

CHAPTER 6

Basic SQL

Chapter 6 Outline

- Basic Retrieval Queries in SQL
- SQL Data Definition and Data Types
- Specifying Constraints in SQL
- INSERT, DELETE, and UPDATE Statements in SQL
- Additional Features of SQL

SQL language

- SQL was one of the first commercial languages for Dr. Edgar F. Codd's relational model.
- It is the most widely used database language.
- Considered one of the major reasons for the commercial success of relational databases

Basic SQL

- The origin of SQL is relational algebra and relational calculus (see Ch.8) which was proposed initially as the language SQUARE.
- **SQL** Actually comes from the word “SEQUEL” which was the original term used in the paper: “SEQUEL TO SQUARE” 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**”.

Basic SQL

- SQL does not entirely adhere to the relational model as described by Codd.
- SQL is an informal or practical rendering of the relational data model with syntax
- Terminology:
 - **Table**, **row**, and **column** used for relational model terms **relation**, **tuple**, and **attribute**.

Features of SQL

- The language has features for :
 - Data definition, Data Manipulation,
 - Transaction control (Transact-SQL, Ch. 20),
 - Indexing (Ch.17),
 - Security specification (Grant and Revoke- see Ch.30),
 - Active databases (Ch.26),
 - Multi-media (Ch.26),
 - Distributed databases (Ch.23) etc.

SQL Standards

- SQL has gone through many standards: starting with SQL-86 or SQL 1.A. SQL-92 is referred to as SQL-2.
- Later standards (from SQL-1999) are divided into **core** specification and specialized **extensions**. The extensions are implemented for different applications – such as data mining, data warehousing, multimedia etc.
- SQL-2006 added XML features (Ch. 13); In 2008 they added Object-oriented features (Ch. 12).
- SQL-3 is the current standard which started with SQL-1999. It is not fully implemented in any RDBMS.

Outline

- **Basic Retrieval Queries in SQL**
- **SQL Data Definition and Data Types**
- **Specifying Constraints in SQL**
- **INSERT, DELETE, and UPDATE Statements in SQL**
- **Additional Features of SQL**

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
 - Tuple-id may be used as a key

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.

■ Each statement in SQL ends with a **semicolon**

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

- Logical comparison operators
 - $=$, $<$, \leq , $>$, \geq , and \neq
- **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.

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

EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	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	<u>Dnumber</u>	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

<u>Dnumber</u>	<u>Dlocation</u>
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

<u>Essn</u>	<u>Pno</u>	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

<u>Pname</u>	<u>Pnumber</u>	<u>Plocation</u>	<u>Dnum</u>
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

<u>Essn</u>	<u>Dependent_name</u>	Sex	<u>Bdate</u>	<u>Relationship</u>
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

Basic Retrieval Queries

<u>Bdate</u>	<u>Address</u>
1965-01-09	731 Fondren, Houston, TX

<u>Fname</u>	<u>Lname</u>	<u>Address</u>
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;

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

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

Basic Retrieval Queries (Contd.)

(c)

<u>Pnumber</u>	<u>Dnum</u>	<u>Lname</u>	<u>Address</u>	<u>Bdate</u>
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;
```

Ambiguous Attribute Names (cont.)

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.

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

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

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

Unspecified WHERE Clause

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

Q9: **SELECT** Ssn
FROM EMPLOYEE;

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

Unspecified WHERE Clause (cont.)

- 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)

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;

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 (cont.)

- 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;`

Salary
30000
40000
25000
43000
38000
25000
25000
55000

Tables as Sets in SQL (cont'd.)

- Set operations
 - **UNION, EXCEPT (difference), INTERSECT**
 - 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');
```

Multiset operations

- Corresponding multiset operations: UNION **ALL**, EXCEPT **ALL**, INTERSECT **ALL**)

(a)

R	S
A	A
a1	a1
a2	a2
a2	a4
a3	a5

(b)

T
A
a1
a1
a1
a2
a2
a2
a3
a4
a5

(c)

T
A
a2
a3

(d)

T
A
a1
a2

Figure 6.5
The results of SQL multiset operations. (a) Two tables, R(A) and S(A).
(b) R(A)UNION ALL S(A).
(c) R(A) EXCEPT ALL S(A).
(d) R(A) INTERSECT ALL S(A).

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.

Arithmetic Operations (cont.)

- 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> ];
```

Outline

- Basic Retrieval Queries in SQL
- **SQL Data Definition and Data Types**
- Specifying Constraints in SQL
- INSERT, DELETE, and UPDATE Statements in SQL
- Additional Features of SQL

Schema and Catalog Concepts in SQL

- We cover the basic standard SQL syntax – there are variations in existing RDBMS systems
- **SQL schema**
 - Identified by a **schema name**
 - Includes an **authorization identifier** and **descriptors** for each element
- **Schema elements** include
 - Tables, constraints, views, domains, and other constructs
- Each statement in SQL ends with a **semicolon**

Schema and Catalog Concepts in SQL (cont'd.)

- CREATE SCHEMA statement
 - CREATE SCHEMA COMPANY AUTHORIZATION 'Jsmith';
- Catalog
 - Named collection of schemas in an SQL environment
- SQL also has the concept of a cluster of catalogs.

The CREATE TABLE Command in SQL

- Specifying a new relation
 - Provide name of table
 - Specify attributes, their types and initial constraints
- Can optionally specify schema:
 - CREATE TABLE COMPANY.EMPLOYEE ...
or
 - CREATE TABLE EMPLOYEE ...

The CREATE TABLE Command in SQL (cont'd.)

- **Base tables (base relations)**
 - Relation and its tuples are actually created and stored as a file by the DBMS
- **Virtual relations (views)**
 - Created through the `CREATE VIEW` statement (Ch. 7). Do not correspond to any physical file.

COMPANY relational database schema (Fig. 5.7)

EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
-------	-------	-------	------------	-------	---------	-----	--------	-----------	-----

DEPARTMENT

Dname	<u>Dnumber</u>	Mgr_ssn	Mgr_start_date
-------	----------------	---------	----------------

DEPT_LOCATIONS

Dnumber	<u>Dlocation</u>
---------	------------------

PROJECT

Pname	<u>Pnumber</u>	Plocation	Dnum
-------	----------------	-----------	------

WORKS_ON

<u>Essn</u>	<u>Pno</u>	Hours
-------------	------------	-------

DEPENDENT

<u>Essn</u>	Dependent_name	Sex	Bdate	Relationship
-------------	----------------	-----	-------	--------------

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

EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	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
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James	E	Borg	888665555	1937-11-10	450 Stone, Houston, TX	M	55000	NULL	1

DEPARTMENT

Dname	<u>Dnumber</u>	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

<u>Dnumber</u>	<u>Dlocation</u>
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

<u>Essn</u>	<u>Pno</u>	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

<u>Pname</u>	<u>Pnumber</u>	<u>Plocation</u>	<u>Dnum</u>
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

<u>Essn</u>	<u>Dependent_name</u>	Sex	<u>Bdate</u>	<u>Relationship</u>
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) ;

continued on next slide

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 or 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

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

- Additional data types
 - **Timestamp** data type
 - Includes the DATE and TIME fields
 - Plus a minimum of six positions for decimal fractions of seconds
 - Optional WITH TIME ZONE qualifier
 - Literal values are represented by single-quoted strings preceded by the keyword TIMESTAMP,
 - For example, **TIMESTAMP '2014-09-27 09:12:47.648302'**

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

- Additional data types
 - **INTERVAL** data type
 - Specifies a relative value that can be used to increment or decrement an absolute value of a date, time, or timestamp
 - **DATE, TIME, Timestamp, INTERVAL** data types can be **cast** or converted to string formats for comparison.

Outline

- Basic Retrieval Queries in SQL
- SQL Data Definition and Data Types
- **Specifying Constraints in SQL**
- INSERT, DELETE, and UPDATE Statements in SQL
- Additional Features of SQL

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

■ Domain

- Name used with the attribute specification
- Makes it easier to change the data type for a domain that is used by numerous attributes
- Improves schema readability
- Example:
 - `CREATE DOMAIN SSN_TYPE AS CHAR(9);`

■ TYPE

- User Defined Types (UDTs) are supported for object-oriented applications. (See Ch.12) Uses the command: `CREATE TYPE`

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 Constraints in SQL (cont.)

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) ;

continued on next slide

Specifying Attribute Constraints

- Other Restrictions on attribute domains:
 - NULL is not permitted for a particular attribute (NOT NULL)
 - Default value of an attribute
 - **DEFAULT <value>**

```
CREATE TABLE EMPLOYEE ( ...,
    Dno INT NOT NULL DEFAULT 1,
    ...
)
```
 - **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

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);
```

Giving Names to Constraints

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

Specifying Constraints on Tuples Using CHECK

- Additional Constraints on individual tuples within a relation are also possible using CHECK
- CHECK clauses at the end of a CREATE TABLE statement
 - Apply to each tuple individually
 - **CHECK** (Dept_create_date <= Mgr_start_date) ;

Outline

- Basic Retrieval Queries in SQL
- SQL Data Definition and Data Types
- Specifying Constraints in SQL
- **INSERT, DELETE, and UPDATE Statements in SQL**
- Additional Features of SQL

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 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;
```

BULK LOADING OF TABLES

- Another variation of **INSERT** is used for bulk-loading of several tuples into tables
- A new table TNEW can be created with the same attributes as T and using LIKE and DATA in the syntax, it can be loaded with entire data.
- **EXAMPLE:**

```
CREATE TABLE D5EMPS LIKE EMPLOYEE  
  (SELECT E.*  
   FROM EMPLOYEE AS E  
   WHERE E.Dno=5)  
  
WITH DATA;
```

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 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 WHERE	EMPLOYEE Lname='Brown';
U4B:	DELETE FROM WHERE	EMPLOYEE Ssn='123456789';
U4C:	DELETE FROM WHERE	EMPLOYEE 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
```

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

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

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

Additional Features of SQL

- Techniques for specifying complex retrieval queries (see Ch.7)
- Writing programs in various programming languages that include SQL statements: Embedded and dynamic SQL, SQL/CLI (Call Level Interface) and its predecessor ODBC, SQL/PSM (Persistent Stored Module) (See Ch.10)
- Set of commands for specifying physical database design parameters, file structures for relations, and access paths, e.g., CREATE INDEX

Additional Features of SQL (cont'd.)

- Transaction control commands (Ch.20)
- Specifying the granting and revoking of privileges to users (Ch.30)
- Constructs for creating triggers (Ch.26)
- Enhanced relational systems known as object-relational define relations as classes. Abstract data types (called User Defined Types- UDTs) are supported with CREATE TYPE
- New technologies such as XML (Ch.13) and OLAP (Ch.29) are added to versions of SQL

Summary

- SQL
 - A Comprehensive language for relational database management
 - Data definition, queries, updates, constraint specification, and view definition
- Covered :
 - Data definition commands for creating tables
 - Commands for constraint specification
 - Simple retrieval queries
 - Database update commands