

# SQL-The Relational Database Standard

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# SQL

- ◆ SQL (Structure Query language)
  - Standard language for commercial relational DBMS
  - Declarative language
    - users specify **what** the result is to be ( ~~how~~ )
    - Based on **relational calculus**
    - **Relational algebra**: users specify **how**, in what order, to execute the query operations
  - Originally, SEQUEL (Structure English QUery Language) & was designed and implemented for IBM System R

# SQL (cont.)

## ◆ SQL (Structure Query language)

### – Versions

- SQL1: SQL-86 (ANSI 1986)
- SQL2: SQL-92
- SQL3:
- SQL 2003, 2006: added XML
- SQL 2008: incorporate more object database features
- SQL 2011: add temporal data *related to time*
- SQL 2016: row pattern matching, polymorphic table functions, JSON
- SQL 2019: multidimensional array

### – Support DDL, DML, VIEW, Security, Authorization, Integrity Constraints, Transaction Control

*data definition language  
(schema, objects)*

*data manipulation language  
(data)*

# An Example Database Application

- ◆ keeps track of a company's **employees, departments & projects**
  - The company is organized into departments.
  - Each department has a unique name, a unique number & a particular employee who manages the department.
  - We keep track of the start date when that employee began managing the department.
  - A department may have several locations
  - A department controls a number of projects, each of which has a unique name, a unique number & a single location
  - We store each employee's name, social security number, address, salary, sex & birth date

# An Example Database Application (cont.)

- An employee is assigned to one department but may work on several projects, which are not necessarily controlled by the same department.
- We keep track of the number of hours per week that an employee works on each project.
- We keep track of the direct supervisor of each employee.
- We keep track of the dependents of each employee for insurance purpose.
- We keep each dependent's first name, sex, birth date & relationship to the employee

## EMPLOYEE

supervisor

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

manager

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

## WORKS\_ON

project

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

# EMPLOYEE

FNAME	MINIT	LNAME	<u>SSN</u>	BDATE	ADDRESS	SEX	SALARY	SUPERSSN	DNO
-------	-------	-------	------------	-------	---------	-----	--------	----------	-----

# DEPARTMENT

DNAME	<u>DNUMBER</u>	MGRSSN	MGRSTARTDATE
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# DEPT\_LOCATIONS

<u>DNUMBER</u>	<u>DLOCATION</u>
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# PROJECT

PNAME	<u>PNUMBER</u>	PLOCATION	DNUM
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# WORKS\_ON

<u>ESSN</u>	<u>PNO</u>	HOURS
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# DEPENDENT

<u>ESSN</u>	<u>DEPENDENT_NAME</u>	SEX	BDATE	RELATIONSHIP
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### EMPLOYEE

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

### DEPARTMENT

Dname	<u>Dnumber</u>	Mgr_ssn	Mgr_start_date
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### DEPT\_LOCATIONS

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

### PROJECT

Pname	<u>Pnumber</u>	Plocation	Dnum
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### WORKS\_ON

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

### DEPENDENT

<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
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**Figure 3.5**

Schema diagram for the COMPANY relational database schema.



# DDL in SQL

## (Data Definition Language)

# Data Definition

- ◆ SQL terms
  - Table: relation
  - Row: tuple
  - Column: attribute
- ◆ DDL support (Data Definition Language)
  - CREATE
  - ALTER
  - DROP

# Schema & Catalog Concepts in SQL

## ◆ SQL schema

- Group together tables & other constructs that belong to the same database application
- Identified by
  - Schema name
  - Authorization identifier
  - Descriptors for each elements (tables, constraints, views, domains & other construct) in schema
- e.g.

**CREATE SCHEMA** company **AUTHORIZATION** 'Jsmith';

## ◆ Catalog (Data Dictionary)

- Collection of schemas
- Contains information of schema, referential constraints, domain definition sharing

# EMPLOYEE

FNAME	MINIT	LNAME	<u>SSN</u>	BDATE	ADDRESS	SEX	SALARY	SUPERSSN	DNO
-------	-------	-------	------------	-------	---------	-----	--------	----------	-----

# DEPARTMENT

DNAME	<u>DNUMBER</u>	MGRSSN	MGRSTARTDATE
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# DEPT\_LOCATIONS

<u>DNUMBER</u>	<u>DLOCATION</u>
----------------	------------------

# PROJECT

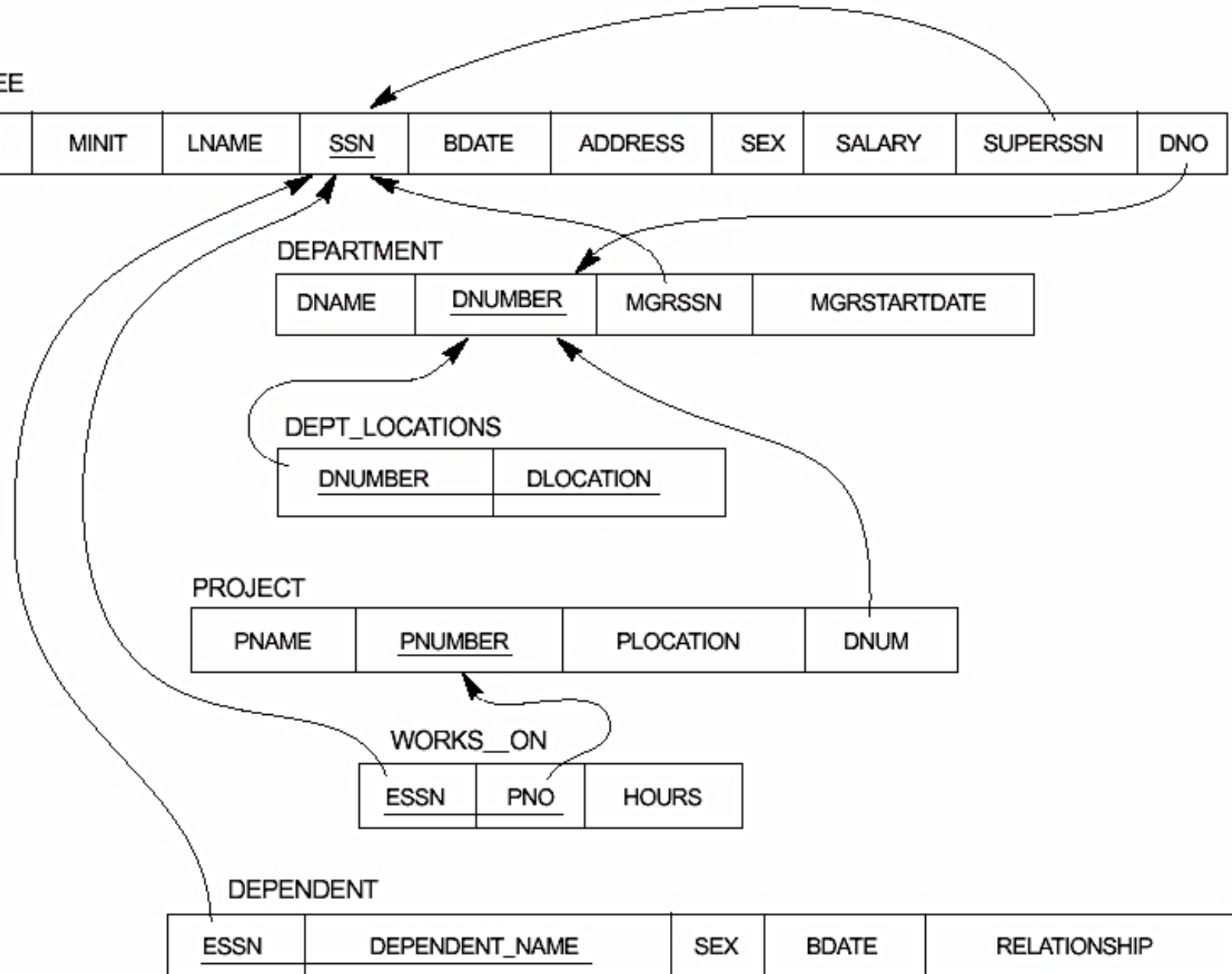
PNAME	<u>PNUMBER</u>	PLOCATION	DNUM
-------	----------------	-----------	------

# WORKS\_ON

<u>ESSN</u>	<u>PNO</u>	HOURS
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# DEPENDENT

<u>ESSN</u>	<u>DEPENDENT_NAME</u>	SEX	BDATE	RELATIONSHIP
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# CREATE TABLE

## ◆ CREATE TABLE Department

(	Dname	Varchar(15)	Not Null,
	Dnumber	Int	Not Null,
	MgrSSN	Char(9)	Not Null,
	MgrStartDate	Date	Not Null,

**Primary Key**(Dnumber),  
**Unique**(Dname),  
**Foreign Key**(MgrSSN) **References** Employee (SSN));

# Data Types & Domains

## ◆ Numeric

- Integer: INTEGER (INT), SMALLINT
- Real numbers (FLOAT, REAL, DOUBLE PRECISION)
- Formatted numbers: DECIMAL (i, j) or DEC(i, j)

## ◆ Character string

- Fixed length: CHAR(n) or CHARACTER (n)
- Variable length
  - VARCHAR(n) or CHAR VARYING(n) or CHARACTER VARYING(n)

*i : total # of digits  
j : # of digits after  
the decimal point*

## ◆ Bit string

- Fixed length: BIT(n)
- Variable length: BIT VARYING(n)

# Data Types (cont.)

- ◆ Boolean: 3-value logic, TRUE, FALSE, UNKNOWN
- ◆ Data and time
  - DATE: year-month-day format yyyy-mm-dd
  - TIME: hour:minute:second format hh:mm:ss
  - TIME(i): hour:minute:second plus i additional digits specifying fractions of a second format is hh:mm:ss:ii...i
  - TIMESTAMP: DATE and TIME components
- ◆ **CREATE DOMAIN SSN\_TYPE AS CHAR(9);**

TIMESTAMP values are stored as the number of seconds since the Unix epoch ('1970-01-01 00:00:00' UTC).

# EMPLOYEE

FNAME	MINIT	LNAME	<u>SSN</u>	BDATE	ADDRESS	SEX	SALARY	SUPERSSN	DNO
-------	-------	-------	------------	-------	---------	-----	--------	----------	-----

# DEPARTMENT

DNAME	<u>DNUMBER</u>	MGRSSN	MGRSTARTDATE
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# 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
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# Constraints

## ◆ **CREATE TABLE** Department

(    Dname            **VARCHAR**(15)            **NOT NULL**,  
     Dnumber        **INT**            **NOT NULL CHECK** (Dnumber <20)  
     MgrSSN          **CHAR**(9) **NOT NULL DEFAULT** '888665555',  
     MgrStartDate **DATE**                            **NOT NULL**,

**CONSTRAINT** Deptpk

**PRIMARY KEY** (Dnumber),

**CONSTRAINT** Deptsk

**UNIQUE** (Dname),

**CONSTRAINT** Deptmgrfk

**FOREIGN KEY** (MgrSSN) **REFERENCES** Employee (SSN)

**ON DELETE Set Default**

**ON UPDATE Cascade**

);

# Drop Schema & Drop Table

- ◆ Drop Schema Company Cascade
  - Cascade: remove all tables, domains & other elements
  - Restrict: schema is dropped only if it has no elements in it
- ◆ Drop table Dependent Cascade
  - Cascade: all constraints & views that reference the table are dropped automatically
  - Restrict: a table is dropped only if it is not referenced in any constraints

# Alter Table

- ◆ Alter table command: schema evolution
  - Adding or dropping a column *Add / Drop*
  - Changing a column definition *Alter*
  - Adding or dropping table constraints *Add Constraint / Drop Constraint*
- ◆ e.g.
  - **Alter Table** Company.Employee **Add** *(COLUMN)* Job varchar(12);
  - **Alter Table** Company.Employee **Drop** Address **Cascade**;
  - **Alter Table** Company.Department **Alter** MgrSSN **Drop** **Default**;
  - **Alter Table** Company.Department **Alter** MgrSSN **Set** **Default** “333445555”;
  - **Alter Table** Company.Department **Drop** **Constraint** EmpSuperFK **Cascade**;

# Basic SQL DML Queries (Data Manipulation Language)

# SQL DML Queries

- ◆ Basic form of Select statement

**SELECT** <attribute list>

**FROM** <table list>

**WHERE** <condition>;

- Attribute list: list of attribute names whose value are to be retrieved by the query
- Table list: a list of relation names required to process the query
- Condition: a conditional (Boolean) expression that identifies the tuples to be retrieved by the query

# EMPLOYEE

FNAME	MINIT	LNAME	<u>SSN</u>	BDATE	ADDRESS	SEX	SALARY	SUPERSSN	DNO
-------	-------	-------	------------	-------	---------	-----	--------	----------	-----

# DEPARTMENT

DNAME	<u>DNUMBER</u>	MGRSSN	MGRSTARTDATE
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# DEPT\_LOCATIONS

<u>DNUMBER</u>	<u>DLOCATION</u>
----------------	------------------

# PROJECT

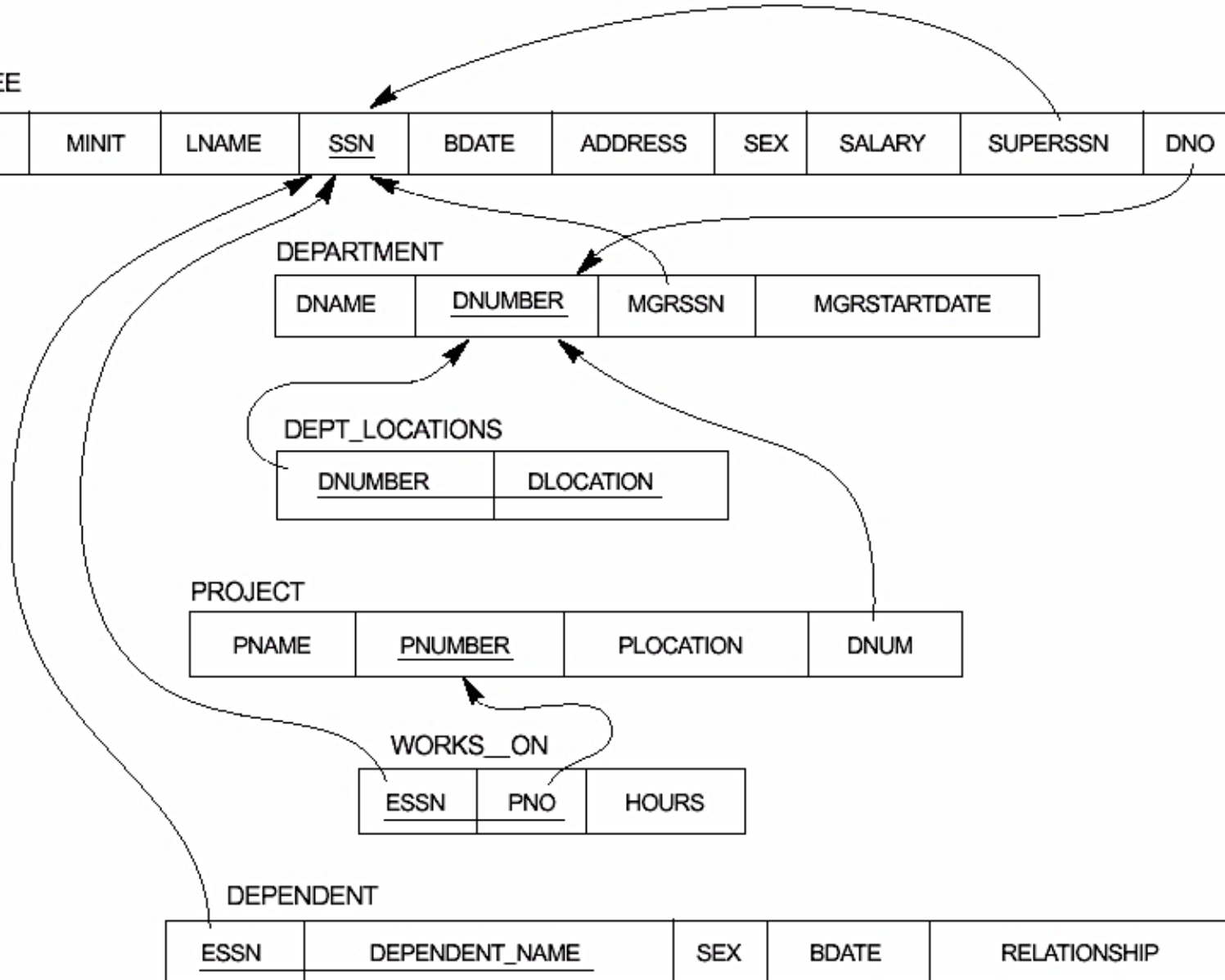
PNAME	<u>PNUMBER</u>	PLOCATION	DNUM
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# WORKS\_ON

<u>ESSN</u>	<u>PNO</u>	HOURS
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# DEPENDENT

<u>ESSN</u>	<u>DEPENDENT_NAME</u>	SEX	BDATE	RELATIONSHIP
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# Basic SQL Queries

- ◆ Q0: Retrieve the birthday and address of the employee(s) whose name is 'John B. Smith'

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

# Basic SQL Queries

- ◆ Q0: Retrieve the birthday and address of the employee(s) whose name is 'John B. Smith'

## EMPLOYEE

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

## DEPARTMENT

Dname	<u>Dnumber</u>	Mgr_ssn	Mgr_start_date
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## DEPT\_LOCATIONS

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

## PROJECT

Pname	<u>Pnumber</u>	Plocation	Dnum
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## WORKS\_ON

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

## DEPENDENT

<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
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**Figure 3.5**

Schema diagram for the COMPANY relational database schema.



# Basic SQL Queries

- ◆ Q0: Retrieve the birthday and address of the employee(s) whose name is 'John B. Smith'

**Select** Bdate, Address

**From** Employee

**Where** Fname='John' **And** Minit='B' **And** Lname='Smith';

# Basic SQL Queries (cont.)

- ◆ Q1: Retrieve the name and address of all employees who work for the 'Research' department.

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

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

# Basic SQL Queries (cont.)

- ◆ Q1: Retrieve the name and address of all employees who work for the 'Research' department.

## 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

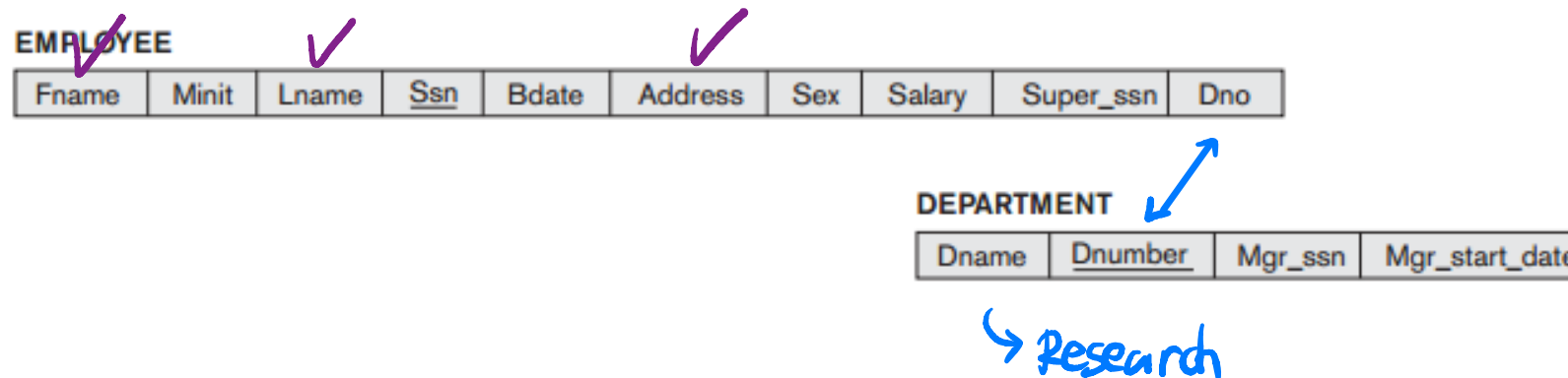
<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
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**Figure 3.5**

Schema diagram for the COMPANY relational database schema.

# Basic SQL Queries (cont.)

- ◆ Q1: Retrieve the name and address of all employees who work for the 'Research' department.



**Select** Fname, Lname, Address

**From** Employee, Department

**Where** DName='Research' **And** DNumber=DNo;

# Basic SQL Queries (cont.)

- ◆ Q2: For every project located in 'Stafford', list the project number, the controlling department number, and the department manager's last name, address, and birthday.

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

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

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

# Basic SQL Queries (cont.)

- ◆ Q2: For every project located in 'Stafford', list the project number, the controlling department number, and the department manager's last name, address, and birthday.

## 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

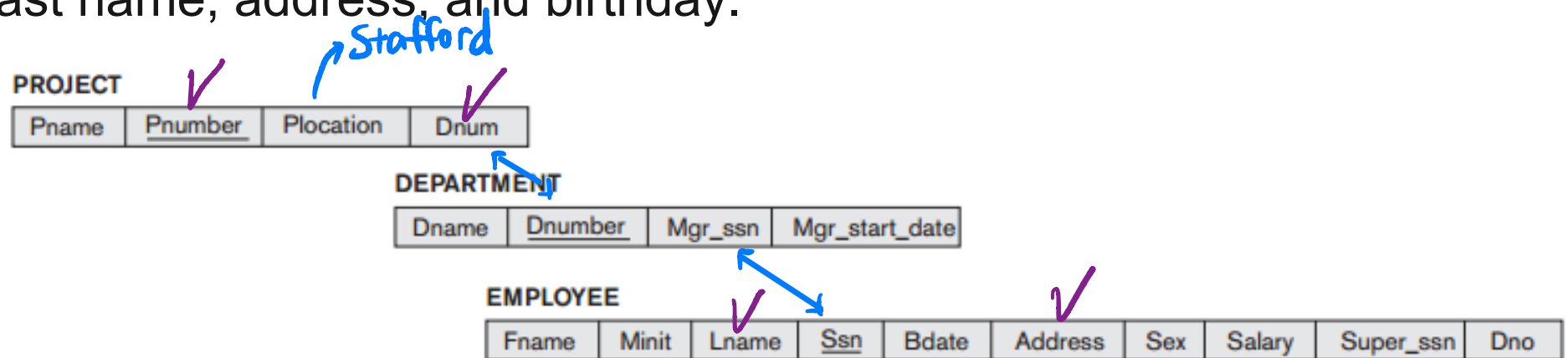
<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
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**Figure 3.5**

Schema diagram for the  
COMPANY relational  
database schema.

# Basic SQL Queries (cont.)

- ◆ Q2: For every project located in 'Stafford', list the project number, the controlling department number, and the department manager's last name, address, and birthday.



```
Select Pnumber, Dnum, Lname, Address, BDate
From Project, Department, Employee
Where Dnum=Dnumber And
      MgrSSN=SSN And
      Plocation='Stafford';
```

# Ambiguous Attribute Name, Aliasing

- ◆ Q1A: Retrieve the name and address of all employees who work for the 'Research' department.

## 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
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**Figure 3.5**

Schema diagram for the COMPANY relational database schema.



# Ambiguous Attribute Name, Aliasing (cont.)

- ◆ Q1A: Retrieve the name and address of all employees who work for the 'Research' department.

**Select**      Fname, Employee.Name, Address  
**From**        Employee, Department  
**Where**       Department.Name='Research' **AND**  
                 Department.DNumber=Employee.DNumber

# Ambiguous Attribute Name, Aliasing (cont.)

- ◆ **Alias** for queries referring to the same relation twice
- ◆ Q8: 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	<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

# Ambiguous Attribute Name, Aliasing (cont.)

- ◆ Q8: 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	<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
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## WORKS\_ON

<u>Essn</u>	<u>Pno</u>	Hours
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## DEPENDENT

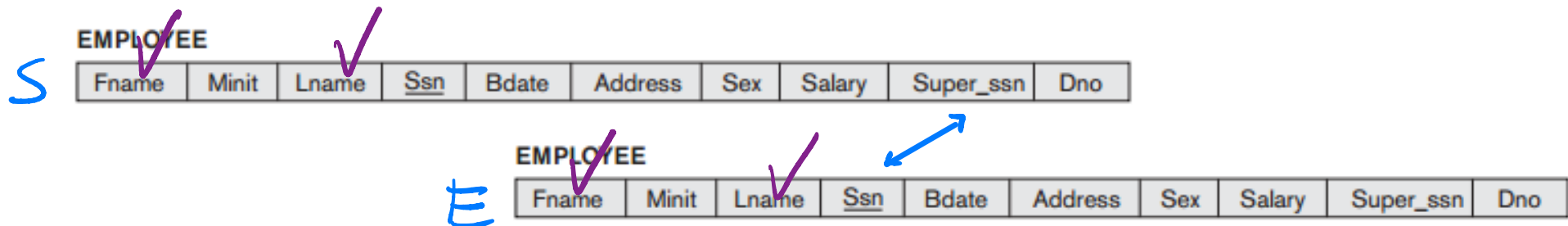
<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
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**Figure 3.5**

Schema diagram for the COMPANY relational database schema.

# Ambiguous Attribute Name, Aliasing (cont.)

- ◆ Q8: 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.SuperSSN = S.SSN;
```

# Unspecified Where Clause

- ◆ Q9: Select all Employee SSNs

**Select** SSN

**From** Employee;

# Unspecified Where Clause (cont.)

**Select** SSN, Dname  
**From** Employee, Department;

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

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

# Unspecified Where Clause (cont.)

- ◆ Q10: Select all combinations of Employee SSN and Department Dname in the database

```
Select    SSN, Dname  
From      Employee, Department;
```

- ◆ **cross product**: all possible combinations, if
  - more than one relation is specified in the from clause and
  - there is no where-clause

# Use of the Asterisk

- ◆ Q1D: Retrieve **all the attributes** of an employee and the attributes of the department he or she works in for every employee of the 'Research' department

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

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



# Use of the Asterisk (cont.)

- ◆ Q1D: Retrieve all the attributes of an employee and the attributes of the department he or she works in for every employee of the 'Research' department

## 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
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## WORKS\_ON

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

## DEPENDENT

<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
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**Figure 3.5**

Schema diagram for the COMPANY relational database schema.

# Use of the Asterisk (cont.)

- ◆ Q1D: Retrieve all the attributes of an employee and the attributes of the department he or she works in for every employee of the 'Research' department

```
Select      *  
From       Employee, Department  
Where      Dname='Research' And Dno=Dnumber;
```

# Tables as Sets in SQL

- ◆ Q11: Retrieve the salary of every employee

```
Select all Salary  
From Employee;
```

# Tables as Sets in SQL (cont.)

- ◆ Q11A: Retrieve all distinct salary values

```
Select Distinct      Salary
From      Employee;
```

- ◆ SQL
  - treats a table not as a set but rather as a **multiset**
  - **Duplicate tuples** can appear more than once in a table and in the result of a query
  - Reasons
    - Duplicate elimination is expensive
    - Users requirement
    - For using Aggregate function (e.g. average score)

# Tables as Sets in SQL (cont.)

- ◆ Q4: 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

**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

**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

# Tables as Sets in SQL (cont.)

- ◆ Q4: 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

## 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
-------------	-----------------------	-----	-------	--------------

**Figure 3.5**

Schema diagram for the COMPANY relational database schema.

# Tables as Sets in SQL (cont.)

- ◆ Q4: 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

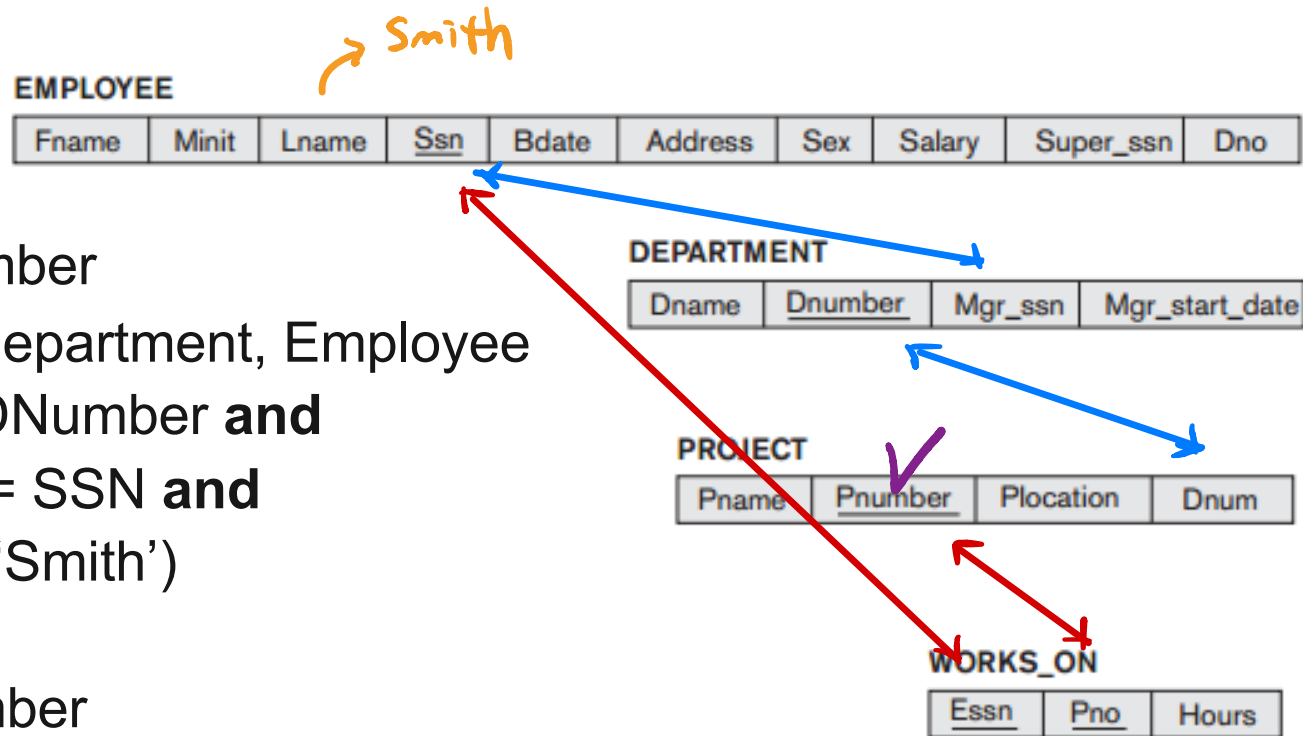
*manager*

**(Select Distinct PNumber**  
**From** Project, Department, Employee  
**Where** Dnum = DNumber **and**  
MgrSSN = SSN **and**  
Lname = 'Smith')

**Union**

**(Select Distinct Pnumber**  
**From** Project, Works\_On, Employee  
**Where** PNumber = Pno **and**  
ESSN = SSN **and**  
Lname = 'Smith');

*employee*



# Tables as Sets in SQL (cont.)

## ◆ Set operations in SQL

- UNION: union operation  $\cup$
- EXCEPT: set difference  $-$
- INTERSECT: intersection  $\cap$

## ◆ Duplicate tuples are eliminated from the result of set operations

## ◆ Union compatible

- ↳ conditions:
- ① same # of columns
  - ② corresponding columns must have compatible data types
  - ③ matching column order



# Substring Pattern Matching

- ◆ Q12: Retrieve all employees whose address is in Houston, Texas

**Select**      FName, LName

**From**        Employee

**Where**      Address **Like** '%Houston, TX%';

# Substring Pattern Matching (cont.)

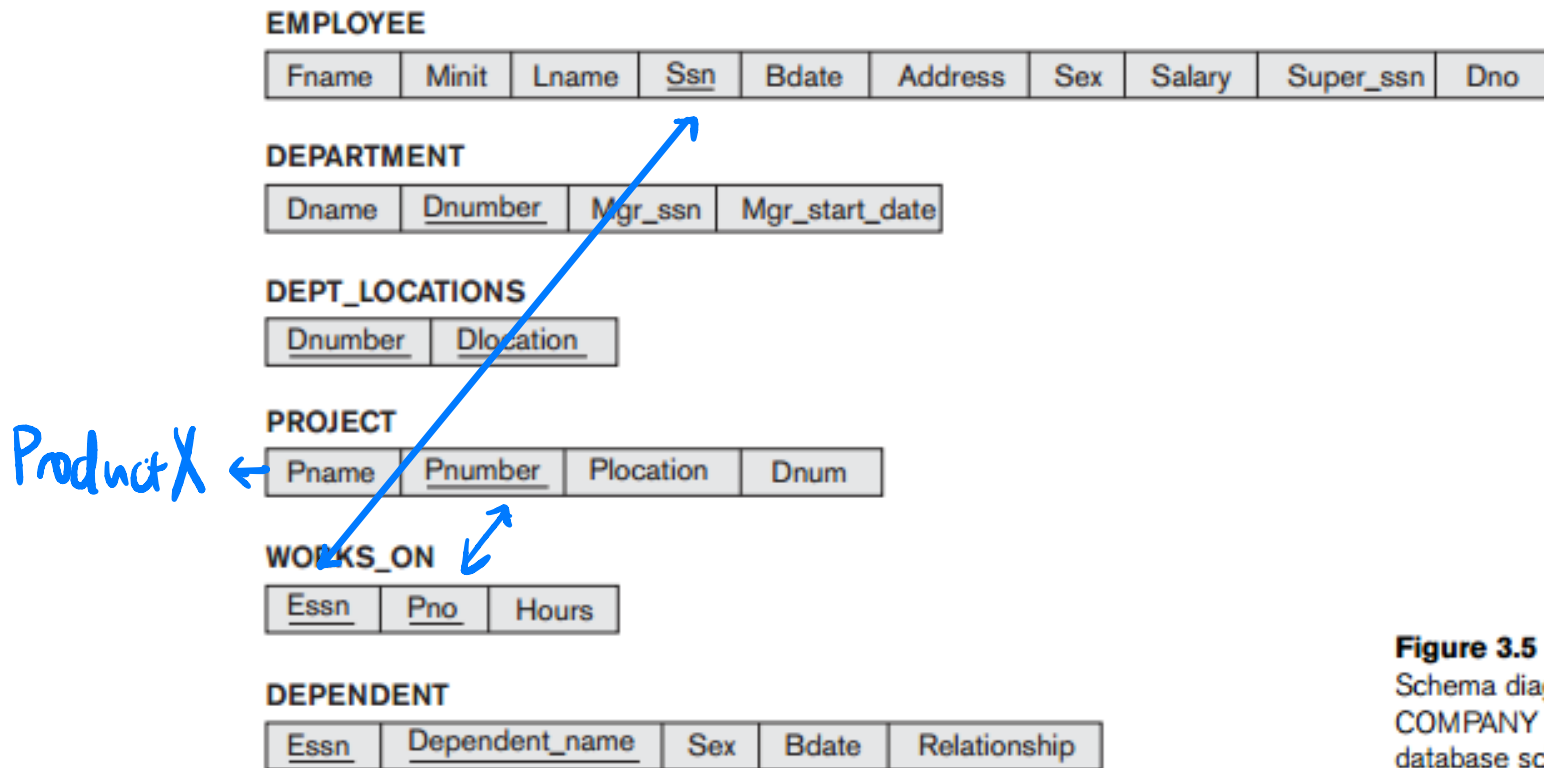
- ◆ Q12A: Find all employees who were born during the 1950s

**Select**      Fname, Lname  
**From**        Employee  
**Where**       Bdate **like** '\_\_\_5\_\_\_\_\_';

wildcard characters { % : represents 0 or more characters  
                          \_ : represents a single character

# Arithmetic Operators

- ◆ Q13: Show the resulting salaries if every employee working on the 'ProductX' project is given a 10 percent raise



**Figure 3.5**  
Schema diagram for the  
COMPANY relational  
database schema.

# Arithmetic Operators (cont.)

- ◆ Q13: Show the resulting salaries if every employee working on the 'ProductX' project is given a 10 percent raise

**Select**      Fname, Lname, 1.1\*Salary  
**From**        Employee, Works\_On, Project  
**Where**       SSN=ESSN   and  
                 Pno=Pnumber and  
                 Pname='ProductX';

↙ expression ^

- ◆ ||: concate operator for appending two string values
- ◆ +, -: for date, time, timestamp by a type-compatible interval

# Arithmetic Operators (cont.)

- ◆ Q14: Retrieve all employees in department 5 whose salary is between \$30,000 and \$40,000

**Select** \*

**From** Employee

**Where** (Salary **Between** 30000 and 40000) and  
DNo=5;

*30k ≤ Salary ≤ 40k*



# Ordering of Query Result

- ◆ Q15: Retrieve a list of employees and the projects they are working on, ordered by **descending order** of department and **ascending order** on LName, FName

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

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

# Ordering of Query Result (cont.)

- ◆ Q15: Retrieve a list of employees and the projects they are working on, ordered by descending order of department and ascending order on LName, Fname

## 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

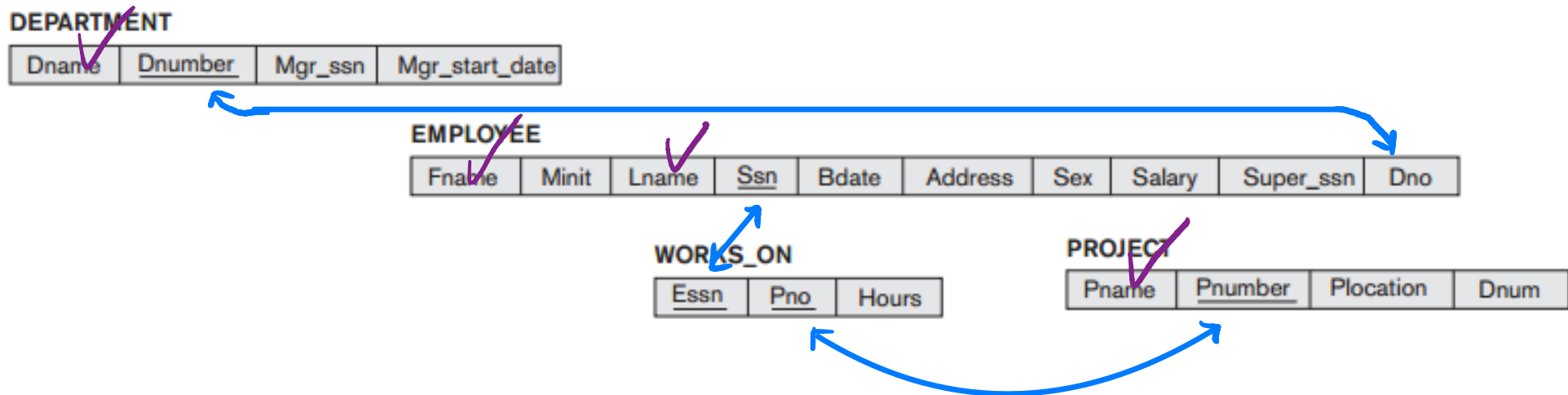
<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
-------------	-----------------------	-----	-------	--------------

**Figure 3.5**

Schema diagram for the COMPANY relational database schema.

# Ordering of Query Result (cont.)

- ◆ Q15: Retrieve a list of employees and the projects they are working on, ordered by descending order of department and ascending order on LName, FName



**Select** Dname, Lname, FName, Pname  
**From** Department, Employee, Works\_On, Project  
**Where** Dnumber=Dno **and**  
SSN=ESSN **and**  
PNO=Pnumber

( 'Asc' by default)

**Order By** Dname **Desc**, Lname **Asc**, FName **Asc**;