



# DBS101 Database Systems Fundamentals



Royal University of Bhutan

## Lesson 5

## Learning Outcomes

1. Understand null values in SQL.
2. Use aggregate functions in SQL.
3. Write nested subqueries.
4. Modify databases using SQL.

## Aggregate Functions

Aggregate functions are functions that take a collection (a set or multiset) of values as input and return a single value.

- AVG(COL): The average of the values in COL
- MIN(COL): The minimum value in COL
- MAX(COL): The maximum value in COL
- COUNT(COL): The number of tuples in the relation

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## The Having Clause

States a condition that applies to groups rather than to tuples.

Example:

```
select dept name, avg (salary) as avg salary  
from instructor  
group by dept name  
having avg (salary) > 42000;
```

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## Aggregation on NULL and Boolean Values

In SQL, aggregate operators like `sum()` ignore null values in their input collection. Therefore, when calculating sums, null values are disregarded rather than resulting in a null sum.

The SQL:1999 standard introduced a Boolean data type allowing values `true`, `false`, and `unknown`. Aggregate functions like `some()` and `every()` can operate on collections of Boolean values, computing disjunction and conjunction, respectively.

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## Date and Time Manipulation

Operations to manipulate DATE and TIME attributes. Can be used in either output or predicates. The specific syntax for date and time operations varies wildly across systems.

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## Output Redirection

Instead of having the result a query returned to the client (e.g., terminal), you can tell the DBMS to store the results into another table. You can then access this data in subsequent queries.

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## Output Control

ORDER BY and LIMIT clauses provide output ordering and restriction on result sets.

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## Nested Subqueries

A subquery is a select-from-where expression that is nested within another query.

```
select distinct course id
from section
where semester = 'Fall' and year= 2017 and
           course id in (select course id
                        from section
                        where semester = 'Spring' and
                        year= 2018);
```

## Nested Subqueries

Invoke queries inside of other queries to execute more complex logic within a single query. Nested queries are often difficult to optimize.

The scope of outer query is included in an inner query (i.e. the inner query can access attributes from outer query), but not the other way around.

Inner queries can appear in almost any part of a query

## Set Membership

SQL allows testing tuples for membership in a relation. The `in` connective tests for set membership, where the set is a collection of values produced by a `select` clause. The `not in` connective tests for the absence of set membership

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## Set Comparison

SQL allows set comparison as well.

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## Testing Relations

SQL allows for testing of relations:

1. Testing for empty relations
2. Test for the Absence of Duplicate Tuples

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## Subqueries in the FROM clause

SQL allows a subquery expression to be used in the from clause.

The key concept applied here is that any select-from-where expression returns a relation as a result and, therefore, can be inserted into another select-from-where anywhere that a relation can appear.

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## The With Clause

The WITH clause, also known as a Common Table Expression (CTE), allows you to define temporary result sets that can be referenced within the scope of a single SQL statement, including SELECT, INSERT, UPDATE, or DELETE statements.

This can help make complex queries more readable and maintainable by breaking them down into smaller, more manageable parts.

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## Scalar Subqueries

SQL allows subqueries to occur wherever an expression returning a value is permitted, provided the subquery returns only one tuple containing a single attribute; such subqueries are called scalar subqueries.

Scalar subqueries are commonly used within a larger SQL statement where a single value is expected, such as in a SELECT list, WHERE clause, or as part of an expression.

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## Nested Queries Results Expressions

- ALL: Must satisfy expression for all rows in sub-query.
- ANY: Must satisfy expression for at least one row in sub-query.
- IN: Equivalent to =ANY().
- EXISTS: At least one row is returned.

## Modification of Database

**Deletion:** A delete request is expressed in much the same way as a query. We can delete only whole tuples; we cannot delete values on only particular attributes. SQL expresses a deletion by:

```
delete from r  
where P;
```

## Modification of Database

**Insertion:** To insert data into a relation, we either specify a tuple to be inserted or write a query whose result is a set of tuples to be inserted.

Example:

```
insert into course  
    values ('CS-437', 'Database Systems', 'Comp.  
Sci.', 4);
```

## Modification of Database

**Updates:** To update values in a table the update statement can be used.

Example:

```
update instructor  
set salary= salary * 1.05;
```

## Window Functions

A window function perform “sliding” calculation across a set of tuples that are related. Like an aggregation but tuples are not grouped into a single output tuple.

It can be used to calculate aggregates, rankings, and perform other analytical tasks without the need for subqueries or self-joins.

## Window Functions

**Functions:** The window function can be any of the aggregation functions discussed above.

There are also also special window functions:

1. **ROW NUMBER:** The number of the current row.
2. **RANK:** The order position of the current row.

**Grouping:** The OVER clause specifies how to group together tuples when computing the window function. Use PARTITION BY to specify group.

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**TEST ANNOUNCEMENT: THEORY QUIZ COVERING UNITS 1 to 3  
WILL BE CONDUCTED ON 4/3/24 MONDAY**

SUBMISSION OF **1ST DRAFT** PRACTICAL ASSIGNMENT  
STAGE 1 ON **8/3/24**,  
SUBMISSION OF **FINAL ERD AND RELATIONAL SCHEMA-**  
PRACTICAL ASSIGNMENT STAGE 2 ON **18/3/24**



10 Minutes Break and We Begin Flipped Class

## Next Session

### Unit IV : Intermediate and Advanced SQL

- 4.1 Join Expressions
- 4.2 Views
- 4.3 Transactions
- 4.4 Integrity Constraints
- 4.5 SQL Data Types and Schemas
- 4.6 Index Definition in SQL
- 4.7 Authorization
- 4.8 Accessing SQL from a Programming Language
- 4.9 Functions and Procedures
- 4.10 Triggers
- 4.11 Recursive Queries
- 4.12 Advanced Aggregation Features