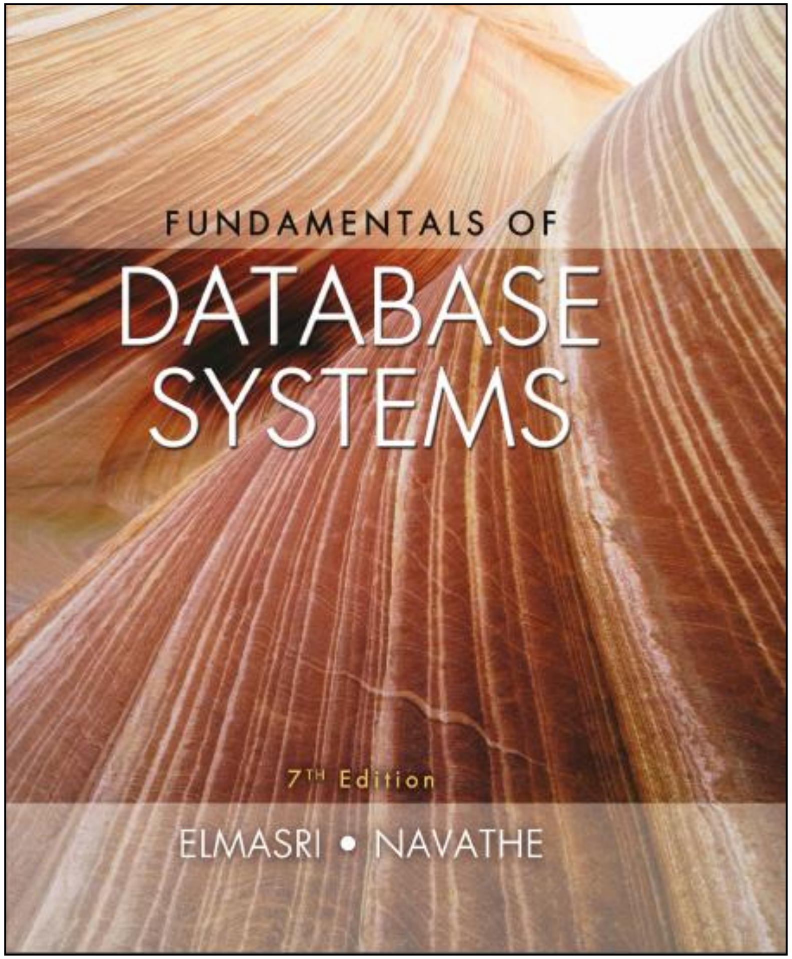
Fundamentals of Database Systems

Seventh Edition



Chapter 7

More SQL:
Complex Queries,
Triggers,
Views,
Schema Modification

Learning Objectives

7.1 More Complex SQL Retrieval Queries

7.2 Specifying Semantic Constraints as Assertions and Actions as Triggers

7.3 Views (Virtual Tables) in SQL

7.4 Schema Modification in SQL

More Complex SQL Retrieval Queries

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

Comparisons Involving NULL and Three-Valued Logic (1 of 3)

- 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` (like Maybe)
- **NULL = NULL** comparison is avoided

Comparisons Involving NULL and Three-Valued Logic (2 of 3)

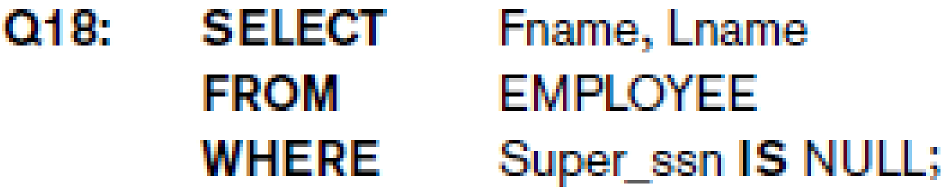
Table 7.1 Logical Connectives in Three-Valued Logic

(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 (3 of 3)

- 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.



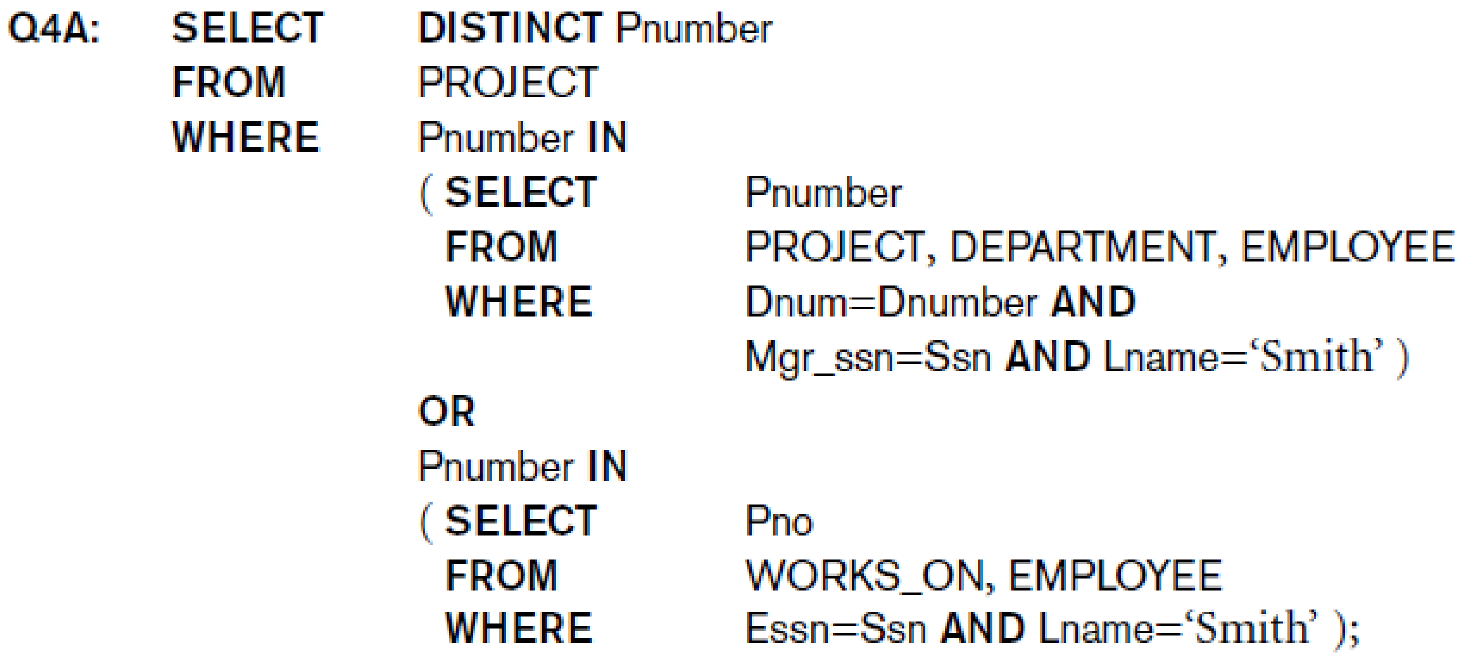
```
Q18:    SELECT    Fname, Lname
        FROM      EMPLOYEE
        WHERE     Super_ssn IS NULL;
```

Nested Queries, Tuples, and Set/Multiset Comparisons

- **Nested queries**
  - Complete select-from-where blocks within WHERE clause of another query
  - **Outer query and nested subqueries**
- 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 (1 of 4)

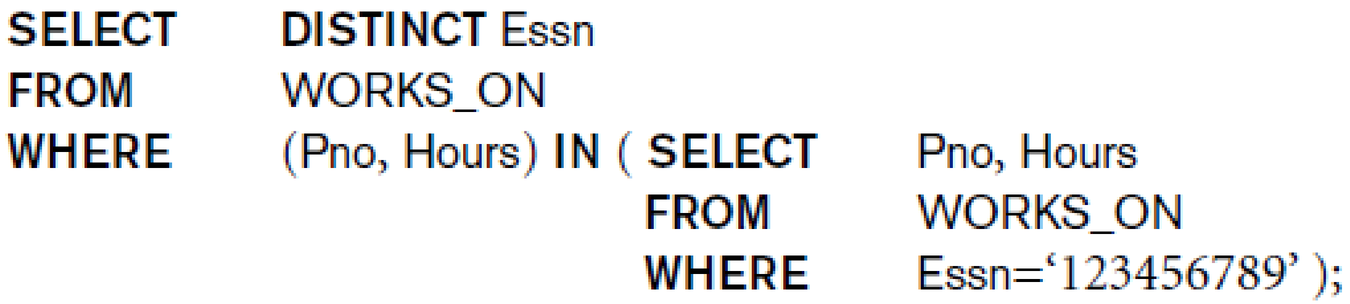
Make a list of all project numbers for projects that involve an employee whose last name is ‘Wong’, either as a worker or as a manager of the department that controls the project.



```
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 (2 of 4)

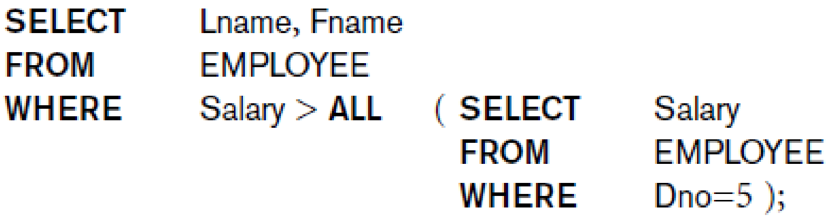
- Use tuples of values in comparisons
  - Place them within parentheses



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

Nested Queries (3 of 4)

- 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 <>
  - ALL: value must exceed all values from nested query

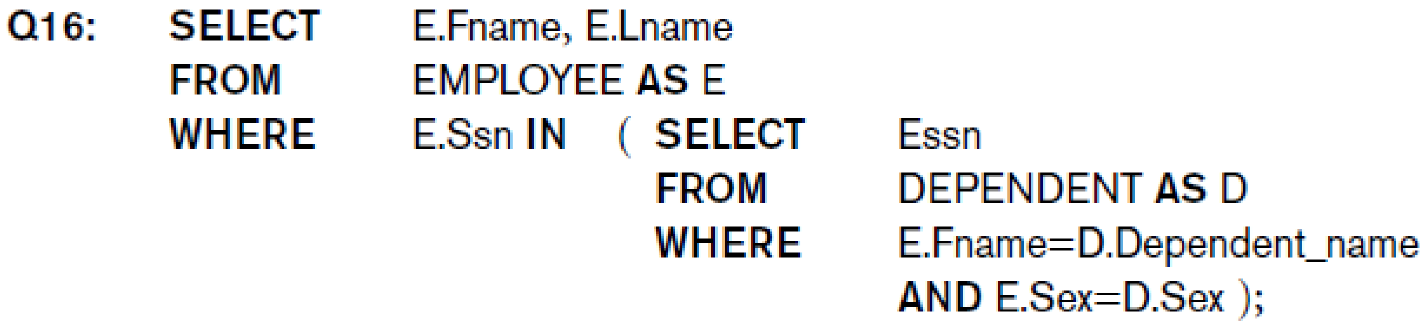


```
SELECT    Lname, Fname
FROM      EMPLOYEE
WHERE     Salary > ALL    ( SELECT     Salary
                            FROM       EMPLOYEE
                            WHERE      Dno=5 );
```

Nested Queries (4 of 4)

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

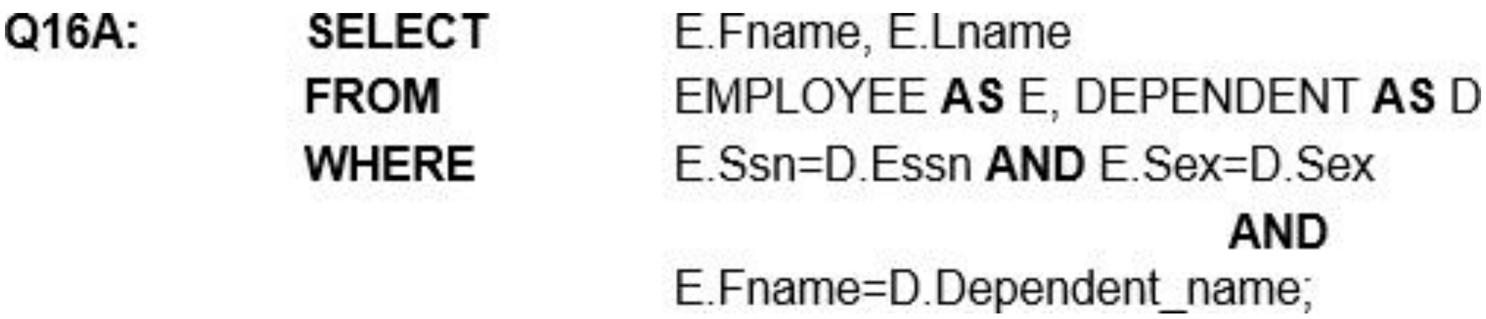
Query 16. Retrieve the name of each employee who has a dependent with the same first name and is the same sex as the employee.



```
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

- **Queries that are nested using the = or IN comparison operator** can be collapsed into one single block: E.g., Q16 can be written as:



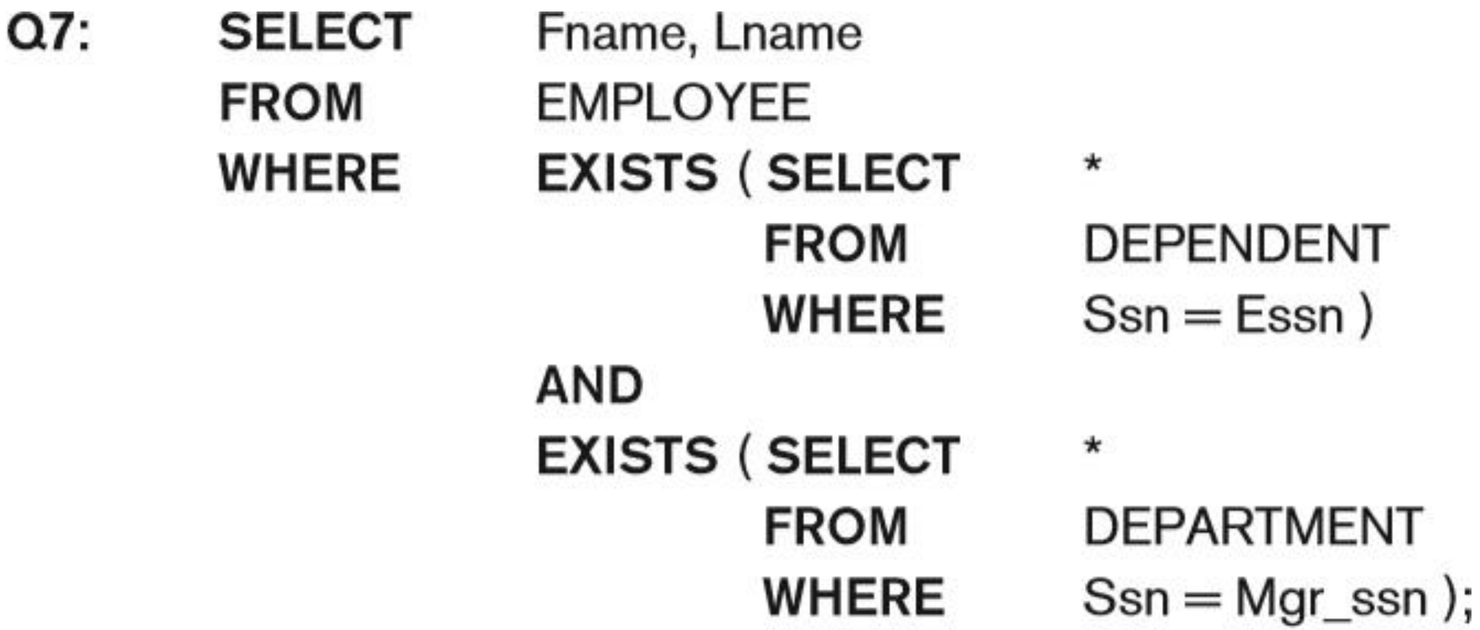
```
Q16A:    SELECT    E.Fname, E.Lname
         FROM      EMPLOYEE AS E, DEPENDENT AS D
         WHERE     E.Ssn=D.Essn AND E.Sex=D.Sex
                                       AND
                   E.Fname=D.Dependent_name;
```

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

The EXISTS and UNIQUE Functions in SQL for Correlating Queries

- `EXISTS` function
  - Check whether the result of a correlated nested query is empty or not. They are Boolean functions that return a TRUE or FALSE result.
- `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

USE of EXISTS

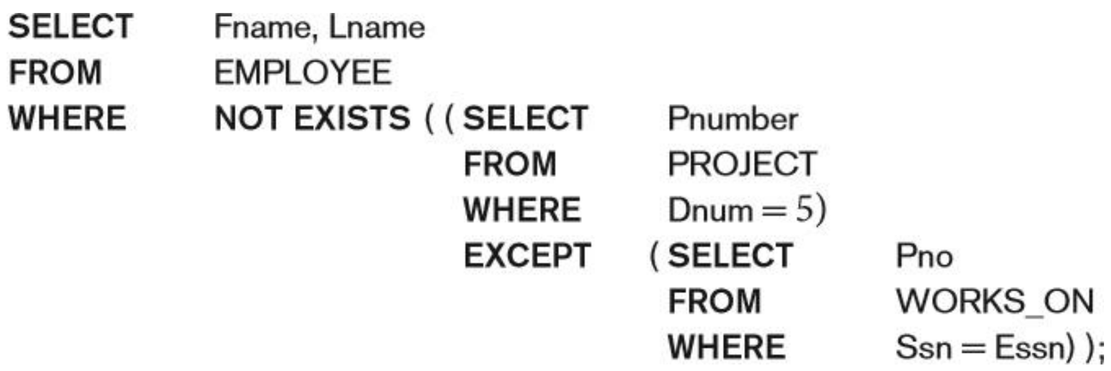


```
Q7:   SELECT   Fname, Lname
      FROM     EMPLOYEE
      WHERE    EXISTS ( SELECT   *
                        FROM     DEPENDENT
                        WHERE    Ssn = Essn )
               AND
               EXISTS ( SELECT   *
                        FROM     DEPARTMENT
                        WHERE    Ssn = Mgr_ssn );
```

USE OF NOT EXISTS

To achieve the “for all” (universal quantifier- see Ch 8) effect, we use double negation this way in SQL:

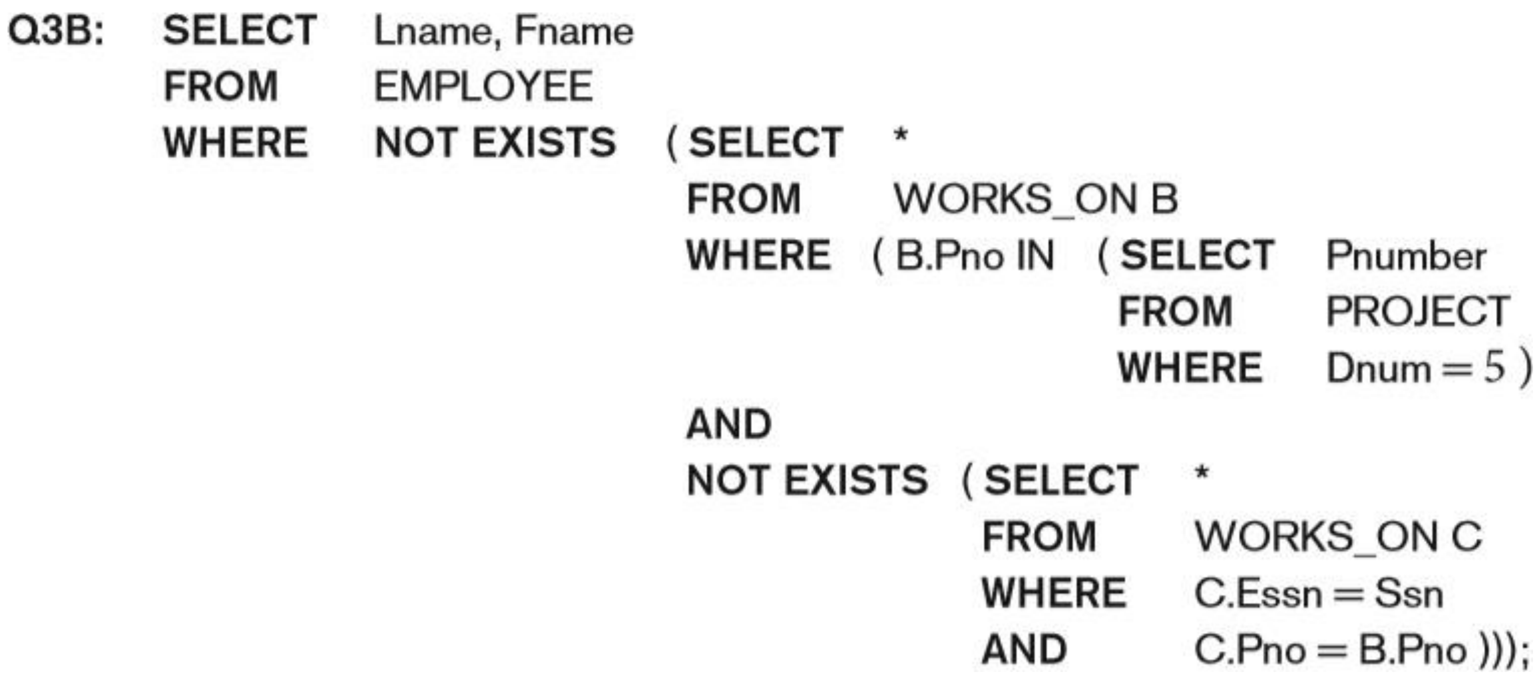
Query: List first and last name of employees who work on **ALL projects controlled by Dno=5.**



```
SELECT     Fname, Lname
FROM       EMPLOYEE
WHERE      NOT EXISTS ( ( SELECT    Pnumber
                          FROM      PROJECT
                          WHERE     Dnum = 5)
                          EXCEPT    ( SELECT    Pno
                                      FROM      WORKS_ON
                                      WHERE     Ssn = Essn) );
```

The above is equivalent to double negation: List names of those employees for whom there does NOT exist a project managed by department no. 5 that they do NOT work on.

Double Negation to Accomplish "for All" in SQL

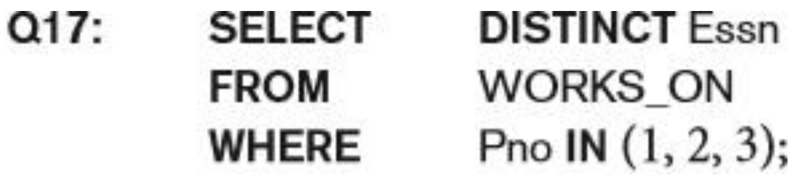


```
Q3B:  SELECT   Lname, Fname
      FROM     EMPLOYEE
      WHERE    NOT EXISTS  ( SELECT   *
                             FROM     WORKS_ON B
                             WHERE    ( B.Pno IN  ( SELECT   Pnumber
                                                    FROM     PROJECT
                                                    WHERE    Dnum = 5 )
                             AND
                             NOT EXISTS  ( SELECT   *
                                           FROM     WORKS_ON C
                                           WHERE    C.Essn = Ssn
                                           AND      C.Pno = B.Pno )));
```

The above is a direct rendering of: List names of those employees for whom there does Not exist a project managed by department no. 5 that they do Not work on.

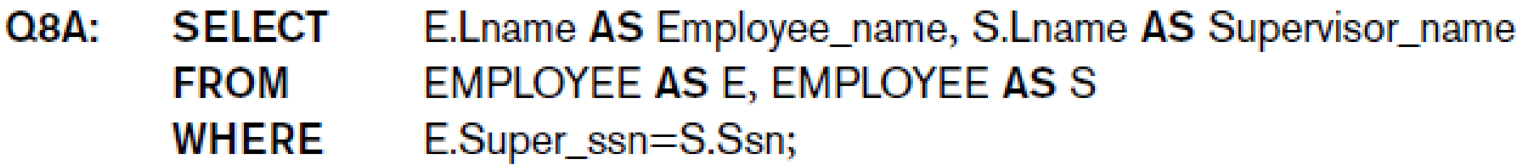
Explicit Sets and Renaming of Attributes in SQL

- Can use explicit set of values in WHERE clause



```
Q17:    SELECT    DISTINCT Essn
        FROM      WORKS_ON
        WHERE     Pno IN (1, 2, 3);
```

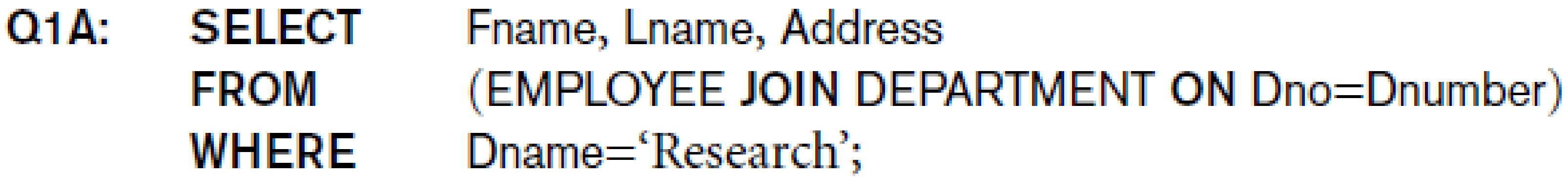
- Use qualifier AS followed by desired new name
  - Rename any attribute that appears in the result of a query



```
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;
```

Specifying Joined Tables in the FROM Clause of SQL

- **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. JOIN may also be called INNER JOIN



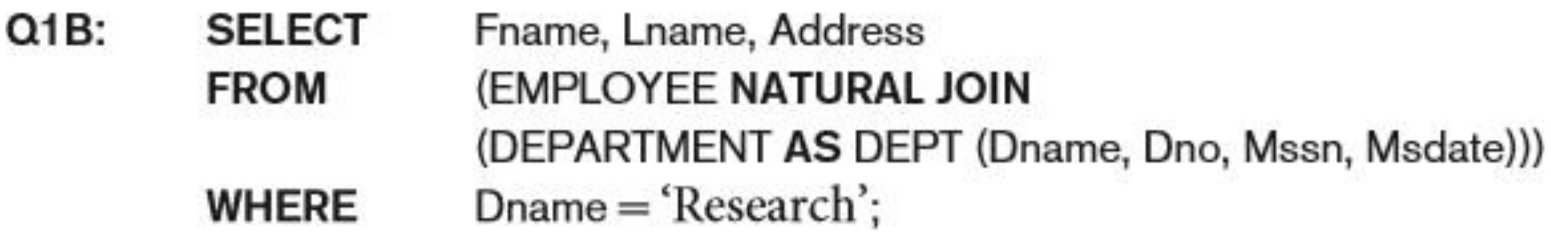
```
Q1A:    SELECT    Fname, Lname, Address
        FROM      (EMPLOYEE JOIN DEPARTMENT ON Dno=Dnumber)
        WHERE     Dname='Research';
```

Different Types of JOINed Tables in SQL

- Specify different types of join
  - NATURAL JOIN
  - Various types of OUTER JOIN (LEFT, RIGHT, FULL)
- NATURAL JOIN on two relations R and S
  - No join condition specified
  - Is equivalent to an implicit EQUIJOIN condition for each pair of attributes with same name from R and S

NATURAL JOIN

- Rename attributes of one relation so it can be joined with another using NATURAL JOIN:



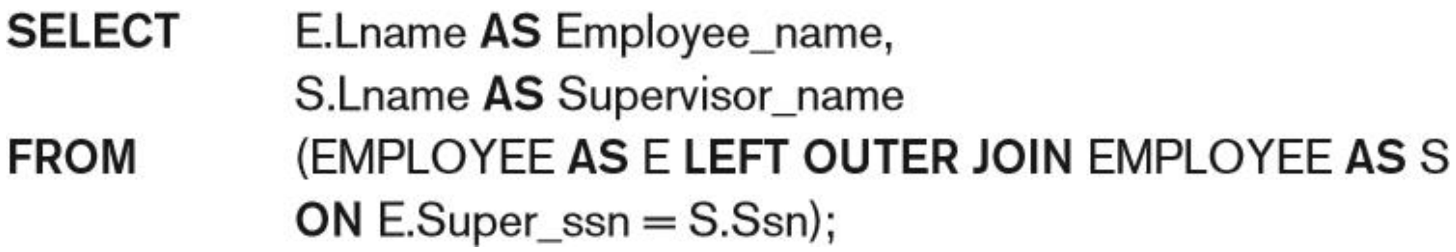
```
Q1B:    SELECT    Fname, Lname, Address
        FROM      (EMPLOYEE NATURAL JOIN
                  (DEPARTMENT AS DEPT (Dname, Dno, Mssn, Msdate)))
        WHERE     Dname = 'Research';
```

The above works with EMPLOYEE.Dno = DEPT.Dno as an implicit join condition

INNER and OUTER Joins

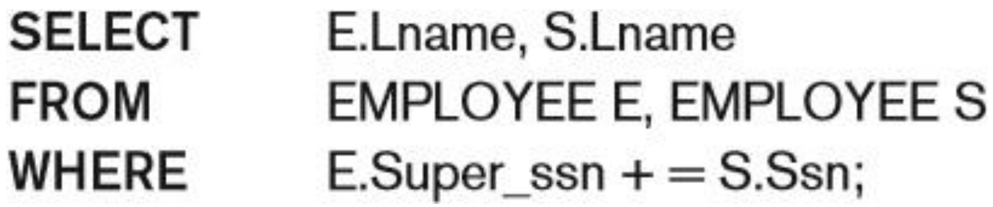
- INNER JOIN (**versus** OUTER JOIN)
  - Default type of join in a joined table
  - Tuple is included in the result only if a matching tuple exists in the other relation
- LEFT OUTER JOIN
  - Every tuple in left table must appear in result
  - If no matching tuple
    - Padded with NULL values for attributes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

Example: LEFT OUTER JOIN



```
SELECT    E.Lname AS Employee_name,
          S.Lname AS Supervisor_name
FROM      (EMPLOYEE AS E LEFT OUTER JOIN EMPLOYEE AS S
          ON E.Super_ssn = S.Ssn);
```

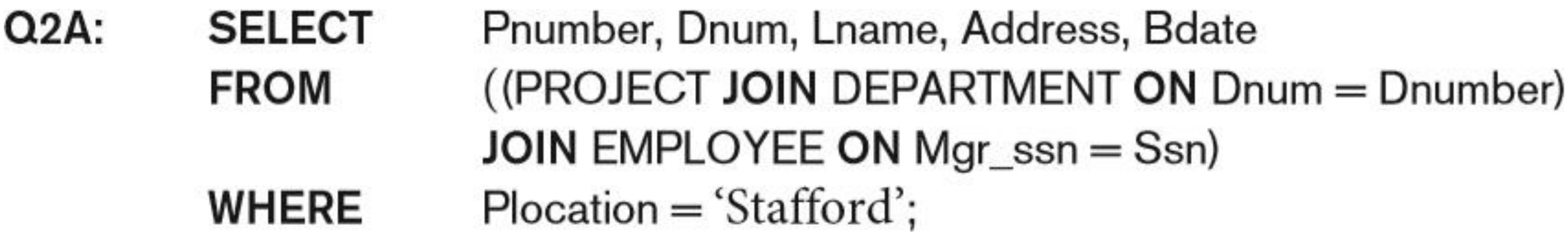
Alternate Syntax:



```
SELECT    E.Lname, S.Lname
FROM      EMPLOYEE E, EMPLOYEE S
WHERE     E.Super_ssn + = S.Ssn;
```

Multiway JOIN in the FROM Clause

- FULL OUTER JOIN – combines result if LEFT and RIGHT OUTER JOIN
- Can nest JOIN specifications for a multiway join:



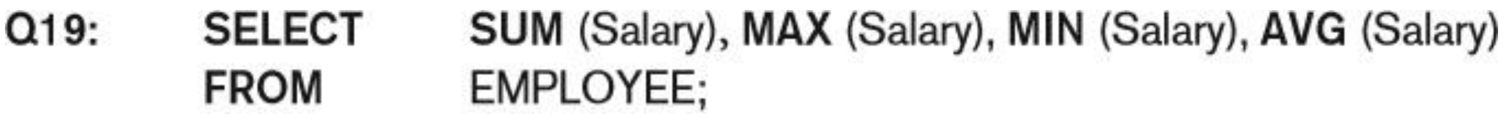
```
Q2A:    SELECT   Pnumber, Dnum, Lname, Address, Bdate
        FROM     ((PROJECT JOIN DEPARTMENT ON Dnum = Dnumber)
                 JOIN EMPLOYEE ON Mgr_ssn = Ssn)
        WHERE    Plocation = 'Stafford';
```

Aggregate Functions in SQL (1 of 3)

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

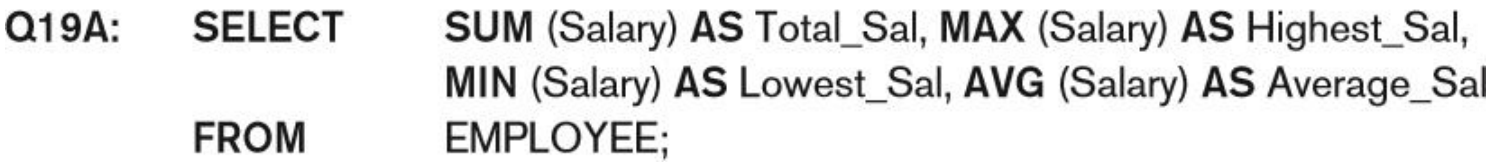
Renaming Results of Aggregation

- Following query returns a single row of computed values from EMPLOYEE table:



```
Q19:    SELECT    SUM (Salary), MAX (Salary), MIN (Salary), AVG (Salary)
        FROM      EMPLOYEE;
```

- The result can be presented with new names:

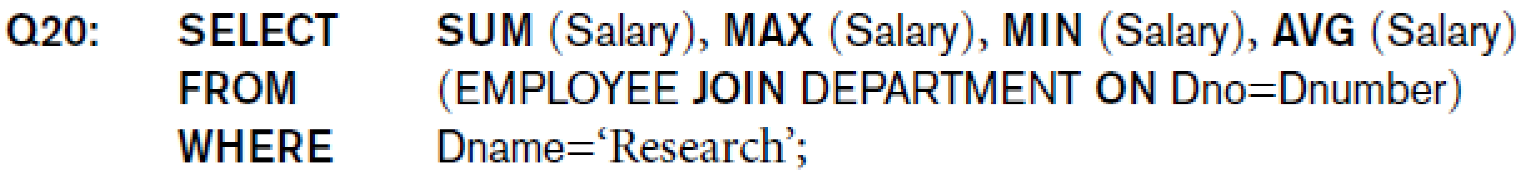


```
Q19A:   SELECT    SUM (Salary) AS Total_Sal, MAX (Salary) AS Highest_Sal,
                  MIN (Salary) AS Lowest_Sal, AVG (Salary) AS Average_Sal
        FROM      EMPLOYEE;
```

Aggregate Functions in SQL (2 of 3)

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

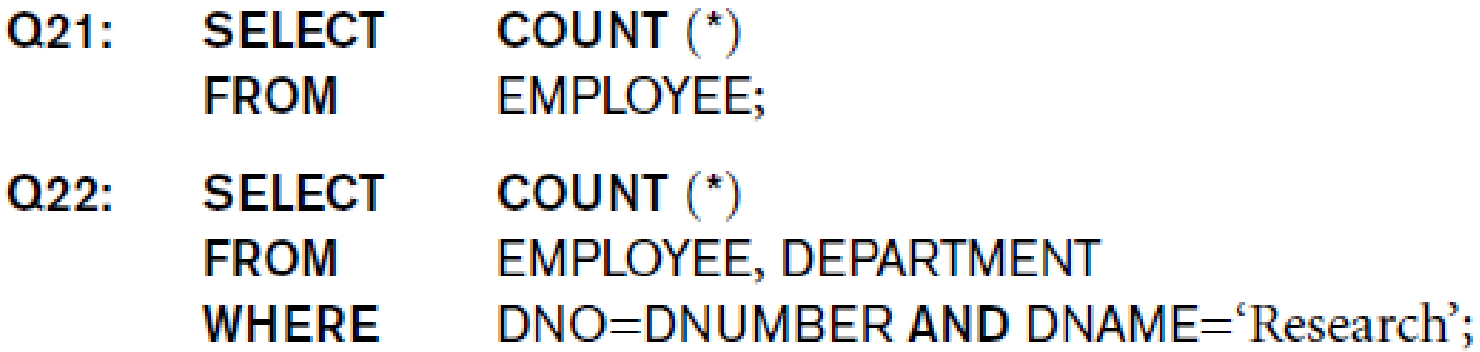
Query 20. Find the sum of the salaries of all employees of the ‘Research’ department, as well as the maximum salary, the minimum salary, and the average salary in this department.



```
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).

Aggregate Functions in SQL (3 of 3)



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

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

Aggregate Functions on Booleans

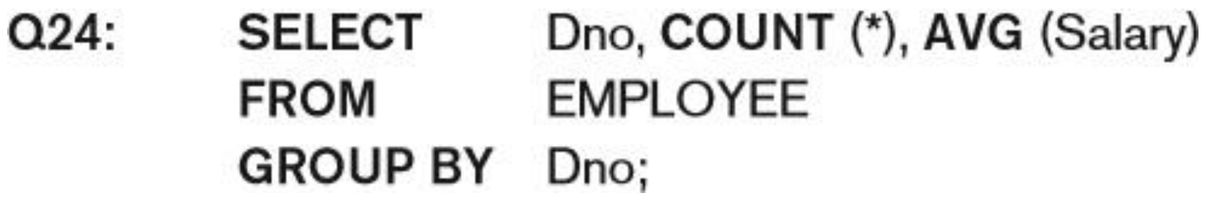
- SOME and ALL may be applied as functions on Boolean Values.
- SOME returns true if at least one element in the collection is TRUE (similar to OR)
- ALL returns true if all of the elements in the collection are TRUE (similar to AND)

Grouping: The GROUP BY Clause

- **Partition** relation into subsets of tuples
  - Based on **grouping attribute(s)**
  - Apply function to each such group independently
- **`GROUP BY`** clause
  - Specifies grouping attributes
- COUNT (*) counts the number of rows in the group

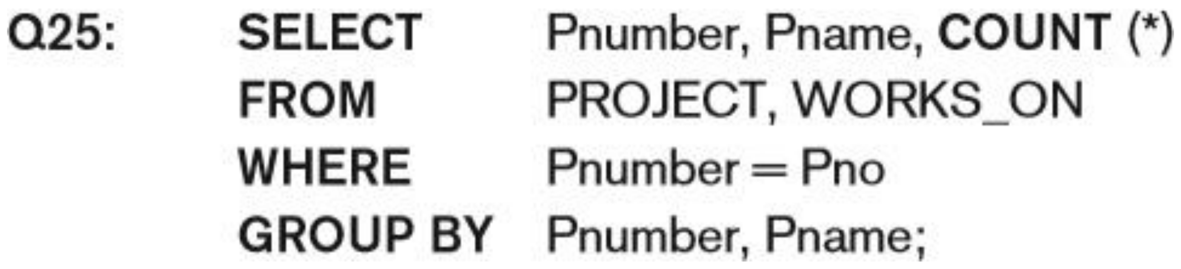
Examples of GROUP BY

- The grouping attribute must appear in the SELECT clause:



```
Q24:    SELECT      Dno, COUNT (*), AVG (Salary)
        FROM        EMPLOYEE
        GROUP BY    Dno;
```

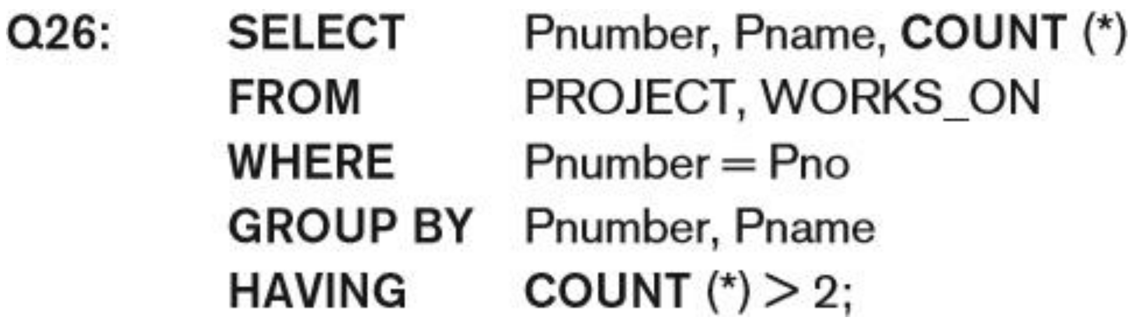
- If the grouping attribute has NULL as a possible value, then a separate group is created for the null value (e.g., null Dno in the above query)
- GROUP BY may be applied to the result of a JOIN:



```
Q25:    SELECT      Pnumber, Pname, COUNT (*)
        FROM        PROJECT, WORKS_ON
        WHERE       Pnumber = Pno
        GROUP BY    Pnumber, Pname;
```

Grouping: The GROUP BY and HAVING Clauses

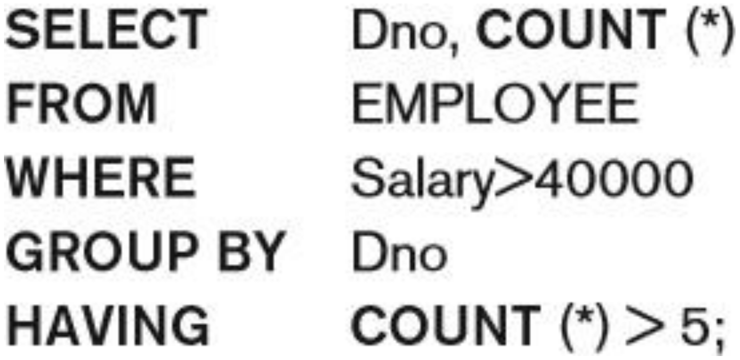
- **`HAVING`** clause
  - Provides a condition to select or reject an entire group:
- **Query 26.** For each project **on which more than two employees work**, retrieve the project number, the project name, and the number of employees who work on the project.



```
Q26:    SELECT      Pnumber, Pname, COUNT (*)
        FROM        PROJECT, WORKS_ON
        WHERE       Pnumber = Pno
        GROUP BY    Pnumber, Pname
        HAVING      COUNT (*) > 2;
```

Combining the WHERE and the HAVING Clause (1 of 2)

- Consider the query: we want to count the **total** number of employees whose salaries exceed $40,000 in each department, but only for departments where more than five employees work.
- Incorrect Query:



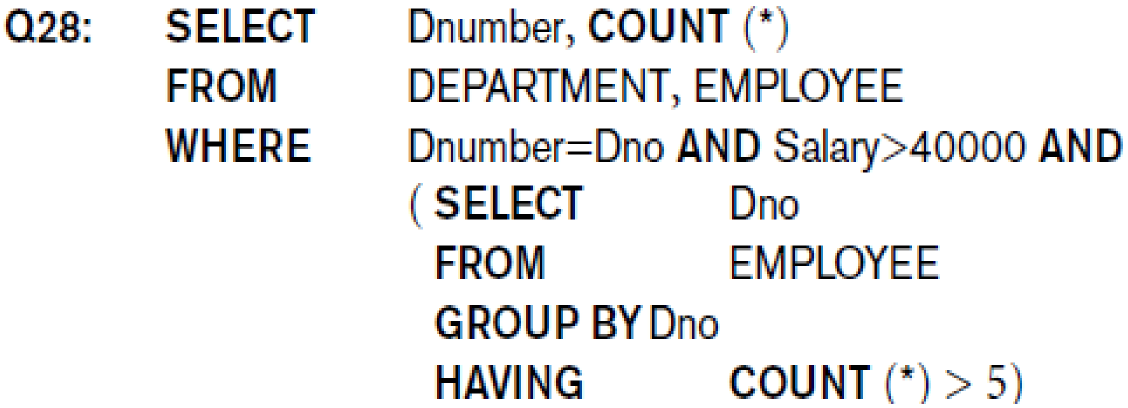
```
SELECT      Dno, COUNT (*)
FROM        EMPLOYEE
WHERE       Salary>40000
GROUP BY    Dno
HAVING      COUNT (*) > 5;
```

Combining the WHERE and the HAVING Clause (2 of 2)

Correct Specification of the Query:

- Note: the WHERE clause applies tuple by tuple whereas HAVING applies to entire group of tuples

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.



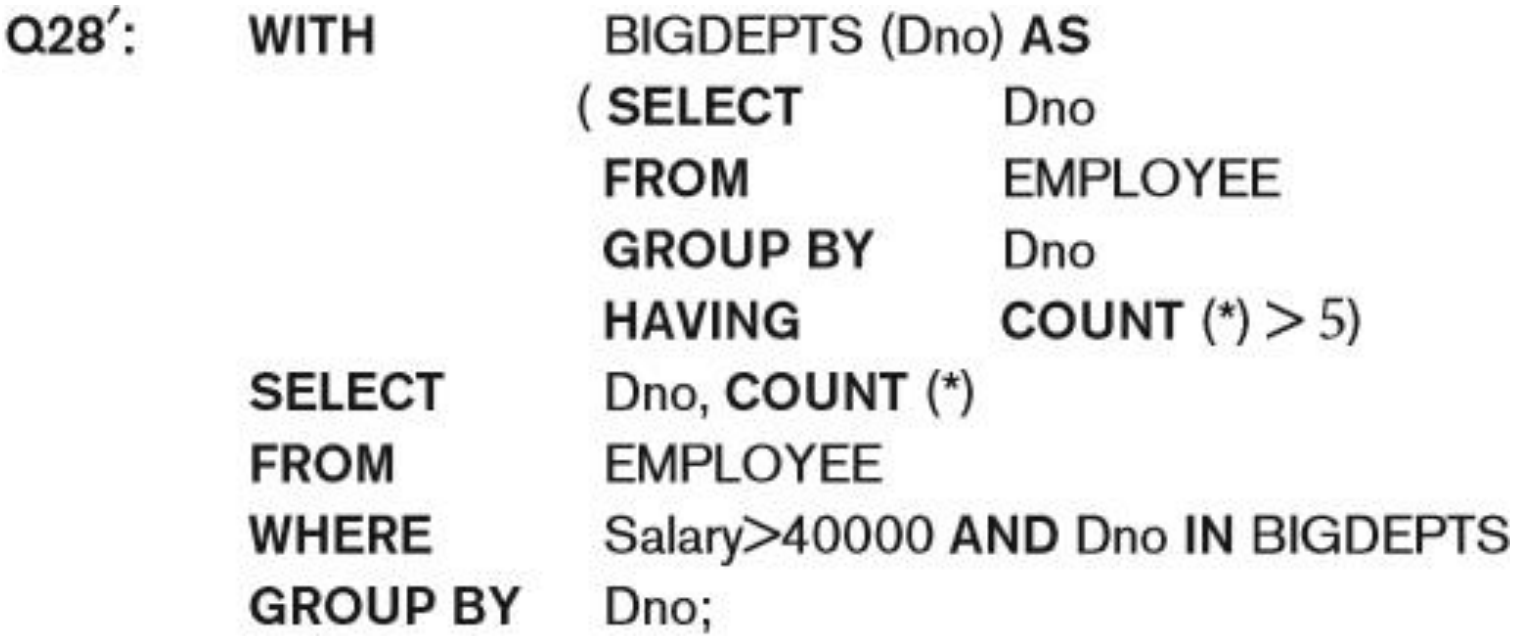
```
Q28:    SELECT      Dnumber, COUNT (*)
        FROM        DEPARTMENT, EMPLOYEE
        WHERE       Dnumber=Dno AND Salary>40000 AND
                    ( SELECT        Dno
                      FROM          EMPLOYEE
                      GROUP BY Dno
                      HAVING        COUNT (*)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

Use of WITH

- The WITH clause allows a user to define a table that will only be used in a particular query (not available in all SQL implementations)
- Used for convenience to create a temporary “View” and use that immediately in a query
- Allows a more straightforward way of looking a step-by-step query

Example of WITH

- See an alternate approach to doing Q28:



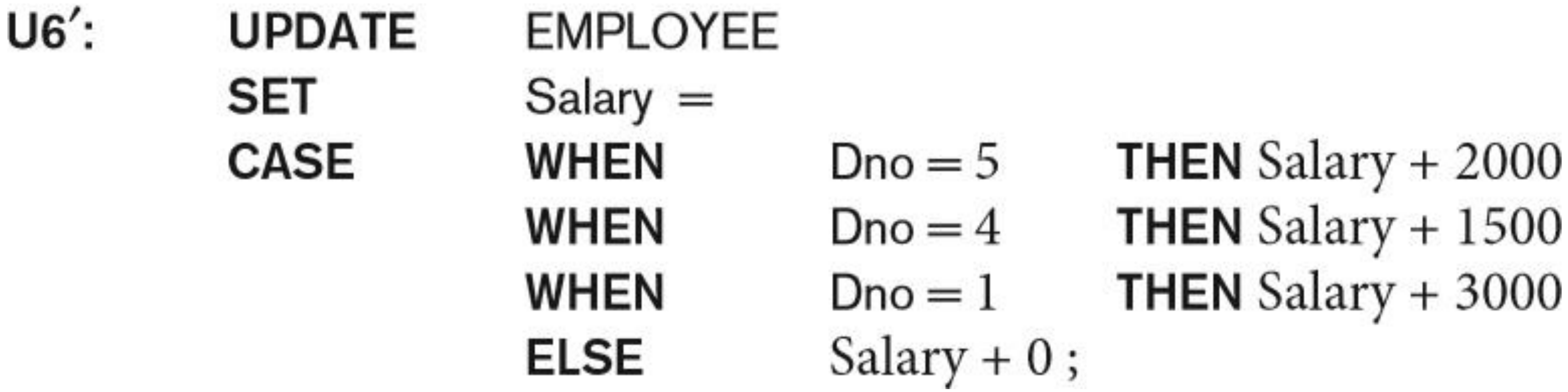
```
Q28′:   WITH        BIGDEPTS (Dno) AS
                   ( SELECT     Dno
                     FROM       EMPLOYEE
                     GROUP BY   Dno
                     HAVING     COUNT (*) > 5)
        SELECT      Dno, COUNT (*)
        FROM        EMPLOYEE
        WHERE       Salary>40000 AND Dno IN BIGDEPTS
        GROUP BY    Dno;
```

Use of CASE

- SQL also has a CASE construct
- Used when a value can be different based on certain conditions.
- Can be used in any part of an SQL query where a value is expected
- Applicable when querying, inserting or updating tuples

EXAMPLE of Use of CASE

- The following example shows that employees are receiving different raises in different departments (A variation of the update U6)

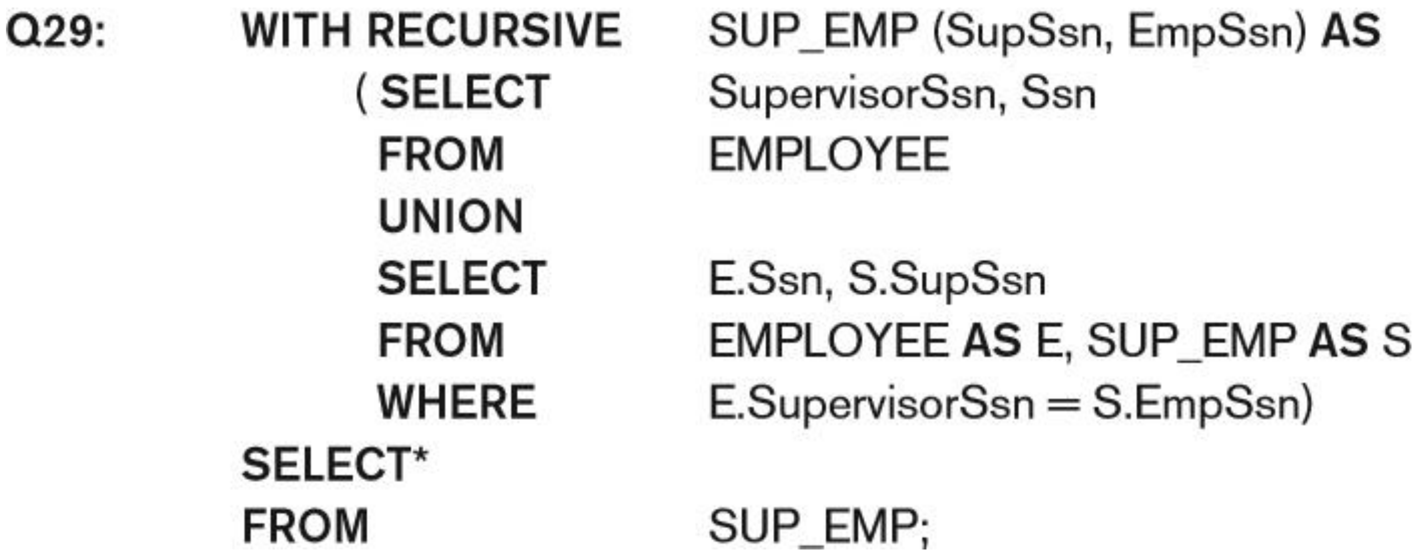


```
U6′:    UPDATE    EMPLOYEE
        SET       Salary =
        CASE      WHEN     Dno = 5     THEN Salary + 2000
                  WHEN     Dno = 4     THEN Salary + 1500
                  WHEN     Dno = 1     THEN Salary + 3000
                  ELSE     Salary + 0 ;
```

Recursive Queries in SQL

- An example of a **recursive relationship** between tuples of the same type is the relationship between an employee and a supervisor.
- This relationship is described by the foreign key Super_ssn of the EMPLOYEE relation
- An example of a **recursive operation** is to retrieve all supervisees of a supervisory employee *e* at all levels—that is, all employees ***e’*** directly supervised by ***e***, all employees ***e’*** directly supervised by each employee ***e’***, all employees ***e”’*** directly supervised by each employee ***e”***, and so on. Thus the CEO would have each employee in the company as a supervisee in the resulting table. Example shows such table SUP_EMP with 2 columns (Supervisor,Supervisee(any level)):

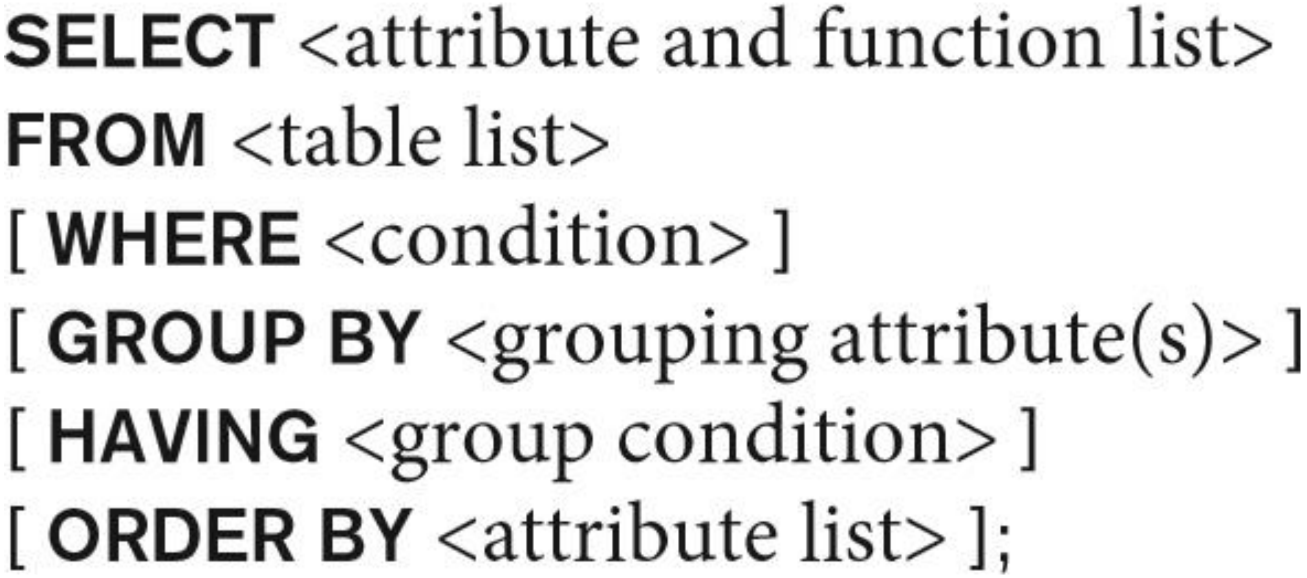
An EXAMPLE of RECURSIVE Query



```
Q29:    WITH RECURSIVE    SUP_EMP (SupSsn, EmpSsn) AS
             ( SELECT     SupervisorSsn, Ssn
               FROM       EMPLOYEE
               UNION
               SELECT     E.Ssn, S.SupSsn
               FROM       EMPLOYEE AS E, SUP_EMP AS S
               WHERE      E.SupervisorSsn = S.EmpSsn)
        SELECT*
        FROM              SUP_EMP;
```

- The above query starts with an empty SUP_EMP and successively builds SUP_EMP table by computing immediate supervisees first, then second level supervisees, etc. until a **fixed point** is reached and no more supervisees can be added

EXPANDED Block Structure 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> ];
```

Learning Objectives

7.1 More Complex SQL Retrieval Queries

7.2 Specifying Semantic Constraints as Assertions and Actions as Triggers

7.3 Views (Virtual Tables) in SQL

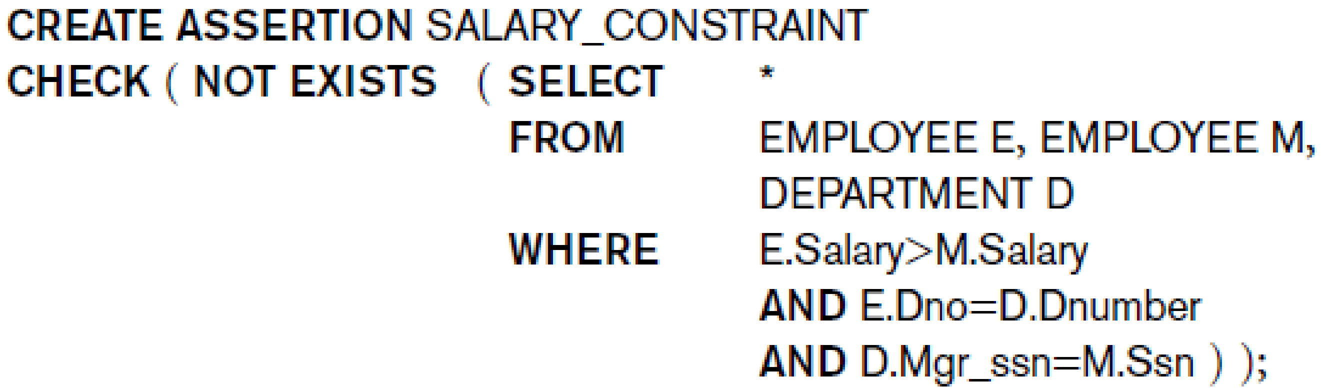
7.4 Schema Modification in SQL

Specifying Constraints as Assertions and Actions as Triggers

- Semantic Constraints: The following are beyond the scope of the EER and relational model
- **`CREATE ASSERTION`**
  - Specify additional types of constraints outside scope of built-in relational model constraints
- **`CREATE TRIGGER`**
  - Specify automatic actions that database system will perform when certain events and conditions occur

Specifying General Constraints as Assertions in SQL

- **`CREATE ASSERTION`**
  - Specify a query that selects any tuples that violate the desired condition
  - Use only in cases where it goes beyond a simple `CHECK` which applies to individual attributes and domains



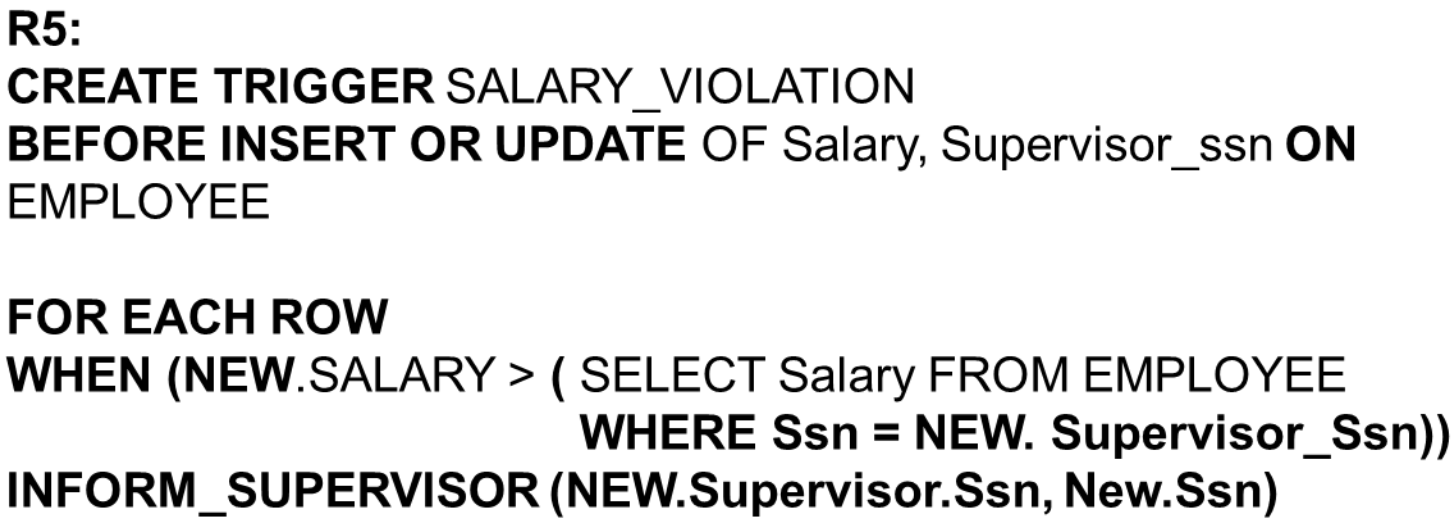
```
CREATE ASSERTION SALARY_CONSTRAINT
CHECK ( NOT EXISTS  ( SELECT     *
                      FROM       EMPLOYEE E, EMPLOYEE M,
                                 DEPARTMENT D
                      WHERE      E.Salary>M.Salary
                                 AND E.Dno=D.Dnumber
                                 AND D.Mgr_ssn=M.Ssn ) );
```

Introduction to Triggers in SQL

- `CREATE TRIGGER` statement
  - Used to monitor the database
- Typical trigger has three components which make it a rule for an “active database “ (more on active databases in section 26.1):
  - **Event(s)**
  - **Condition**
  - **Action**

Use of TRIGGERS

- An EXAMPLE with standard Syntax.(Note : other SQL implementations like PostgreSQL use a different syntax.)



```
R5:
CREATE TRIGGER SALARY_VIOLATION
BEFORE INSERT OR UPDATE OF Salary, Supervisor_ssn ON
EMPLOYEE

FOR EACH ROW
WHEN (NEW.SALARY > ( SELECT Salary FROM EMPLOYEE
                     WHERE Ssn = NEW. Supervisor_Ssn))
INFORM_SUPERVISOR (NEW.Supervisor.Ssn, New.Ssn)
```

Learning Objectives

7.1 More Complex SQL Retrieval Queries

7.2 Specifying Semantic Constraints as Assertions and Actions as Triggers

7.3 **Views (Virtual Tables) in SQL**

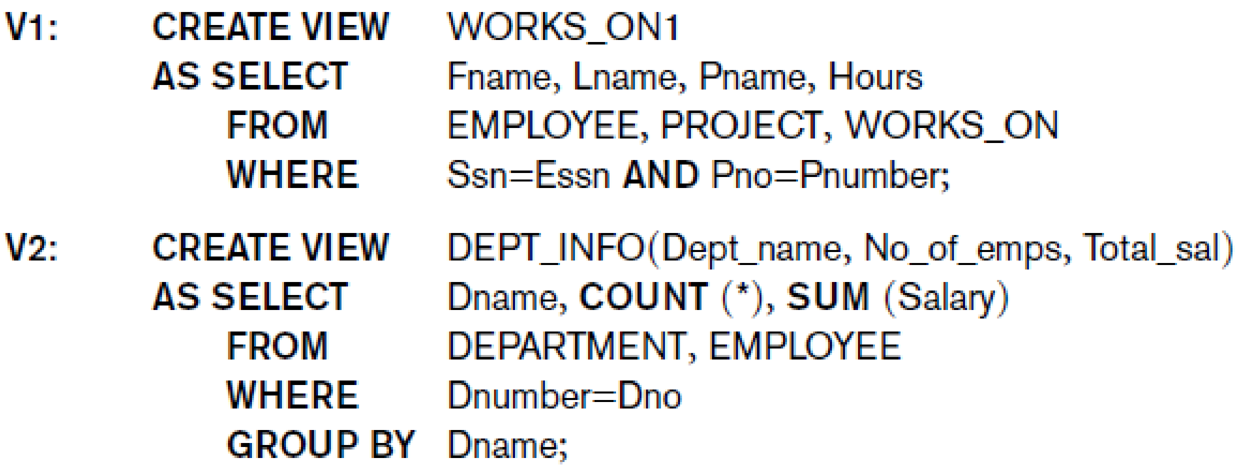
7.4 Schema Modification in SQL

Views (Virtual Tables) in SQL

- Concept of a view in SQL
  - Single table derived from other tables called the **defining tables**
  - Considered to be a virtual table that is not necessarily populated

Specification of Views in SQL (1 of 2)

- **`CREATE VIEW`** command
  - Give table name, list of attribute names, and a query to specify the contents of the view
  - In V1, attributes retain the names from base tables. In V2, attributes are assigned names



```
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 (2 of 2)

- Once a View is defined, SQL queries can use the View relation in the FROM clause
- View is 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
- **Strategy1: Query modification** approach
  - Compute the view as and when needed. Do not store permanently
  - 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 Materialization (1 of 2)

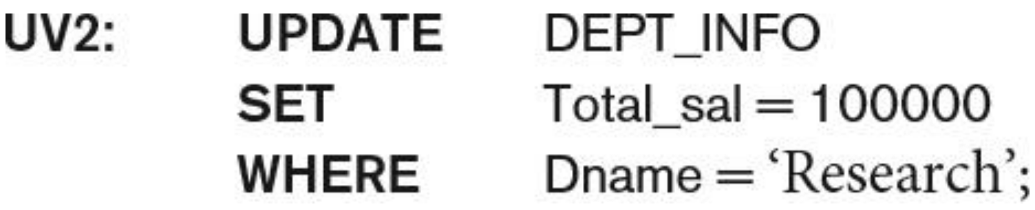
- **Strategy 2: View materialization**
  - Physically create a temporary view table when the view is first queried
  - Keep that table on the assumption that other queries on the view will follow
  - Requires efficient strategy for automatically updating the view table when the base tables are updated
- **Incremental update strategy for materialized views**
  - DBMS determines what new tuples must be inserted, deleted, or modified in a materialized view table

View Materialization (2 of 2)

- Multiple ways to handle materialization:
  - **immediate update** strategy updates a view as soon as the base tables are changed
  - **lazy update** strategy updates the view when needed by a view query
  - **periodic update** strategy updates the view periodically (in the latter strategy, a view query may get a result that is not up-to-date). This is commonly used in Banks, Retail store operations, etc.

View Update

- Update on a view defined on a single table without any aggregate functions
  - Can be mapped to an update on underlying base table- possible if the primary key is preserved in the view
- Update not permitted on aggregate views. E.g.,



```
UV2:     UPDATE     DEPT_INFO
         SET        Total_sal = 100000
         WHERE      Dname = 'Research';
```

cannot be processed because Total_sal is a computed value in the view definition

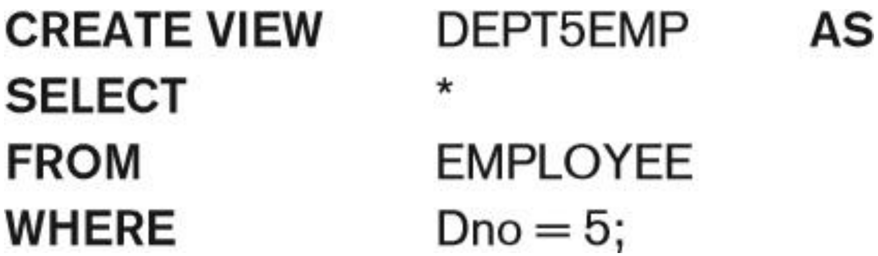
View Update and Inline Views

- View involving joins
  - Often not possible for DBMS to determine which of the updates is intended
- Clause **`WITH CHECK OPTION`**
  - Must be added at the end of the view definition if a view is to be updated to make sure that tuples being updated stay in the view
- **In-line view**
  - Defined in the `FROM` clause of an SQL query (e.g., we saw its used in the WITH example)

Views as Authorization Mechanism

- SQL query authorization statements (GRANT and REVOKE) are described in detail in Chapter 30
- Views can be used to hide certain attributes or tuples from unauthorized users
- E.g., For a user who is only allowed to see employee information for those who work for department 5, he may only access the view

DEPT5EMP:



```
CREATE VIEW     DEPT5EMP     AS
SELECT          *
FROM            EMPLOYEE
WHERE           Dno = 5;
```

Learning Objectives

7.1 More Complex SQL Retrieval Queries

7.2 Specifying Semantic Constraints as Assertions and Actions as Triggers

7.3 Views (Virtual Tables) in SQL

7.4 Schema Modification in SQL

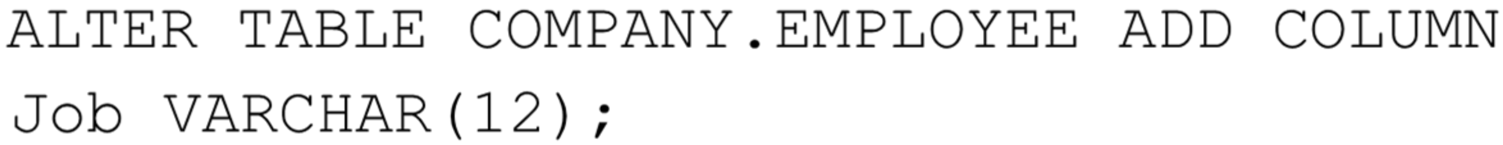
Schema Change Statements in SQL

- **Schema evolution commands**
  - DBA may want to change the schema 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;`
  - This removes the schema and all its elements including tables, views, constraints, etc.

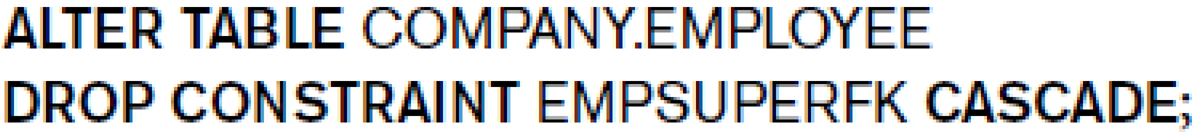
The ALTER Table Command

- **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);
```

Adding and Dropping Constraints

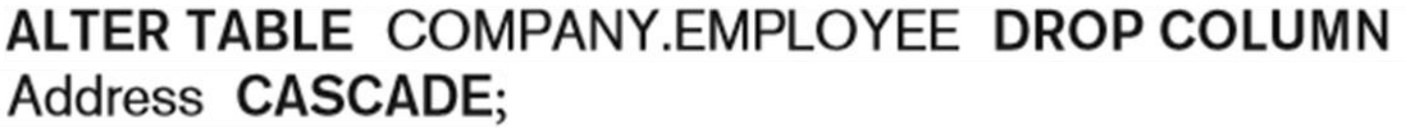
- Change constraints specified on a table
  - Add or drop a named constraint



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

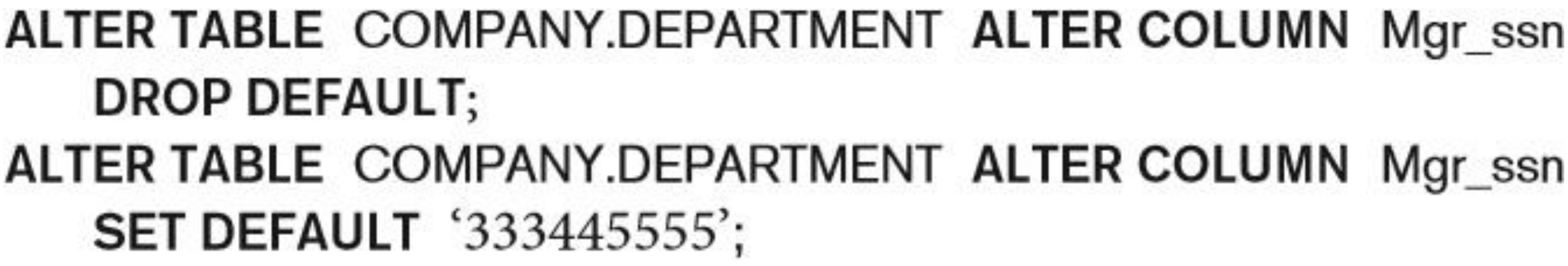
Dropping Columns, Default Values

- To drop a column
  - Choose either `CASCADE` or `RESTRICT`
  - `CASCADE` would drop the column from views etc. `RESTRICT` is possible if no views refer to it.



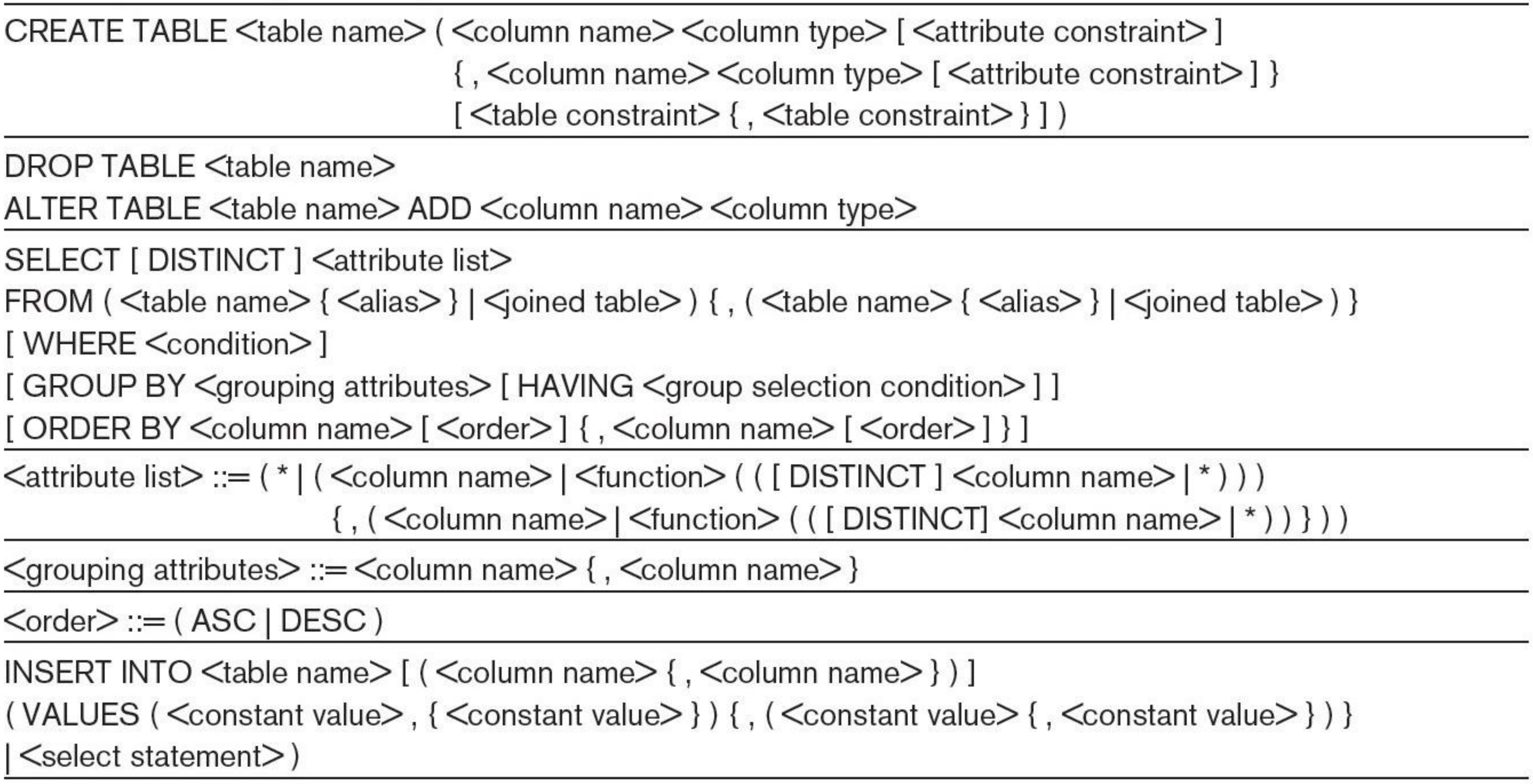
```
ALTER TABLE  COMPANY.EMPLOYEE  DROP COLUMN
Address  CASCADE;
```

- Default values can be dropped and altered :



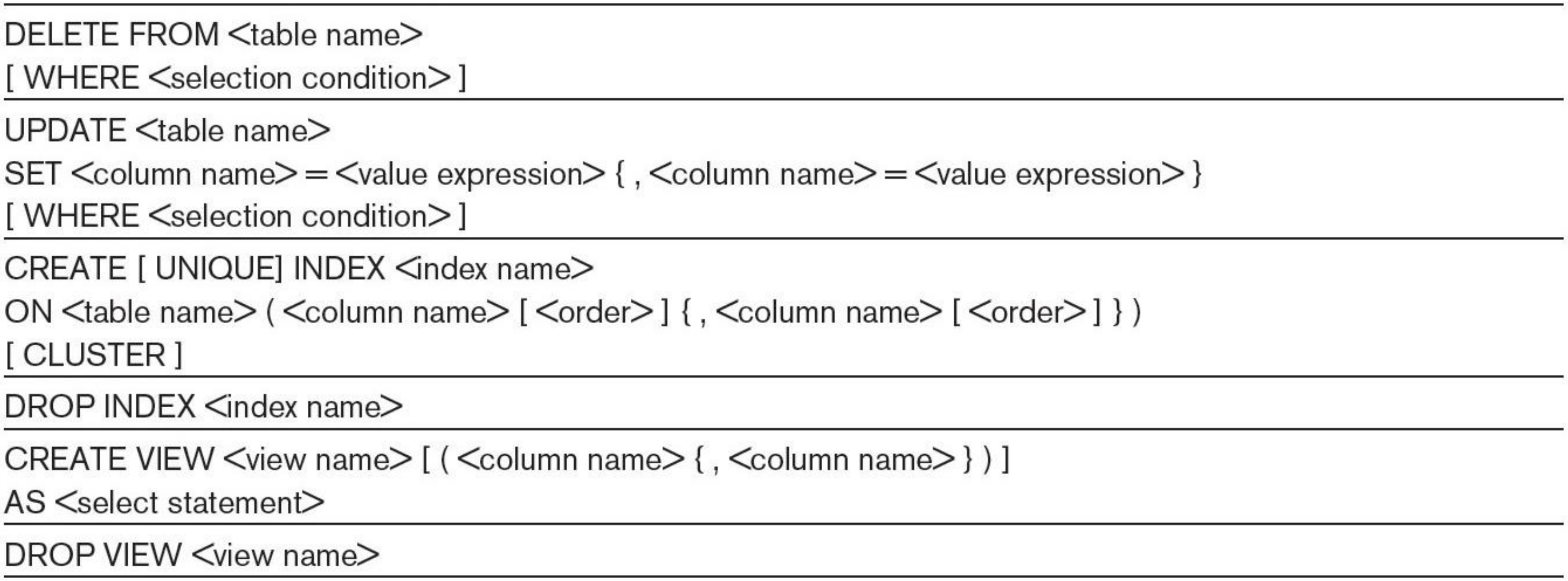
```
ALTER TABLE  COMPANY.DEPARTMENT  ALTER COLUMN  Mgr_ssn
     DROP DEFAULT;
ALTER TABLE  COMPANY.DEPARTMENT  ALTER COLUMN  Mgr_ssn
     SET DEFAULT  '333445555';
```

Table 7.2 Summary of SQL Syntax (1 of 2)



```
CREATE TABLE <table name> ( <column name> <column type> [ <attribute constraint> ]
                            { , <column name> <column type> [ <attribute constraint> ] }
                            [ <table constraint> { , <table constraint> } ] )
---
DROP TABLE <table name>
ALTER TABLE <table name> ADD <column name> <column type>
---
SELECT [ DISTINCT ] <attribute list>
FROM ( <table name> { <alias> } | <joined table> ) { , ( <table name> { <alias> } | <joined table> ) }
[ WHERE <condition> ]
[ GROUP BY <grouping attributes> [ HAVING <group selection condition> ] ]
[ ORDER BY <column name> [ <order> ] { , <column name> [ <order> ] } ]
---
<attribute list> ::= ( * | ( <column name> | <function> ( ( [ DISTINCT ] <column name> | * ) ) )
                     { , ( <column name> | <function> ( ( [ DISTINCT] <column name> | * ) ) } ) )
---
<grouping attributes> ::= <column name> { , <column name> }
---
<order> ::= ( ASC | DESC )
---
INSERT INTO <table name> [ ( <column name> { , <column name> } ) ]
( VALUES ( <constant value> , { <constant value> } ) { , ( <constant value> { , <constant value> } ) }
| <select statement> )
```

Table 7.2 Summary of SQL Syntax (2 of 2)



DELETE FROM <table name> [WHERE <selection condition>]

UPDATE <table name>
SET <column name> = <value expression> { , <column name> = <value expression> }
[WHERE <selection condition>]

CREATE [UNIQUE] INDEX <index name> ON <table name> (<column name> [<order>] { , <column name> [<order>] }) [CLUSTER]
DROP INDEX <index name>
CREATE VIEW <view name> [(<column name> { , <column name> })] AS <select statement>
DROP VIEW <view name>

Note: The commands for creating and dropping indexes are not part of standard SQL.

Summary

- Complex SQL:
  - Nested queries, joined tables (in the FROM clause), outer joins, aggregate functions, grouping
- Handling semantic constraints with `CREATE ASSERTION` and `CREATE TRIGGER`
- `CREATE VIEW` statement and materialization strategies
- Schema Modification for the DBAs using `ALTER TABLE`, `ADD AND DROP COLUMN`, `ALTER CONSTRAINT` etc.