

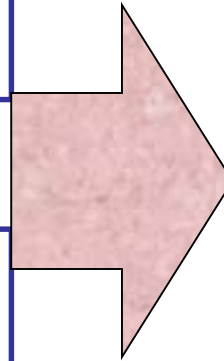


CHAPTER 6

Basic SQL

ER and EER
Conceptual data models

Relational Model
(Tables)



How to convert EER to
Relational Model
(next Lecture)

Use SQL query
language on relational
model

Chapter 6 Outline

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

Basic SQL

- SQL language

- Considered one of the major reasons for the commercial success of relational databases

- SQL

- The origin of SQL is relational predicate calculus called tuple 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”.
- SQL is an informal or practical rendering of the relational data model with syntax

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 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.

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. 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

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

PROJECT

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

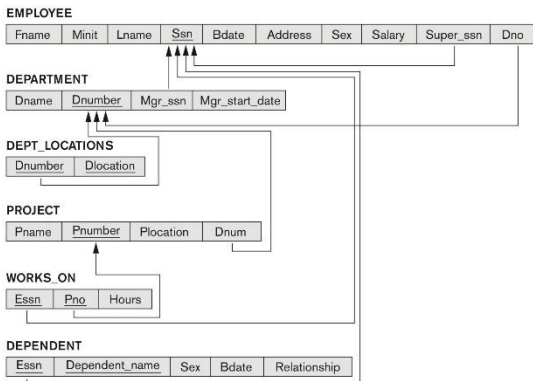
WORKS_ON

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

DEPENDENT

<u>Essn</u>	<u>Dependent_name</u>	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
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

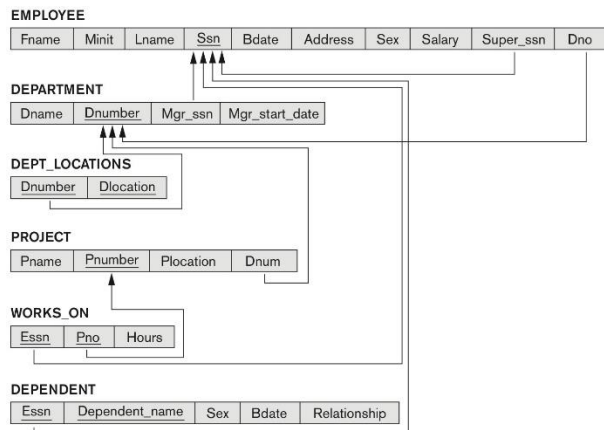
DEPARTMENT

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>	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

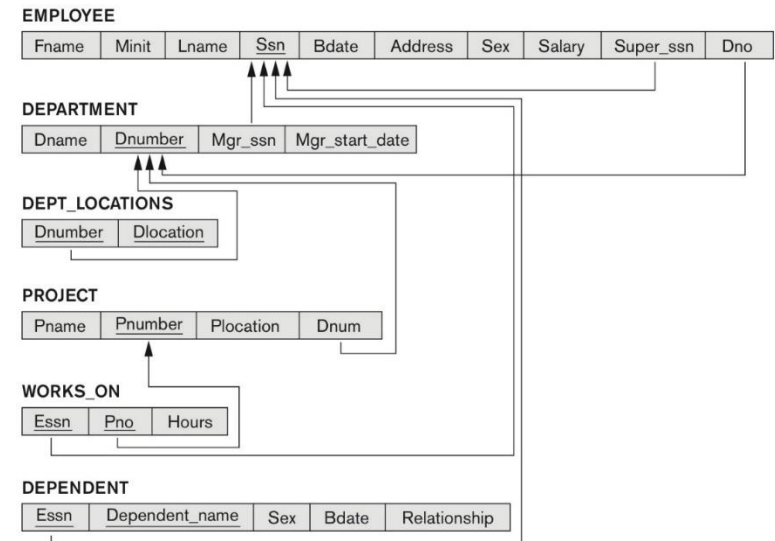
<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
333445555	Alice	F	1986-04-05	Daughter
333445555	Theodore	M	1983-10-25	Son
333445555	Joy	F	1958-05-03	Spouse
987654321	Abner	M	1942-02-28	Spouse
123456789	Michael	M	1988-01-04	Son
123456789	Alice	F	1988-12-30	Daughter
123456789	Elizabeth	F	1967-05-05	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,                NOT NULL,
  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)
  Pnumber        INT
  Plocation      VARCHAR(15),
  Dnum           INT
```

PRIMARY KEY (Pnumber),

UNIQUE (Pname),

FOREIGN KEY (Dnum) **REFERENCES** DEPARTMENT(Dnumber));

CREATE TABLE WORKS_ON

```
( Essn           CHAR(9)
  Pno            INT
  Hours          DECIMAL(3,1)
```

PRIMARY KEY (Essn, Pno),

FOREIGN KEY (Essn) **REFERENCES** EMPLOYEE(Ssn),

FOREIGN KEY (Pno) **REFERENCES** PROJECT(Pnumber));

CREATE TABLE DEPENDENT

```
( Essn           CHAR(9)
  Dependent_name VARCHAR(15)
  Sex            CHAR,
  Bdate          DATE,
  Relationship    VARCHAR(8),
```

PRIMARY KEY (Essn, Dependent_name),

FOREIGN KEY (Essn) **REFERENCES** EMPLOYEE(Ssn));

NOT NULL,
NOT NULL,

NOT NULL,

NOT NULL,
NOT NULL,
NOT NULL,

NOT NULL,
NOT NULL,

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
------	----------------	-----	-------	--------------

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

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

- **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.

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.

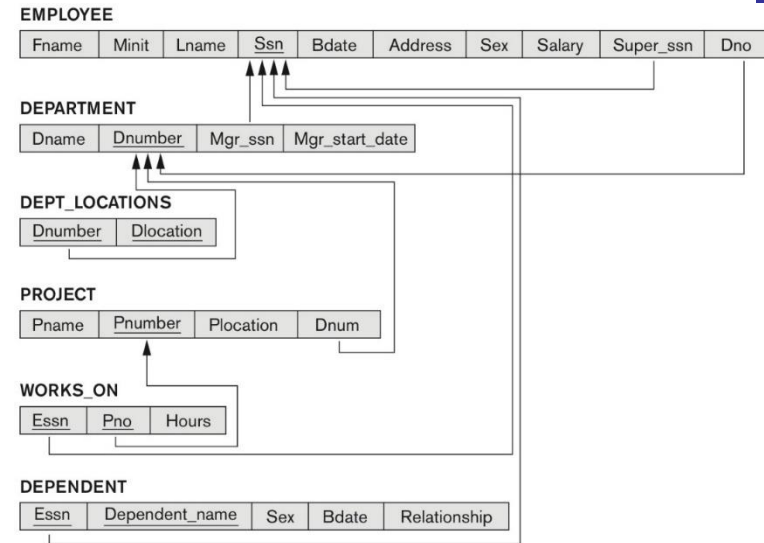
Specifying Attribute Constraints

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);`

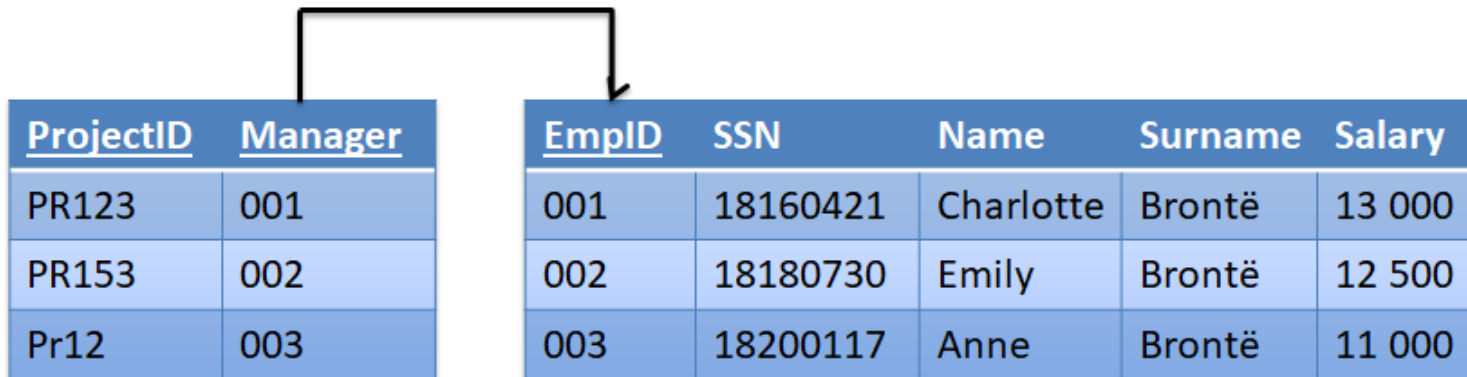
Specifying Key and Referential Integrity Constraints

- **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

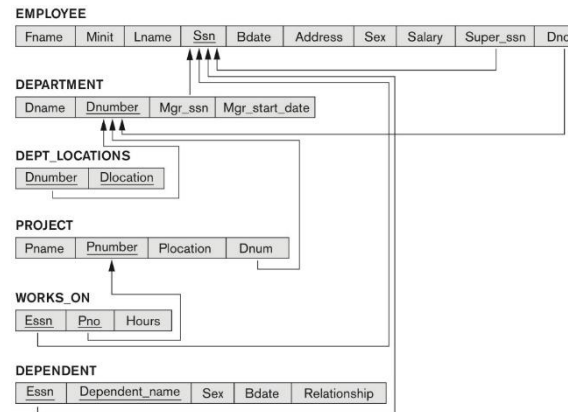
- Using the Keyword **CONSTRAINT**
 - Name a constraint
 - Useful for later altering

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

```
CREATE TABLE EMPLOYEE
( ... ,
  Dno          INT          NOT NULL    DEFAULT 1,
  CONSTRAINT EMPKP
  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);
```



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

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);`

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.

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

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

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';

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

Basic Retrieval Queries

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

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;

<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

Basic Retrieval Queries (Contd.)

PROJECT

Pname	<u>Pnumber</u>	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

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
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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

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';

Basic Retrieval Queries (Contd.)

PROJECT

Pname	<u>Pnumber</u>	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

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
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Joyce	A	English	453453453	1972-07-31	5631 Rice, Houston, TX	F	25000	333445555	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

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';

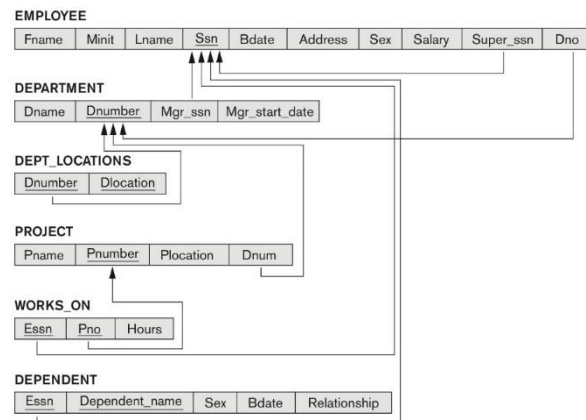
(c)

<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

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)

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;**

**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   |

**(a)**

| Salary |
|--------|
| 30000  |
| 40000  |
| 25000  |
| 43000  |
| 38000  |
| 25000  |
| 25000  |
| 55000  |

**(b)**

| Salary |
|--------|
| 30000  |
| 40000  |
| 25000  |
| 43000  |
| 38000  |
| 55000  |



# 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);
```

EMPLOYEE

| Fname | Minit | Lname | Ssn  | Bdate | Address | Sex | Salary | Super_ssn | Dno |
|-------|-------|-------|------|-------|---------|-----|--------|-----------|-----|
|       |       |       | ↑↑↑↑ |       |         |     |        |           |     |

- 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 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;**

**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   |

# 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
```

PROJECT

| Pname           | <u>Pnumber</u> | 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    |

# 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

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        |

# 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