Lecture x

More SQL: Complex Queries, Views, and Schema Modification

AT71.01
Database Design

Asian Institute of Technology

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Outline (Chapter 5)

- More Complex SQL Retrieval Queries
- Views (Virtual Tables) in SQL
- Schema Change Statements in SQL

MORE COMPLEX SQL RETRIEVAL QUERIES

More Complex SQL Retrieval Queries

- Additional features allow users to specify more complex retrievals from database:
  - Nested queries, joined tables, outer joins, aggregate functions, and grouping

Comparisons Involving NULL and Three-Valued Logic

- Meanings of NULL
  - **Unknown value**
  - **Unavailable or withheld value**
  - **Not applicable attribute**
- Each individual NULL value considered to be different from every other NULL value
- SQL uses a three-valued logic:
  - TRUE, FALSE, and UNKNOWN

Comparisons Involving NULL and Three-Valued Logic (cont'd.)

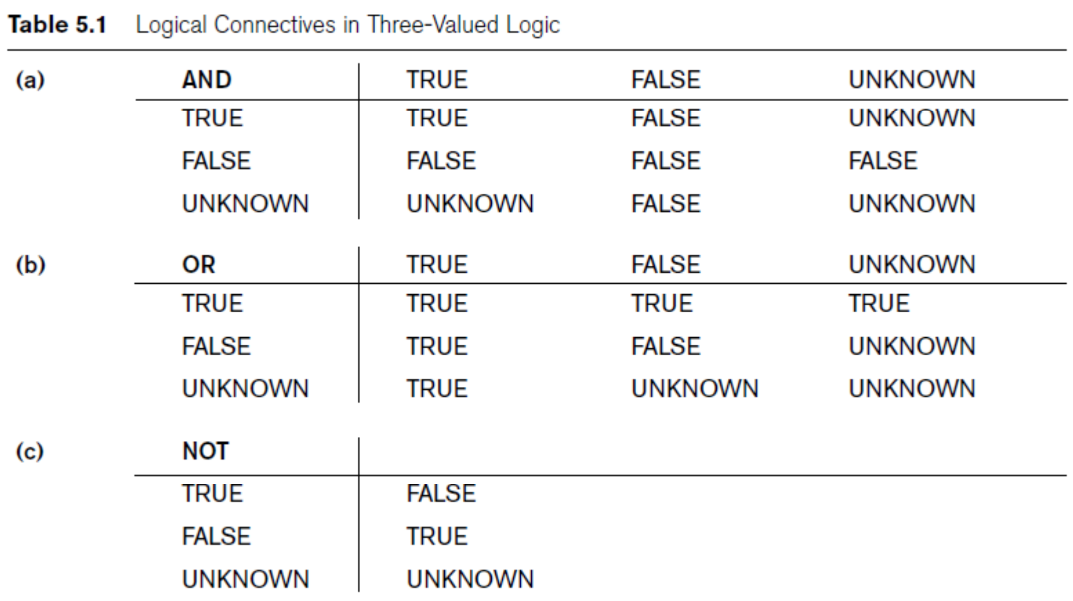


Table 5.1 Logical Connectives in Three-Valued Logic

(a)

AND	TRUE	FALSE	UNKNOWN
TRUE	TRUE	FALSE	UNKNOWN
FALSE	FALSE	FALSE	FALSE
UNKNOWN	UNKNOWN	FALSE	UNKNOWN

(b)

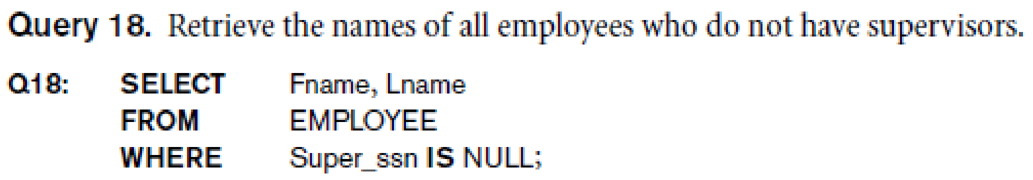
OR	TRUE	FALSE	UNKNOWN
TRUE	TRUE	TRUE	TRUE
FALSE	TRUE	FALSE	UNKNOWN
UNKNOWN	TRUE	UNKNOWN	UNKNOWN

(c)

NOT	
TRUE	FALSE
FALSE	TRUE
UNKNOWN	UNKNOWN

Comparisons Involving NULL and Three-Valued Logic (cont'd.)

- SQL allows queries that check whether an attribute value is NULL
  - `IS` or `IS NOT NULL`



Query 18. Retrieve the names of all employees who do not have supervisors.

```
Q18:   SELECT    Fname, Lname
       FROM      EMPLOYEE
       WHERE     Super_ssn IS NULL;
```

Nested Queries, Tuples, and Set/Multiset Comparisons

- **Nested queries**
  - Complete select-from-where blocks within WHERE clause of another query
  - **Outer query**
- Comparison operator `IN`
  - Compares value *v* with a set (or multiset) of values *V*
  - Evaluates to TRUE if *v* is one of the elements in *V*

Nested Queries (cont'd.)

```
Q4A:  SELECT    DISTINCT Pnumber
      FROM      PROJECT
      WHERE     Pnumber IN
                ( SELECT    Pnumber
                  FROM      PROJECT, DEPARTMENT, EMPLOYEE
                  WHERE     Dnum=Dnumber AND
                            Mgr_ssn=Ssn AND Lname='Smith' )
                OR
                Pnumber IN
                ( SELECT    Pno
                  FROM      WORKS_ON, EMPLOYEE
                  WHERE     Essn=Ssn AND Lname='Smith' );
```

Nested Queries (cont'd.)

- Use tuples of values in comparisons
  - Place them within parentheses

```
SELECT    DISTINCT Essn
FROM      WORKS_ON
WHERE     (Pno, Hours) IN ( SELECT    Pno, Hours
                            FROM      WORKS_ON
                            WHERE     Essn='123456789' );
```

Nested Queries (cont'd.)

- Use other comparison operators to compare a single value *v*
  - = ANY (or = SOME) operator
    - Returns TRUE if the value *v* is equal to some value in the set *V* and is hence equivalent to IN
  - Other operators that can be combined with ANY (or SOME): >, >=, <, <=, and <>

```
SELECT    Lname, Fname
FROM      EMPLOYEE
WHERE     Salary > ALL   ( SELECT    Salary
                           FROM      EMPLOYEE
                           WHERE     Dno=5 );
```

Nested Queries (cont'd.)

- Avoid potential errors and ambiguities
  - Create tuple variables (aliases) for all tables referenced in SQL query

Query 16. Retrieve the name of each employee who has a dependent with the same first name and is the same sex as the employee.

```
Q16:   SELECT    E.Fname, E.Lname
       FROM      EMPLOYEE AS E
       WHERE     E.Ssn IN   ( SELECT    Essn
                              FROM      DEPENDENT AS D
                              WHERE     E.Fname=D.Dependent_name
                                        AND E.Sex=D.Sex );
```

Correlated Nested Queries

- **Correlated** nested query
  - Evaluated once for each tuple in the outer query

The EXISTS and UNIQUE Functions in SQL

- `EXISTS` function
  - Check whether the result of a correlated nested query is empty or not
- `EXISTS` and `NOT EXISTS`
  - Typically used in conjunction with a correlated nested query
- SQL function `UNIQUE(Q)`
  - Returns TRUE if there are no duplicate tuples in the result of query Q

Explicit Sets and Renaming of Attributes in SQL

- Can use explicit set of values in WHERE clause
- Use qualifier AS followed by desired new name
  - Rename any attribute that appears in the result of a query

```
Q8A:   SELECT   E.Lname AS Employee_name, S.Lname AS Supervisor_name
       FROM     EMPLOYEE AS E, EMPLOYEE AS S
       WHERE    E.Super_ssn=S.Ssn;
```

Joined Tables in SQL and Outer Joins

- **Joined table**
  - Permits users to specify a table resulting from a join operation in the FROM clause of a query
- The FROM clause in Q1A
  - Contains a single joined table

```
Q1A:   SELECT   Fname, Lname, Address
       FROM     (EMPLOYEE JOIN DEPARTMENT ON Dno=Dnumber)
       WHERE    Dname='Research';
```

Joined Tables in SQL and Outer Joins (cont'd.)

- Specify different types of join
  - NATURAL JOIN
  - Various types of OUTER JOIN
- NATURAL JOIN on two relations R and S
  - No join condition specified
  - Implicit EQUIJOIN condition for each pair of attributes with same name from R and S

Joined Tables in SQL and Outer Joins (cont'd.)

- **Inner join**
  - Default type of join in a joined table
  - Tuple is included in the result only if a matching tuple exists in the other relation
- LEFT OUTER JOIN
  - Every tuple in left table must appear in result
  - If no matching tuple
    - Padded with NULL values for attributes of right table

Joined Tables in SQL and Outer Joins (cont'd.)

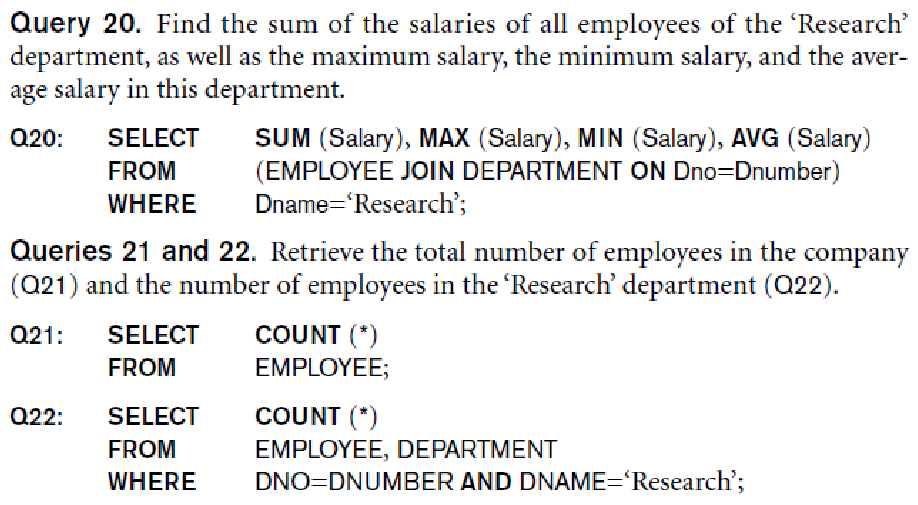
- RIGHT OUTER JOIN
  - Every tuple in right table must appear in result
  - If no matching tuple
    - Padded with NULL values for the attributes of left table
- FULL OUTER JOIN
- Can nest join specifications

Aggregate Functions in SQL

- Used to summarize information from multiple tuples into a single-tuple summary
- **Grouping**
  - Create subgroups of tuples before summarizing
- Built-in aggregate functions
  - **`COUNT`**, **`SUM`**, **`MAX`**, **`MIN`**, and **`AVG`**
- Functions can be used in the `SELECT` clause or in a `HAVING` clause

Aggregate Functions in SQL (cont'd.)

- NULL values discarded when aggregate functions are applied to a particular column



Query 20. Find the sum of the salaries of all employees of the 'Research' department, as well as the maximum salary, the minimum salary, and the average salary in this department.

```
Q20:    SELECT    SUM (Salary), MAX (Salary), MIN (Salary), AVG (Salary)
        FROM      (EMPLOYEE JOIN DEPARTMENT ON Dno=Dnumber)
        WHERE     Dname='Research';
```

Queries 21 and 22. Retrieve the total number of employees in the company (Q21) and the number of employees in the 'Research' department (Q22).

```
Q21:    SELECT    COUNT (*)
        FROM      EMPLOYEE;

Q22:    SELECT    COUNT (*)
        FROM      EMPLOYEE, DEPARTMENT
        WHERE     DNO=DNUMBER AND DNAME='Research';
```

Grouping: The GROUP BY and HAVING Clauses

- **Partition** relation into subsets of tuples
  - Based on **grouping attribute(s)**
  - Apply function to each such group independently
- **GROUP BY** clause
  - Specifies grouping attributes
- If NULLs exist in grouping attribute
  - Separate group created for all tuples with a NULL value in grouping attribute

Grouping: The GROUP BY and HAVING Clauses (cont'd.)

- **HAVING** clause
  - Provides a condition on the summary information

Query 28. For each department that has more than five employees, retrieve the department number and the number of its employees who are making more than $40,000.

```
Q28:    SELECT    Dnumber, COUNT (*)
        FROM      DEPARTMENT, EMPLOYEE
        WHERE     Dnumber=Dno AND Salary>40000 AND
                  ( SELECT      Dno
                    FROM        EMPLOYEE
                    GROUP BY Dno
                    HAVING      COUNT (*) > 5)
```

Discussion and Summary of SQL Queries

```
SELECT <attribute and function list>
FROM <table list>
[ WHERE <condition> ]
[ GROUP BY <grouping attribute(s)> ]
[ HAVING <group condition> ]
[ ORDER BY <attribute list> ];
```

VIEWS (VIRTUAL TABLES) IN SQL

Views (Virtual Tables) in SQL

- Concept of a view in SQL
  - Single table derived from other tables
  - Considered to be a virtual table

Specification of Views in SQL

- **CREATE VIEW** command
  - Give table name, list of attribute names, and a query to specify the contents of the view

```
V1:    CREATE VIEW    WORKS_ON1
       AS SELECT      Fname, Lname, Pname, Hours
          FROM        EMPLOYEE, PROJECT, WORKS_ON
          WHERE       Ssn=Essn AND Pno=Pnumber;

V2:    CREATE VIEW    DEPT_INFO(Dept_name, No_of_emps, Total_sal)
       AS SELECT      Dname, COUNT (*), SUM (Salary)
          FROM        DEPARTMENT, EMPLOYEE
          WHERE       Dnumber=Dno
          GROUP BY    Dname;
```

Specification of Views in SQL (cont'd.)

- Specify SQL queries on a view
- View always up-to-date
  - Responsibility of the DBMS and not the user
- **DROP VIEW** command
  - Dispose of a view

View Implementation, View Update, and Inline Views

- Complex problem of efficiently implementing a view for querying
- **Query modification** approach
  - Modify view query into a query on underlying base tables
  - Disadvantage: inefficient for views defined via complex queries that are time-consuming to execute

View Implementation

- **View materialization approach**
  - Physically create a temporary view table when the view is first queried
  - Keep that table on the assumption that other queries on the view will follow
  - Requires efficient strategy for automatically updating the view table when the base tables are updated

View Implementation (cont'd.)

- **Incremental update strategies**
  - DBMS determines what new tuples must be inserted, deleted, or modified in a materialized view table

View Update and Inline Views

- Update on a view defined on a single table without any aggregate functions
  - Can be mapped to an update on underlying base table
- View involving joins
  - Often not possible for DBMS to determine which of the updates is intended

View Update and Inline Views (cont'd.)

- Clause **`WITH CHECK OPTION`**
  - Must be added at the end of the view definition if a view is to be updated
- **In-line view**
  - Defined in the `FROM` clause of an SQL query

SCHEMA CHANGE STATEMENTS IN SQL

Schema Change Statements in SQL

- **Schema evolution commands**
  - Can be done while the database is operational
  - Does not require recompilation of the database schema

The DROP Command

- DROP command
  - Used to drop named schema elements, such as tables, domains, or constraint
- Drop behavior options:
  - CASCADE and RESTRICT
- Example:
  - `DROP SCHEMA COMPANY CASCADE;`

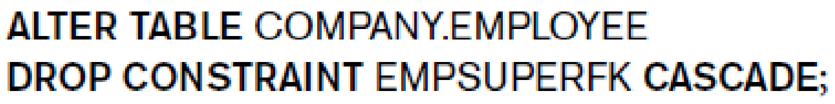
The ALTER Command

- **Alter table actions** include:
  - Adding or dropping a column (attribute)
  - Changing a column definition
  - Adding or dropping table constraints
- Example:

  -
    ```
    ALTER TABLE COMPANY.EMPLOYEE ADD
    COLUMN Job VARCHAR(12);
    ```
- To drop a column
  - Choose either CASCADE or RESTRICT

The ALTER Command (cont'd.)

- Change constraints specified on a table
  - Add or drop a named constraint



```
ALTER TABLE COMPANY.EMPLOYEE
DROP CONSTRAINT EMPSUPERFK CASCADE;
```

SUMMARY

Summary

- Complex SQL:
  - Nested queries, joined tables, outer joins, aggregate functions, grouping
- `CREATE ASSERTION` and `CREATE TRIGGER`
- Views
  - Virtual or derived tables