CHAPTER 6

Basic SQL

Basic SQL

- SQL language
  - Considered one of the major reasons for the commercial success of relational databases
- SQL
  - SQL Actually comes from the word “SEQUEL” termed by Chamberlin and Boyce. IBM could not copyright that term, so they abbreviated to SQL and copyrighted the term SQL.
  - Now popularly known as “Structured Query language”.

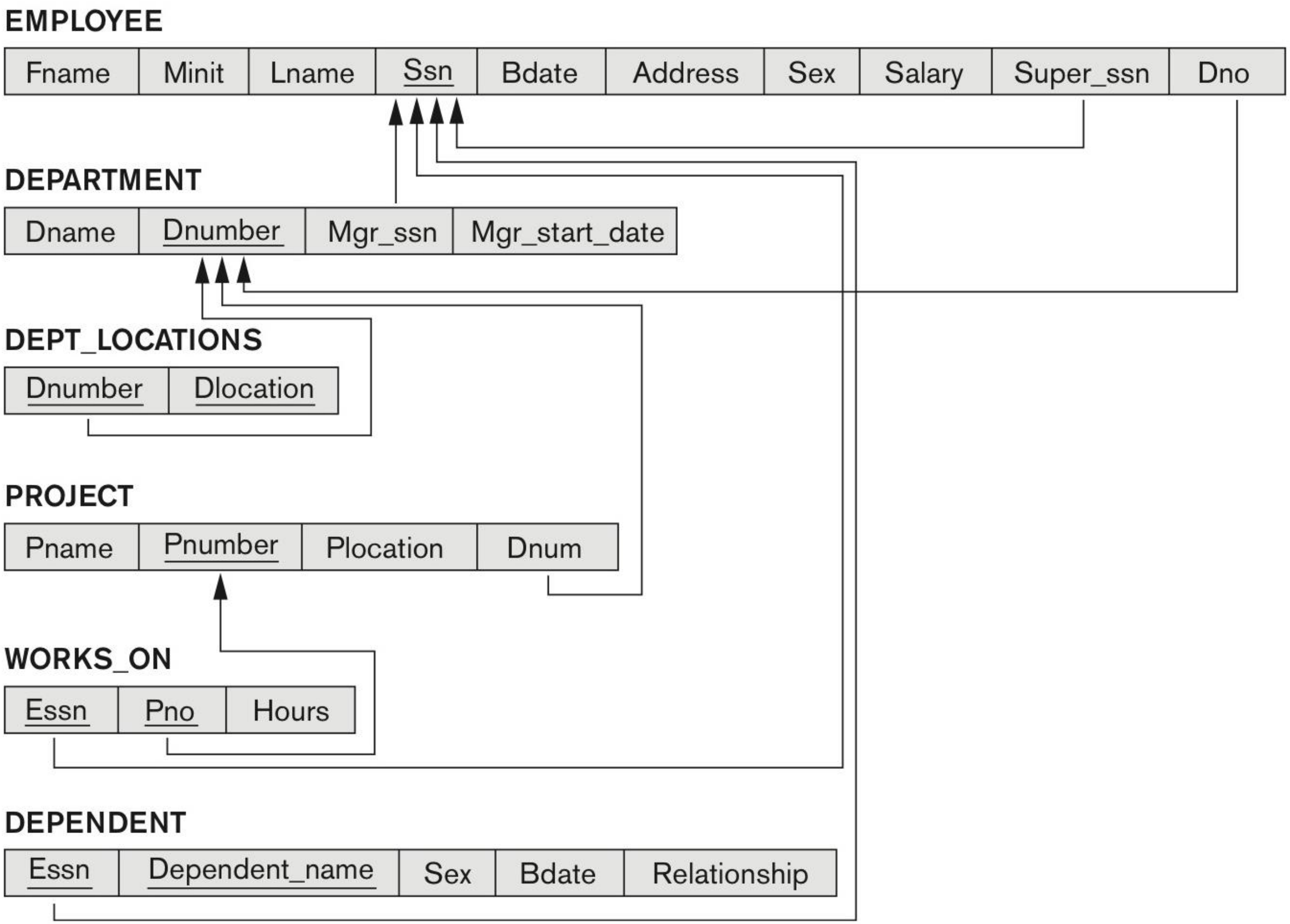
SQL Data Definition, Data Types, Standards

- Terminology:
  - **Table**, **row**, and **column** used for relational model terms relation, tuple, and attribute
- `CREATE` statement
  - Main SQL command for data definition

The CREATE TABLE Command in SQL

- Specifying a new relation
  - Provide name of table
  - Specify attributes, their types and initial constraints
  - `CREATE TABLE EMPLOYEE ...`

COMPANY relational database schema (Fig. 5.7)



EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date

DEPT_LOCATIONS

Dnumber	Dlocation

PROJECT

Pname	Pnumber	Plocation	Dnum

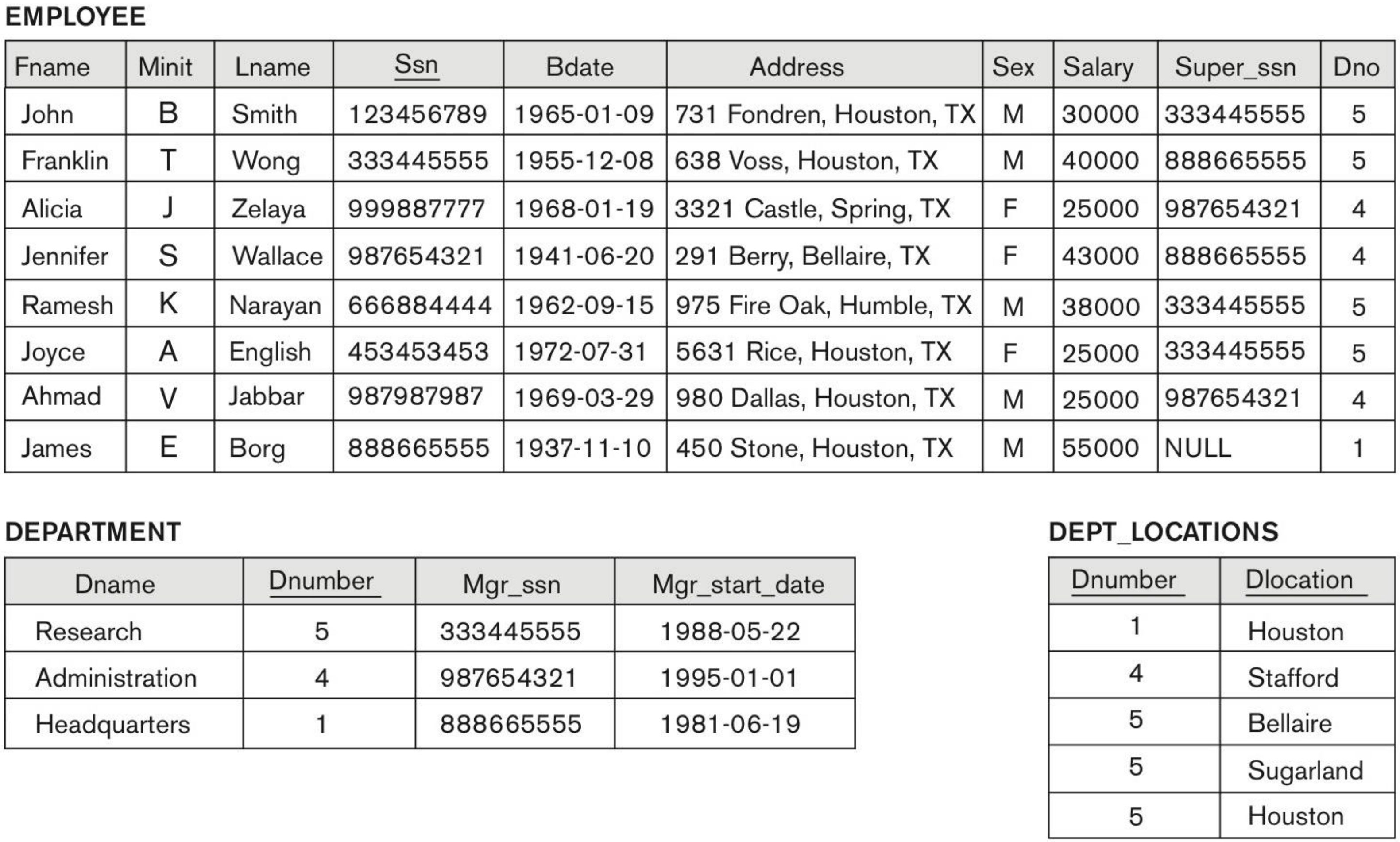
WORKS_ON

Essn	Pno	Hours

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship

One possible database state for the COMPANY relational database schema (Fig. 5.6)



EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno
John	B	Smith	123456789	1965-01-09	731 Fondren, Houston, TX	M	30000	333445555	5
Franklin	T	Wong	333445555	1955-12-08	638 Voss, Houston, TX	M	40000	888665555	5
Alicia	J	Zelaya	999887777	1968-01-19	3321 Castle, Spring, TX	F	25000	987654321	4
Jennifer	S	Wallace	987654321	1941-06-20	291 Berry, Bellaire, TX	F	43000	888665555	4
Ramesh	K	Narayan	666884444	1962-09-15	975 Fire Oak, Humble, TX	M	38000	333445555	5
Joyce	A	English	453453453	1972-07-31	5631 Rice, Houston, TX	F	25000	333445555	5
Ahmad	V	Jabbar	987987987	1969-03-29	980 Dallas, Houston, TX	M	25000	987654321	4
James	E	Borg	888665555	1937-11-10	450 Stone, Houston, TX	M	55000	NULL	1

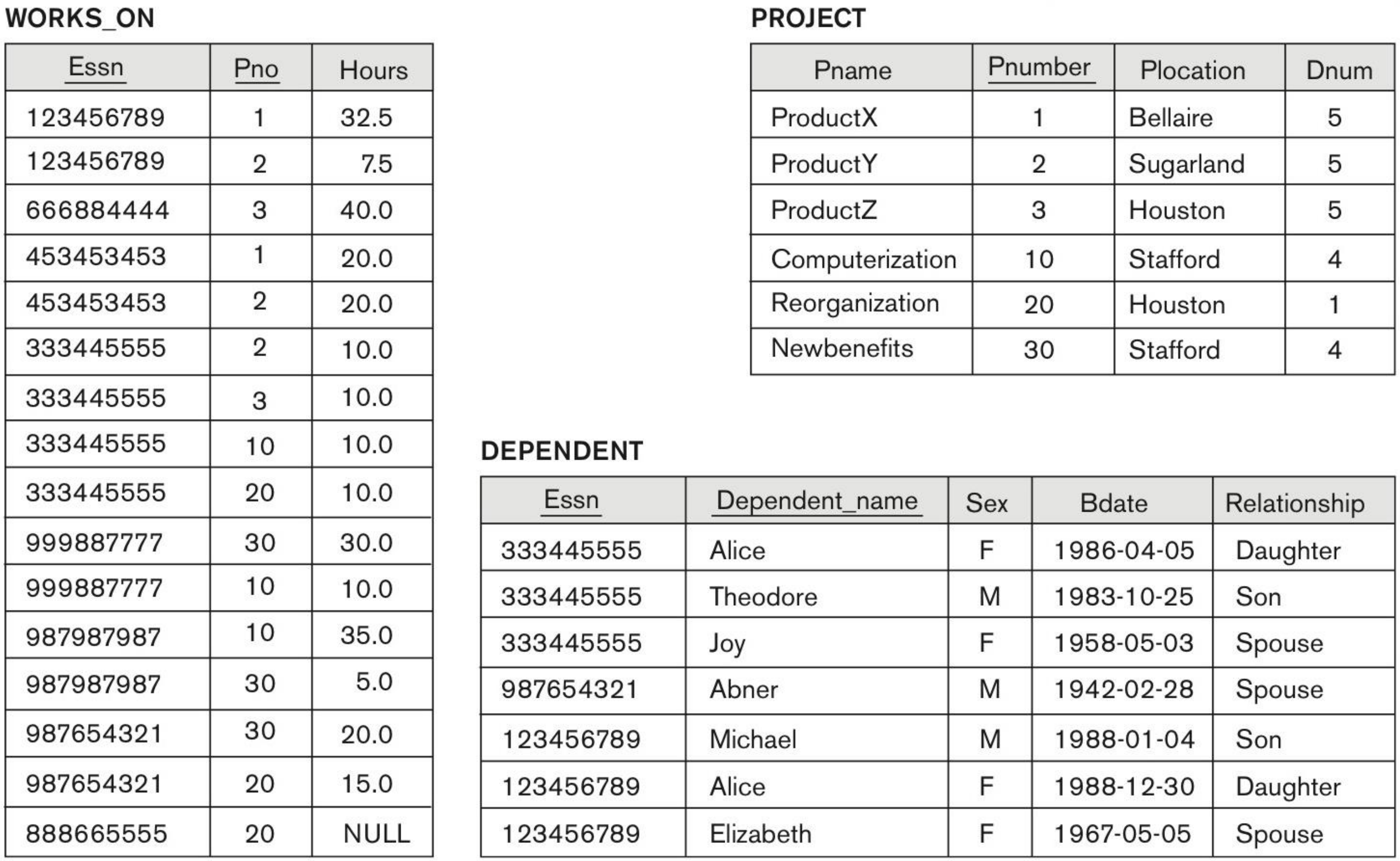
DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date
Research	5	333445555	1988-05-22
Administration	4	987654321	1995-01-01
Headquarters	1	888665555	1981-06-19

DEPT_LOCATIONS

Dnumber	Dlocation
1	Houston
4	Stafford
5	Bellaire
5	Sugarland
5	Houston

One possible database state for the COMPANY relational database schema – continued (Fig. 5.6)



WORKS_ON

Essn	Pno	Hours
123456789	1	32.5
123456789	2	7.5
666884444	3	40.0
453453453	1	20.0
453453453	2	20.0
333445555	2	10.0
333445555	3	10.0
333445555	10	10.0
333445555	20	10.0
999887777	30	30.0
999887777	10	10.0
987987987	10	35.0
987987987	30	5.0
987654321	30	20.0
987654321	20	15.0
888665555	20	NULL

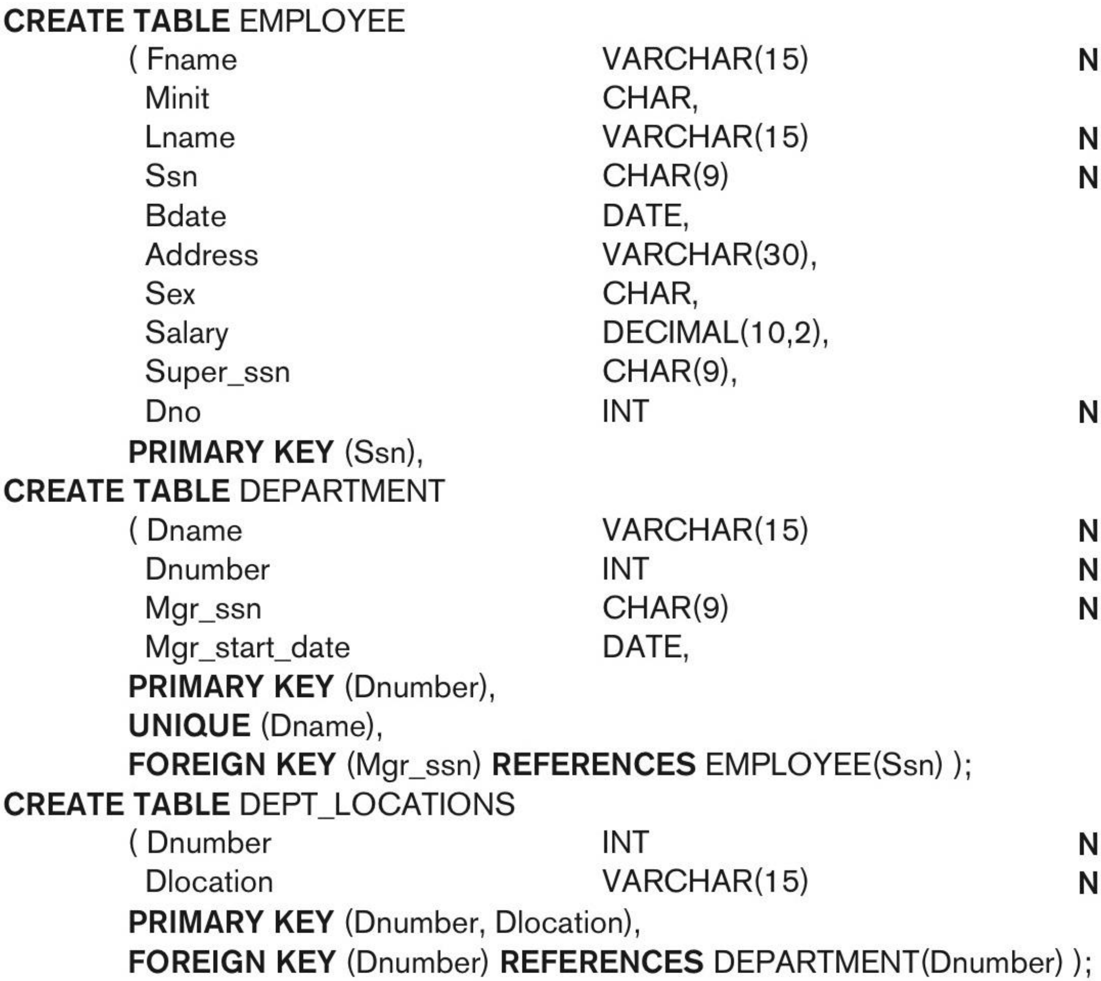
PROJECT

Pname	Pnumber	Plocation	Dnum
ProductX	1	Bellaire	5
ProductY	2	Sugarland	5
ProductZ	3	Houston	5
Computerization	10	Stafford	4
Reorganization	20	Houston	1
Newbenefits	30	Stafford	4

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship
333445555	Alice	F	1986-04-05	Daughter
333445555	Theodore	M	1983-10-25	Son
333445555	Joy	F	1958-05-03	Spouse
987654321	Abner	M	1942-02-28	Spouse
123456789	Michael	M	1988-01-04	Son
123456789	Alice	F	1988-12-30	Daughter
123456789	Elizabeth	F	1967-05-05	Spouse

SQL CREATE TABLE data definition statements for defining the COMPANY schema from Figure 5.7 (Fig. 6.1)



```
CREATE TABLE EMPLOYEE
        ( Fname                         VARCHAR(15)                    NOT NULL,
          Minit                         CHAR,
          Lname                         VARCHAR(15)                    NOT NULL,
          Ssn                           CHAR(9)                        NOT NULL,
          Bdate                         DATE,
          Address                       VARCHAR(30),
          Sex                           CHAR,
          Salary                        DECIMAL(10,2),
          Super_ssn                     CHAR(9),
          Dno                           INT                            NOT NULL,
        PRIMARY KEY (Ssn),
CREATE TABLE DEPARTMENT
        ( Dname                         VARCHAR(15)                    NOT NULL,
          Dnumber                       INT                            NOT NULL,
          Mgr_ssn                       CHAR(9)                        NOT NULL,
          Mgr_start_date                DATE,
        PRIMARY KEY (Dnumber),
        UNIQUE (Dname),
        FOREIGN KEY (Mgr_ssn) REFERENCES EMPLOYEE(Ssn) );
CREATE TABLE DEPT_LOCATIONS
        ( Dnumber                       INT                            NOT NULL,
          Dlocation                     VARCHAR(15)                    NOT NULL,
        PRIMARY KEY (Dnumber, Dlocation),
        FOREIGN KEY (Dnumber) REFERENCES DEPARTMENT(Dnumber) );
```

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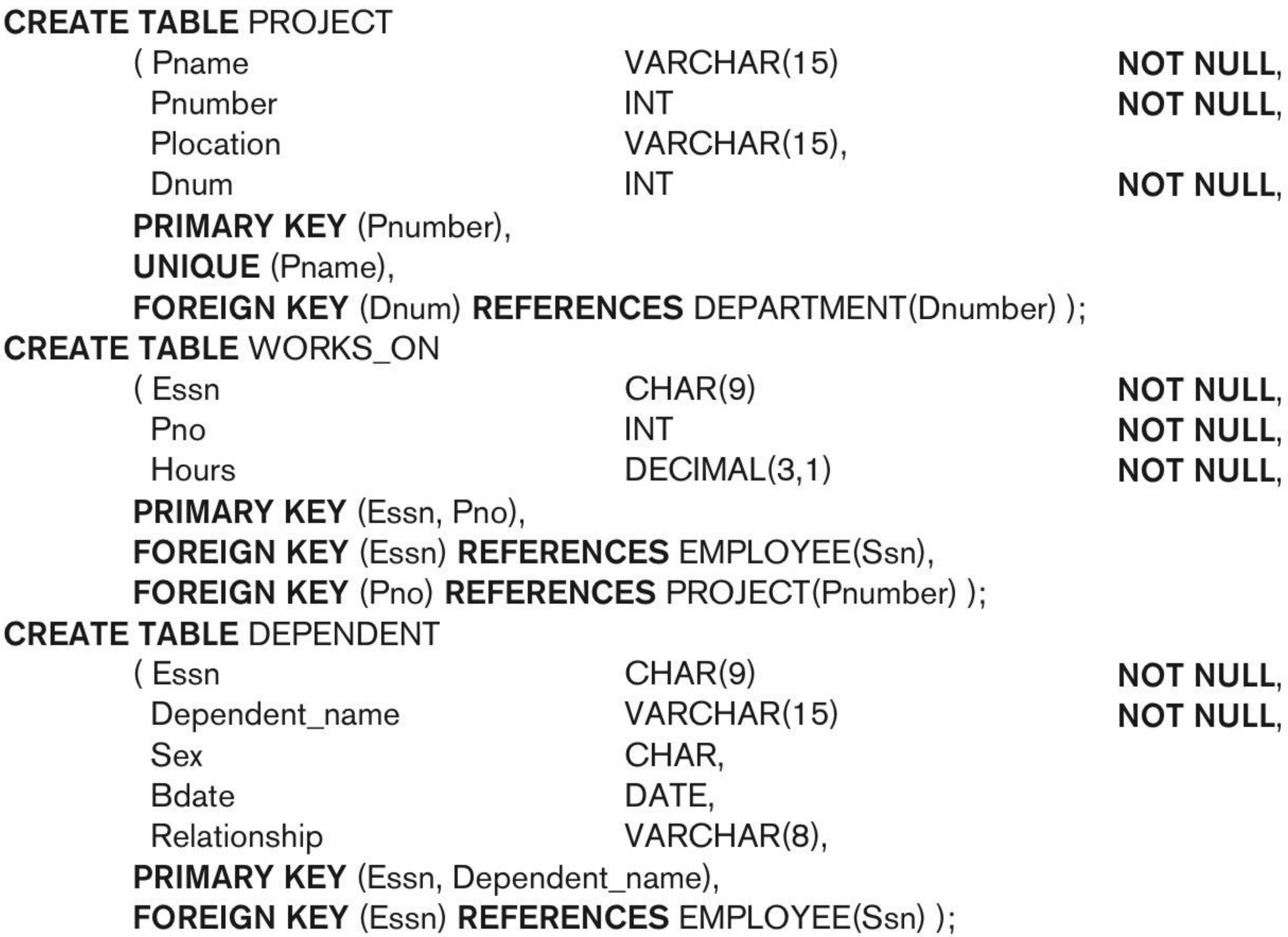
SQL CREATE TABLE data definition statements for defining the COMPANY schema from Figure 5.7 (Fig. 6.1)-continued



```
CREATE TABLE PROJECT
        ( Pname                         VARCHAR(15)                  NOT NULL,
          Pnumber                       INT                          NOT NULL,
          Plocation                     VARCHAR(15),
          Dnum                          INT                          NOT NULL,
        PRIMARY KEY (Pnumber),
        UNIQUE (Pname),
        FOREIGN KEY (Dnum) REFERENCES DEPARTMENT(Dnumber) );
CREATE TABLE WORKS_ON
        ( Essn                          CHAR(9)                      NOT NULL,
          Pno                           INT                          NOT NULL,
          Hours                         DECIMAL(3,1)                 NOT NULL,
        PRIMARY KEY (Essn, Pno),
        FOREIGN KEY (Essn) REFERENCES EMPLOYEE(Ssn),
        FOREIGN KEY (Pno) REFERENCES PROJECT(Pnumber) );
CREATE TABLE DEPENDENT
        ( Essn                          CHAR(9)                      NOT NULL,
          Dependent_name                VARCHAR(15)                  NOT NULL,
          Sex                           CHAR,
          Bdate                         DATE,
          Relationship                  VARCHAR(8),
        PRIMARY KEY (Essn, Dependent_name),
        FOREIGN KEY (Essn) REFERENCES EMPLOYEE(Ssn) );
```

Attribute Data Types and Domains in SQL

- Basic **data types**
  - **Numeric** data types
    - Integer numbers: `INTEGER`, `INT`, and `SMALLINT`
    - Floating-point (real) numbers: `FLOAT` or `REAL`, and `DOUBLE PRECISION`
  - **Character-string** data types
    - Fixed length: `CHAR(`*n*`)`, `CHARACTER(`*n*`)`
    - Varying length: `VARCHAR(`*n*`)`, `CHAR VARYING(`*n*`)`, `CHARACTER VARYING(`*n*`)`

Attribute Data Types and Domains in SQL (cont'd.)

- **Bit-string** data types
  - Fixed length: `BIT(`*n*`)`
  - Varying length: `BIT VARYING(`*n*`)`
- **Boolean** data type
  - Values of `TRUE` or `FALSE` or `NULL`
- **DATE** data type
  - Ten positions
  - Components are `YEAR`, `MONTH`, and `DAY` in the form YYYY-MM-DD
  - Multiple mapping functions available in RDBMSs to change date formats

Specifying Constraints in SQL

Basic constraints:

- Relational Model has 3 basic constraint types that are supported in SQL:
  - **Key** constraint: A primary key value cannot be duplicated
  - **Entity Integrity** Constraint: A primary key value cannot be null
  - **Referential integrity** constraints : The “foreign key “ must have a value that is already present as a primary key, or may be null.

Specifying Attribute Constraints

Other Restrictions on attribute domains:

- Default value of an attribute
  - **DEFAULT** `<value>`
  - NULL is not permitted for a particular attribute (NOT NULL)
- **CHECK** clause
  - `Dnumber INT NOT NULL CHECK (Dnumber > 0 AND Dnumber < 21);`

Specifying Key and Referential Integrity Constraints

- **PRIMARY KEY** clause
  - Specifies one or more attributes that make up the primary key of a relation
  - `Dnumber INT PRIMARY KEY;`
- **UNIQUE** clause
  - Specifies alternate (secondary) keys (called CANDIDATE keys in the relational model).
  - `Dname VARCHAR(15) UNIQUE;`

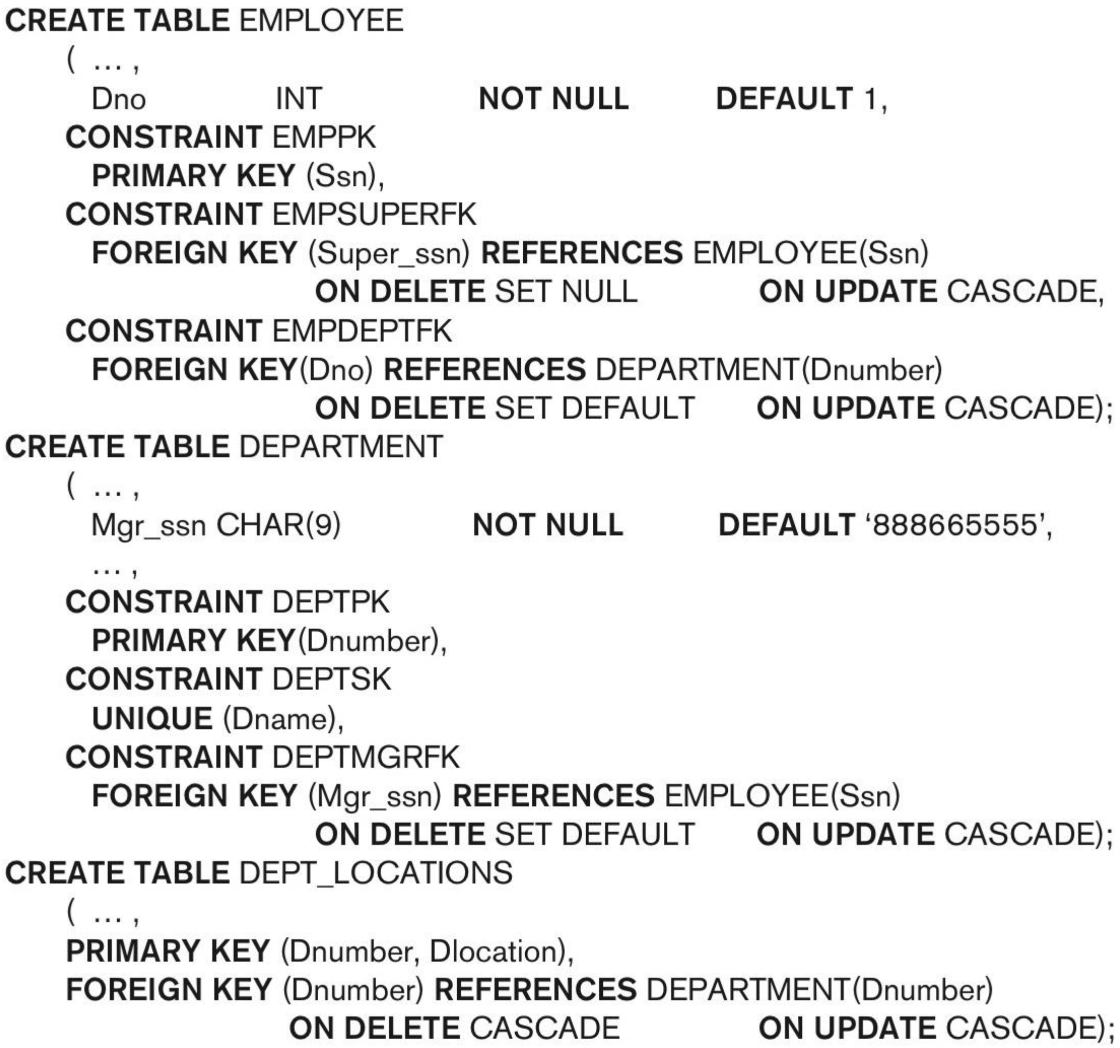
Specifying Key and Referential Integrity Constraints (cont'd.)

- **`FOREIGN KEY`** clause
  - Default operation: reject update on violation
  - Attach **referential triggered action** clause
    - Options include `SET NULL`, `CASCADE`, and `SET DEFAULT`
    - Action taken by the DBMS for `SET NULL` or `SET DEFAULT` is the same for both `ON DELETE` and `ON UPDATE`
    - `CASCADE` option suitable for "relationship" relations

Giving Names to Constraints

- Using the Keyword **`CONSTRAINT`**
  - Name a constraint
  - Useful for later altering

Default attribute values and referential integrity triggered action specification (Fig. 6.2)



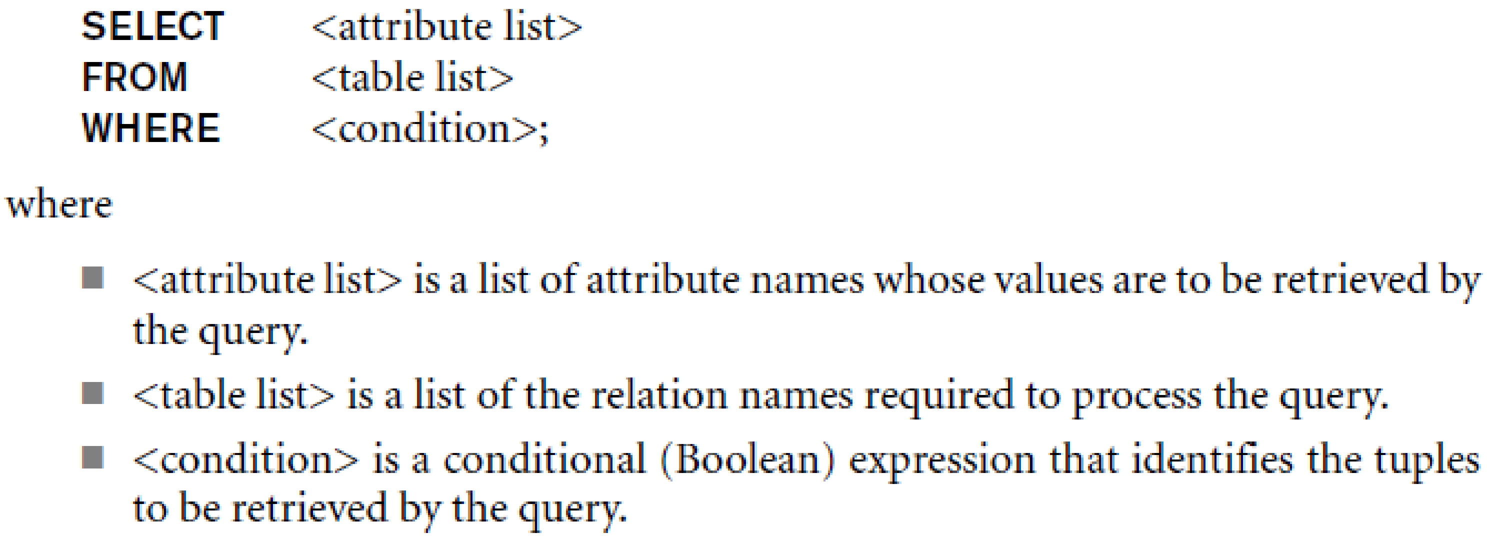
```
CREATE TABLE EMPLOYEE
    ( … ,
      Dno            INT           NOT NULL      DEFAULT 1,
    CONSTRAINT EMPPK
      PRIMARY KEY (Ssn),
    CONSTRAINT EMPSUPERFK
      FOREIGN KEY (Super_ssn) REFERENCES EMPLOYEE(Ssn)
                    ON DELETE SET NULL          ON UPDATE CASCADE,
    CONSTRAINT EMPDEPTFK
      FOREIGN KEY(Dno) REFERENCES DEPARTMENT(Dnumber)
                    ON DELETE SET DEFAULT       ON UPDATE CASCADE);
CREATE TABLE DEPARTMENT
    ( … ,
      Mgr_ssn CHAR(9)        NOT NULL      DEFAULT '888665555',
      … ,
    CONSTRAINT DEPTPK
      PRIMARY KEY(Dnumber),
    CONSTRAINT DEPTSK
      UNIQUE (Dname),
    CONSTRAINT DEPTMGRFK
      FOREIGN KEY (Mgr_ssn) REFERENCES EMPLOYEE(Ssn)
                    ON DELETE SET DEFAULT       ON UPDATE CASCADE);
CREATE TABLE DEPT_LOCATIONS
    ( … ,
    PRIMARY KEY (Dnumber, Dlocation),
    FOREIGN KEY (Dnumber) REFERENCES DEPARTMENT(Dnumber)
                  ON DELETE CASCADE             ON UPDATE CASCADE);
```

Basic Retrieval Queries in SQL

- `SELECT` statement
  - One basic statement for retrieving information from a database
- SQL allows a table to have two or more tuples that are identical in all their attribute values
  - Unlike relational model (relational model is strictly set-theory based)
  - Multiset or bag behavior

The SELECT-FROM-WHERE Structure of Basic SQL Queries

- Basic form of the `SELECT` statement:



```
SELECT      <attribute list>
FROM        <table list>
WHERE       <condition>;
```

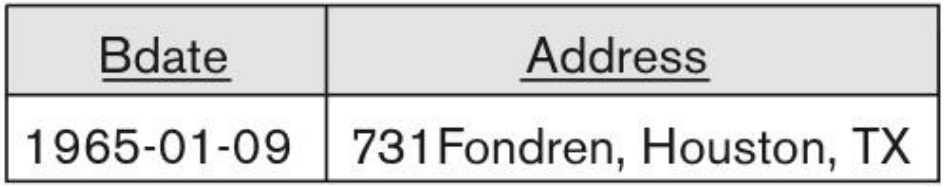
where

- <attribute list> is a list of attribute names whose values are to be retrieved by the query.
- <table list> is a list of the relation names required to process the query.
- <condition> is a conditional (Boolean) expression that identifies the tuples to be retrieved by the query.

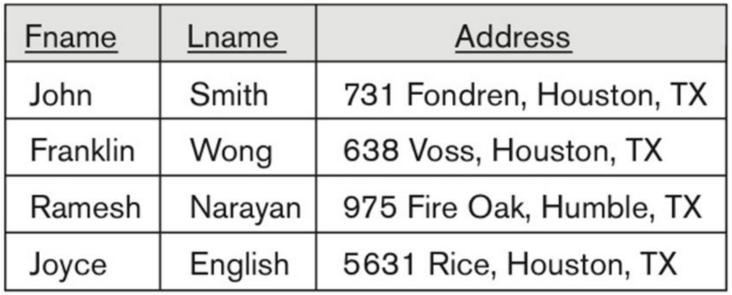
The SELECT-FROM-WHERE Structure of Basic SQL Queries (cont'd.)

- Logical comparison operators
  - =, <, <=, >, >=, and <>
- **Projection attributes**
  - Attributes whose values are to be retrieved
- **Selection condition**
  - Boolean condition that must be true for any retrieved tuple. Selection conditions include join conditions (see Ch.8) when multiple relations are involved.

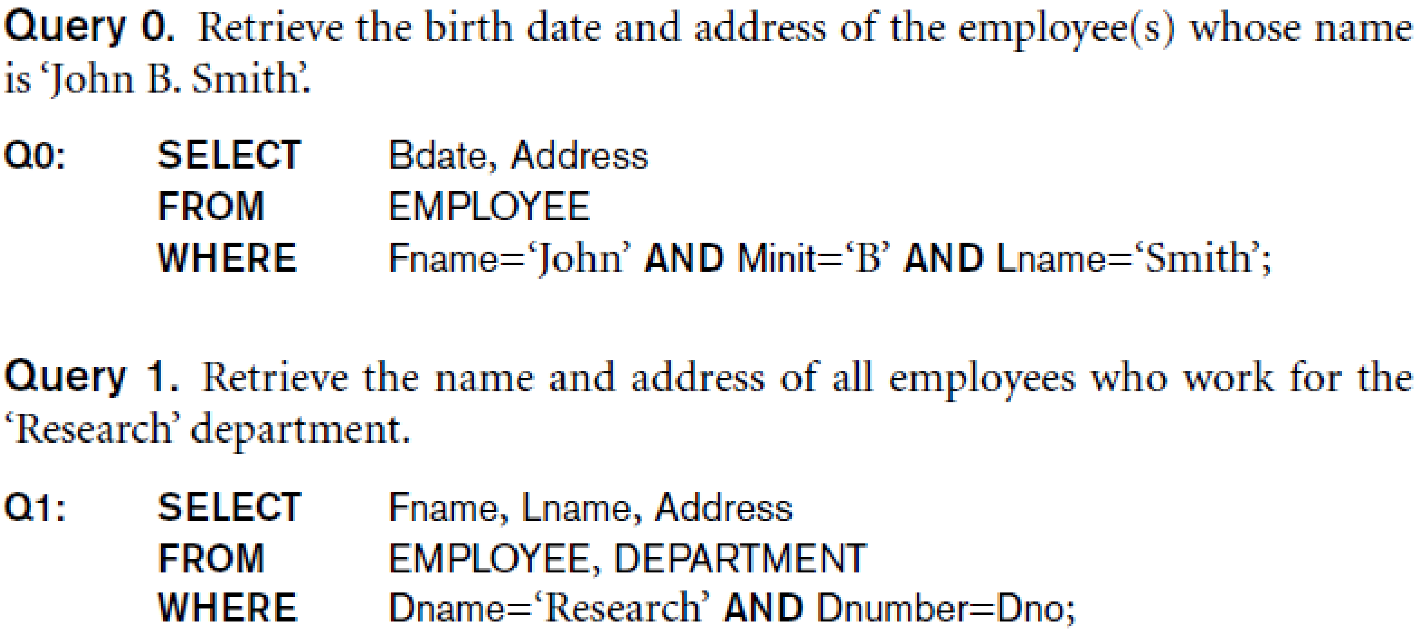
Basic Retrieval Queries



Bdate	Address
1965-01-09	731 Fondren, Houston, TX



Fname	Lname	Address
John	Smith	731 Fondren, Houston, TX
Franklin	Wong	638 Voss, Houston, TX
Ramesh	Narayan	975 Fire Oak, Humble, TX
Joyce	English	5631 Rice, Houston, TX



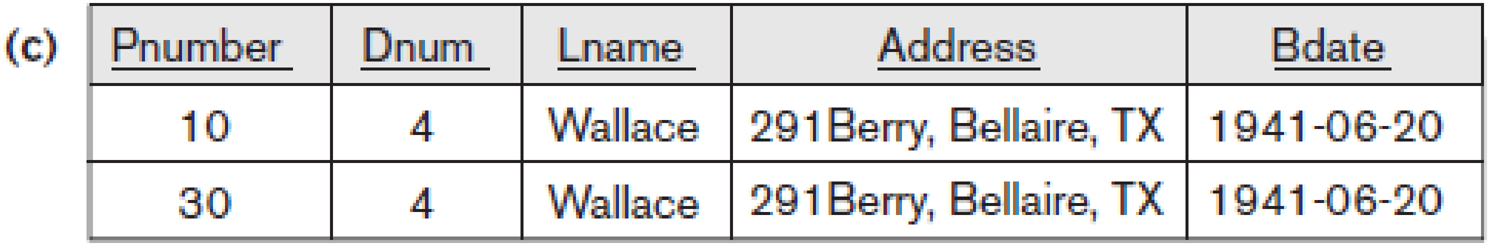
Query 0. Retrieve the birth date and address of the employee(s) whose name is 'John B. Smith'.

```
Q0:    SELECT    Bdate, Address
       FROM      EMPLOYEE
       WHERE     Fname='John' AND Minit='B' AND Lname='Smith';
```

Query 1. Retrieve the name and address of all employees who work for the 'Research' department.

```
Q1:    SELECT    Fname, Lname, Address
       FROM      EMPLOYEE, DEPARTMENT
       WHERE     Dname='Research' AND Dnumber=Dno;
```

Basic Retrieval Queries (Contd.)



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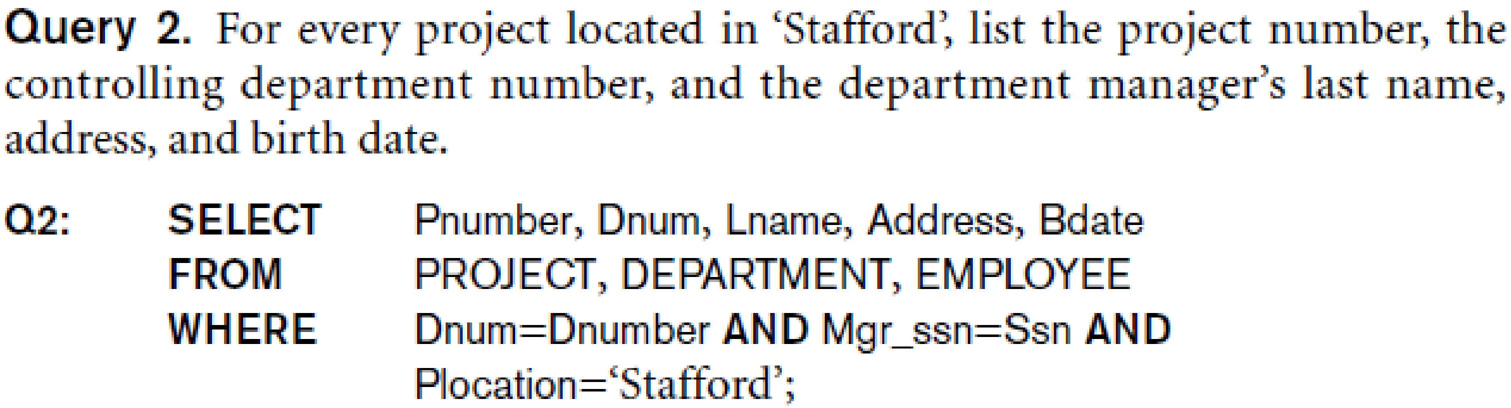
Pnumber	Dnum	Lname	Address	Bdate
10	4	Wallace	291Berry, Bellaire, TX	1941-06-20
30	4	Wallace	291Berry, Bellaire, TX	1941-06-20

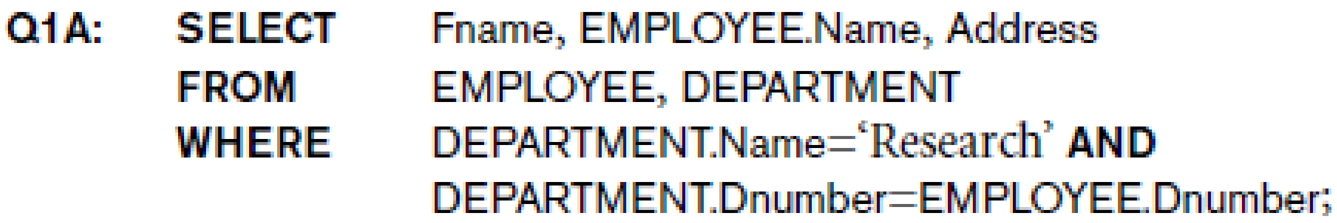


Query 2. For every project located in 'Stafford', list the project number, the controlling department number, and the department manager's last name, address, and birth date.

```
Q2:     SELECT    Pnumber, Dnum, Lname, Address, Bdate
        FROM      PROJECT, DEPARTMENT, EMPLOYEE
        WHERE     Dnum=Dnumber AND Mgr_ssn=Ssn AND
                  Plocation='Stafford';
```

Ambiguous Attribute Names

- Same name can be used for two (or more) attributes in different relations
  - As long as the attributes are in different relations
  - Must **qualify** the attribute name with the relation name to prevent ambiguity



```
Q1A:    SELECT    Fname, EMPLOYEE.Name, Address
        FROM      EMPLOYEE, DEPARTMENT
        WHERE     DEPARTMENT.Name='Research' AND
                  DEPARTMENT.Dnumber=EMPLOYEE.Dnumber;
```

Aliasing, and Renaming

- **Aliases** or **tuple variables**
  - Declare alternative relation names E and S to refer to the EMPLOYEE relation twice in a query:

Query 8. For each employee, retrieve the employee's first and last name and the first and last name of his or her immediate supervisor.

- **SELECT** E.Fname, E.Lname, S.Fname, S.Lname
  FROM EMPLOYEE **AS** E, EMPLOYEE **AS** S
  WHERE E.Super_ssn=S.Ssn;

  - Recommended practice to abbreviate names and to prefix same or similar attribute from multiple tables.

Aliasing,Renaming and Tuple Variables (contd.)

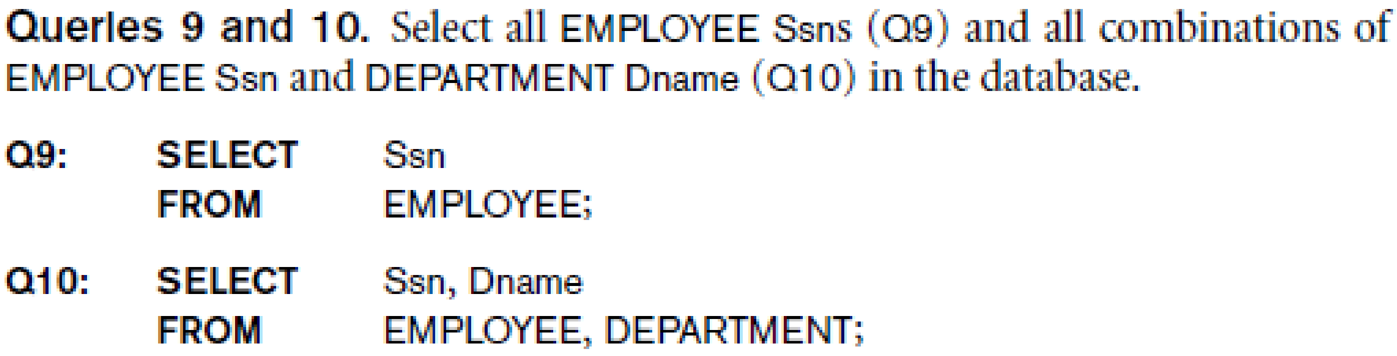
- The attribute names can also be renamed

```
EMPLOYEE AS E(Fn, Mi, Ln, Ssn, Bd,
  Addr, Sex, Sal, Sssn, Dno)
```

- Note that the relation EMPLOYEE now has a variable name E which corresponds to a tuple variable
- The "AS" may be dropped in most SQL implementations

Unspecified WHERE Clause and Use of the Asterisk

- Missing `WHERE` clause
  - Indicates no condition on tuple selection
- Effect is a `CROSS PRODUCT`
  - Result is all possible tuple combinations (or the Algebra operation of Cartesian Product– see Ch.8) result



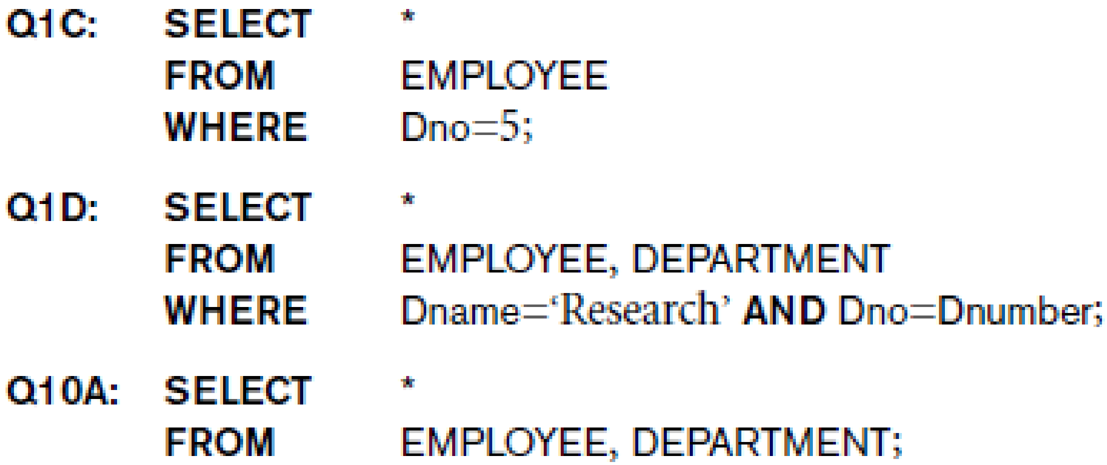
Queries 9 and 10. Select all EMPLOYEE Ssns (Q9) and all combinations of EMPLOYEE Ssn and DEPARTMENT Dname (Q10) in the database.

```
Q9:     SELECT    Ssn
        FROM      EMPLOYEE;

Q10:    SELECT    Ssn, Dname
        FROM      EMPLOYEE, DEPARTMENT;
```

Unspecified WHERE Clause and Use of the Asterisk (cont'd.)

- Specify an asterisk (*)
  - Retrieve all the attribute values of the selected tuples
  - The * can be prefixed by the relation name; e.g., EMPLOYEE *



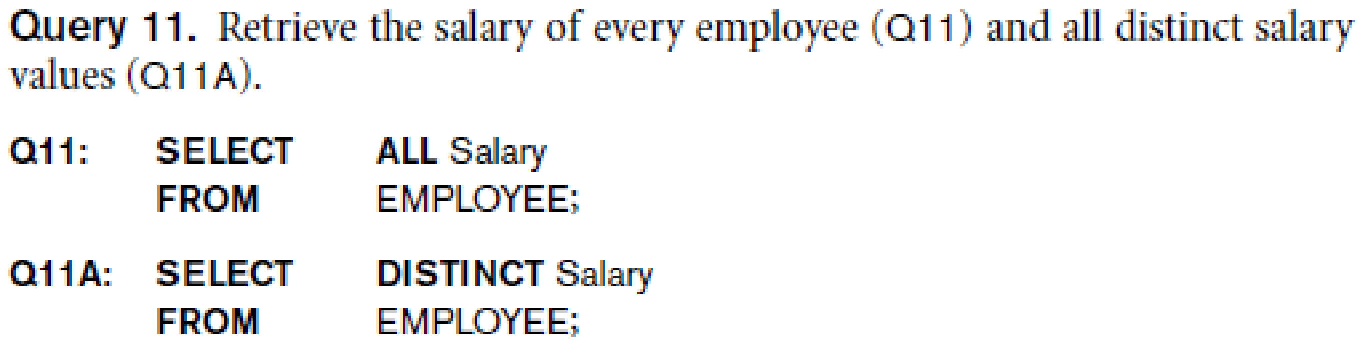
```
Q1C:    SELECT   *
        FROM     EMPLOYEE
        WHERE    Dno=5;

Q1D:    SELECT   *
        FROM     EMPLOYEE, DEPARTMENT
        WHERE    Dname='Research' AND Dno=Dnumber;

Q10A:   SELECT   *
        FROM     EMPLOYEE, DEPARTMENT;
```

Tables as Sets in SQL

- SQL does not automatically eliminate duplicate tuples in query results
- For aggregate operations (See sec 7.1.7) duplicates must be accounted for
- Use the keyword **DISTINCT** in the `SELECT` clause
  - Only distinct tuples should remain in the result



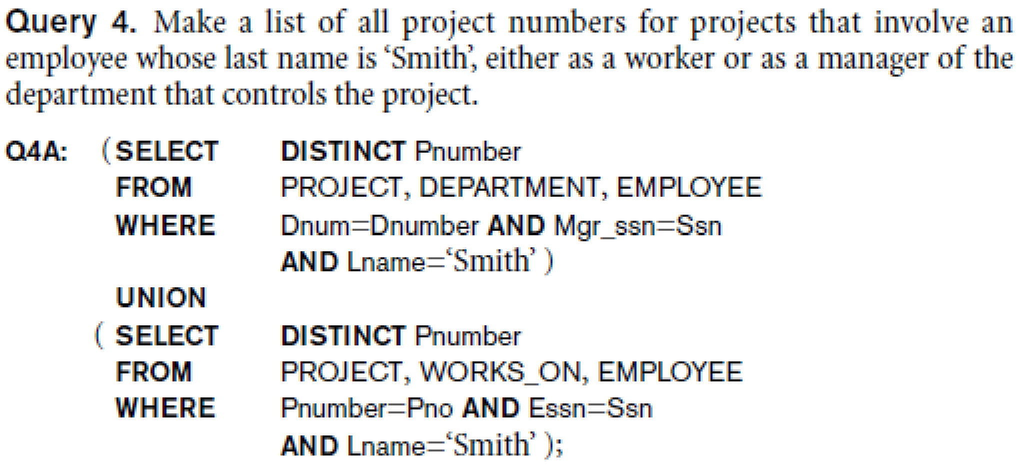
Query 11. Retrieve the salary of every employee (Q11) and all distinct salary values (Q11A).

```
Q11:    SELECT    ALL Salary
        FROM      EMPLOYEE;

Q11A:   SELECT    DISTINCT Salary
        FROM      EMPLOYEE;
```

Tables as Sets in SQL (cont'd.)

- Set operations
  - **UNION**, **EXCEPT** (difference), **INTERSECT**
  - Corresponding multiset operations: UNION ALL, EXCEPT ALL, INTERSECT ALL)
  - Type compatibility is needed for these operations to be valid



Query 4. Make a list of all project numbers for projects that involve an employee whose last name is 'Smith', either as a worker or as a manager of the department that controls the project.

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

Substring Pattern Matching and Arithmetic Operators

- **LIKE** comparison operator
  - Used for string **pattern matching**
  - % replaces an arbitrary number of zero or more characters
  - underscore (_) replaces a single character
  - Examples: **WHERE** Address **LIKE** ‘%Houston,TX%’;
  - **WHERE** Ssn **LIKE** ‘_ _ 1_ _ 8901’;
- **BETWEEN** comparison operator

E.g., in Q14 :

WHERE(Salary **BETWEEN** 30000 **AND** 40000)
AND Dno = 5;

Arithmetic Operations

- Standard arithmetic operators:
  - Addition (+), subtraction (–), multiplication (*), and division (/) may be included as a part of **SELECT**

- **Query 13.** Show the resulting salaries if every employee working on the ‘ProductX’ project is given a 10 percent raise.

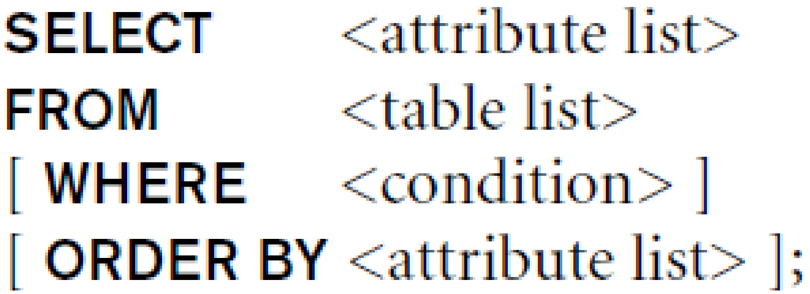
```
SELECT  E.Fname, E.Lname, 1.1 * E.Salary AS Increased_sal
FROM  EMPLOYEE AS E, WORKS_ON AS W, PROJECT AS P
WHERE  E.Ssn=W.Essn AND W.Pno=P.Pnumber AND
    P.Pname=‘ProductX’;
```

Ordering of Query Results

- Use **`ORDER BY`** clause
  - Keyword **`DESC`** to see result in a descending order of values
  - Keyword **`ASC`** to specify ascending order explicitly
  - Typically placed at the end of the query

```
ORDER BY D.Dname DESC, E.Lname ASC,
  E.Fname ASC
```

Basic SQL Retrieval Query Block



```
SELECT        <attribute list>
FROM          <table list>
[ WHERE       <condition> ]
[ ORDER BY <attribute list> ];
```

INSERT, DELETE, and UPDATE Statements in SQL

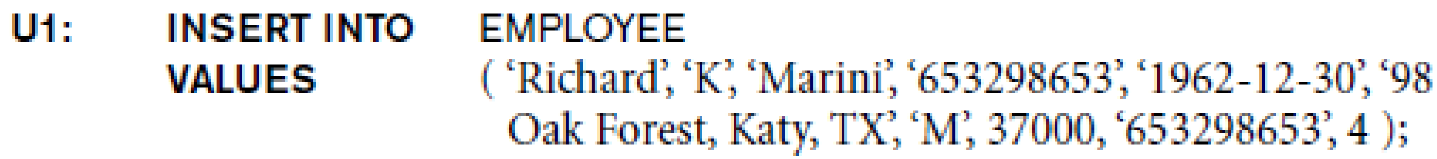
- Three commands used to modify the database:
  - INSERT, DELETE, and UPDATE
- INSERT typically inserts a tuple (row) in a relation (table)
- UPDATE may update a number of tuples (rows) in a relation (table) that satisfy the condition
- DELETE may also update a number of tuples (rows) in a relation (table) that satisfy the condition

INSERT

- In its simplest form, it is used to add one or more tuples to a relation
- Attribute values should be listed in the same order as the attributes were specified in the **CREATE TABLE** command
- Constraints on data types are observed automatically
- Any integrity constraints as a part of the DDL specification are enforced

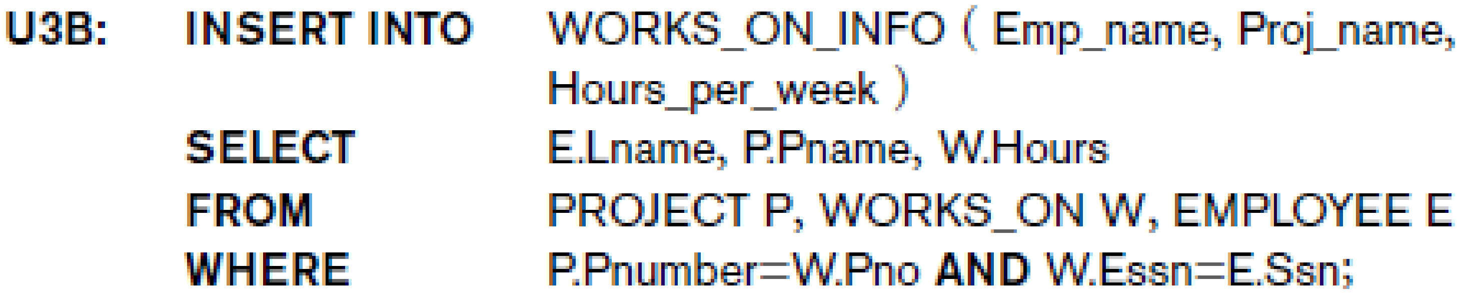
The INSERT Command

- Specify the relation name and a list of values for the tuple. All values including nulls are supplied.



```
U1:     INSERT INTO     EMPLOYEE
        VALUES          ( ‘Richard’, ‘K’, ‘Marini’, ‘653298653’, ‘1962-12-30’, ‘98
                          Oak Forest, Katy, TX’, ‘M’, 37000, ‘653298653’, 4 );
```

- The variation below inserts multiple tuples where a new table is loaded values from the result of a query.



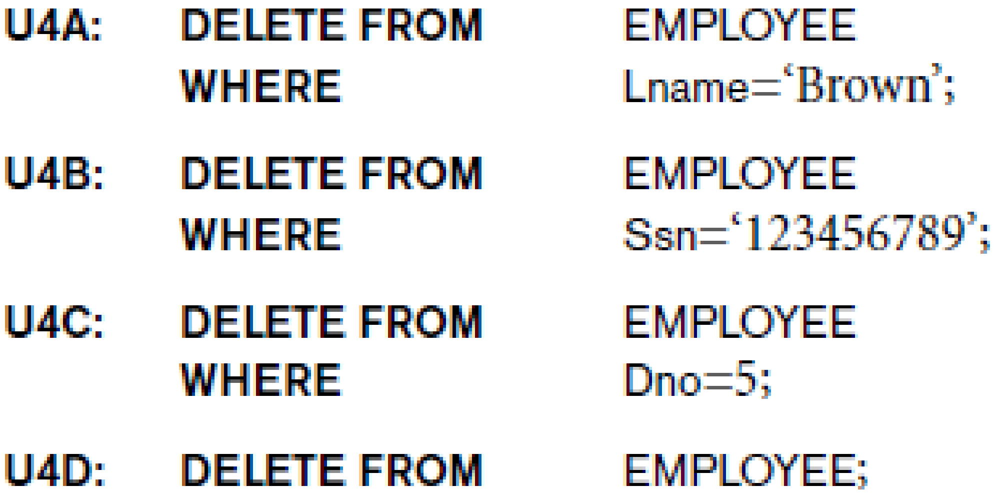
```
U3B:    INSERT INTO     WORKS_ON_INFO ( Emp_name, Proj_name,
                        Hours_per_week )
        SELECT          E.Lname, P.Pname, W.Hours
        FROM            PROJECT P, WORKS_ON W, EMPLOYEE E
        WHERE           P.Pnumber=W.Pno AND W.Essn=E.Ssn;
```

DELETE

- Removes tuples from a relation
  - Includes a WHERE-clause to select the tuples to be deleted
  - Referential integrity should be enforced
  - Tuples are deleted from only *one table* at a time (unless CASCADE is specified on a referential integrity constraint)
  - A missing WHERE-clause specifies that *all tuples* in the relation are to be deleted; the table then becomes an empty table
  - The number of tuples deleted depends on the number of tuples in the relation that satisfy the WHERE-clause

The DELETE Command

- Removes tuples from a relation
  - Includes a `WHERE` clause to select the tuples to be deleted. The number of tuples deleted will vary.



```
U4A:    DELETE FROM     EMPLOYEE
        WHERE           Lname='Brown';
U4B:    DELETE FROM     EMPLOYEE
        WHERE           Ssn='123456789';
U4C:    DELETE FROM     EMPLOYEE
        WHERE           Dno=5;
U4D:    DELETE FROM     EMPLOYEE;
```

UPDATE

- Used to modify attribute values of one or more selected tuples
- A WHERE-clause selects the tuples to be modified
- An additional SET-clause specifies the attributes to be modified and their new values
- Each command modifies tuples *in the same relation*
- Referential integrity specified as part of DDL specification is enforced

UPDATE (contd.)

- Example: Change the location and controlling department number of project number 10 to 'Bellaire' and 5, respectively

```
U5:     UPDATE    PROJECT
        SET       PLOCATION = 'Bellaire',
                        DNUM = 5
        WHERE     PNUMBER=10
```

UPDATE (contd.)

- Example: Give all employees in the 'Research' department a 10% raise in salary.

```
U6:UPDATE       EMPLOYEE
   SET          SALARY = SALARY *1.1
   WHERE        DNO  IN (SELECT     DNUMBER
                   FROM         DEPARTMENT
                   WHERE        DNAME='Research')
```

- In this request, the modified SALARY value depends on the original SALARY value in each tuple
  - The reference to the SALARY attribute on the right of = refers to the old SALARY value before modification
  - The reference to the SALARY attribute on the left of = refers to the new SALARY value after modification