID , SUM(C.CourseCreditHours* R.GPA)/ SUM(C.CourseCreditHours) AS [CGPA]
From Students S inner join Registration R on R.StudentID=S.StudentID
inner join Courses C on C.CourseID=R.CourseID
where S.StudentBatch=2013 --condition on simple columns are to be placed in where clause
Group by S.StudentName,S.StudentID
having SUM(C.CourseCreditHours* R.GPA)/ SUM(C.CourseCreditHours) <2 --condition on aggregate are to be place in having clause
```

Results Messages

StudentName	StudentID	CGPA
Aysha	2	1.83333333333333

NOTE: THE ORDER OF EACH CLAUSE IS TO BE MAINTAINED AS FOLLOW

1. SELECT (COMPULSORY)
2. FROM (COMPULSORY)
3. WHERE
4. GROUP
5. HAVING



8. Set operations

Result of two (or more) select queries can be combined using Set operations such as UNION, INTERSECT, EXCEPT.

Syntax

```
Select ColumnX, ColumnY  
From Table1
```

Union/Intersect/Except

```
Select ColumnA, ColumnB  
From Table2
```

NOTE: The output of first select query should have same number and type of column as of second select query.

Try this –Set operations

```
--List IDs of all the students that have not registered in any course  
select StudentID From Students  
except  
select StudentID from Registration
```

Results Messages

StudentID
3
4
5

```
---list ID of all the instructors that are taking some course  
Select InstructorID from Instructors  
Intersect  
Select InstructorID from Courses
```

Results Messages

InstructorID
1
2

```
--List all the Names of instructors and Students  
Select StudentName From Students  
Union  
Select InstructorsName From Instructors
```

Results Messages

StudentName
Ahmed
Ali
Aysha
Bilal
Sadia
Saima
Zafar



Try this- error to look out for in set operations

```
--Fails because Datatype of Corresponding Columns is not same
Select StudentName From Students
Union
Select StudentID From Students
```

Results Messages

Msg 245, Level 16, State 1, Line 1
Conversion failed when converting the varchar value 'Ali' to data type int.

```
--Fails becuse Number of Columns in 1st select query are not same as number of columns in 2nd select query
Select StudentName From Students
Union
Select StudentID, StudentName From Students
```

Messages

Msg 205, Level 16, State 1, Line 2
All queries combined using a UNION, INTERSECT or EXCEPT operator must have an equal number of expressions in their target lists.