# SQL: Schema Definition, Basic Constraints, and Queries

# SQL INTRODUCTION

- SQL stands for **S**tructured **Q**uery **L**anguage

- Standard language for querying and manipulating data

| **Data Definition Language (DDL)** | • Create, alter, delete tables and their attributes |
|---|---|
| **Data Manipulation Language (DML)** | • Query one or more tables<br>• Insert, delete, modify tuples in tables |

Many standards out there:

ANSI SQL,  SQL92 (a.k.a. SQL2),  SQL99 (a.k.a. SQL3), …

# SQL CONSTRAINTS

○ Assigning Names to Constraints

**CONSTRAINT** deptPK **PRIMARY KEY**(Dnumber)

**CONSTRAINT** deptSK **UNIQUE**(Dname)

# ALTER COMMAND

- The definition of table can be changed using ALTER command
- ALTER can be used to add an attribute to the relation
  - Initially, the new attribute will have NULLs in all the tuples of the relation
  - NOT NULL constraint is *not allowed* for such an attribute

**Example :**

**ALTER TABLE  EMPLOYEE  ADD JOB   VARCHAR(12);**

The database user have to enter a value for the new attribute JOB for each EMPLOYEE tuple.

# DROP COMMAND

- Drop Command is used to delete schema or named schema elements such as table, domains, or constraints

**Example:**

**DROP TABLE  DEPENDENT;**
**DROP TABLE EMPLOYEE CASCADE;**
**DROP SCHEMA COMPANY;**

**In SQL-Server (T-SQL),** DROP TABLE cannot be used to drop a table that is referenced by a FOREIGN KEY.  The referencing FOREIGN KEY or the referencing table must first be dropped.

# SQL QUERIES

**Basic form**

> SELECT   <attributes>
> FROM     <one or more relations>
> WHERE   <conditions>

***Not same*** *as*  the Select **σ** operation of the relational algebra

Try SQLFiddle for online SQL practice
http://sqlfiddle.com/

https://www.db-fiddle.com/

# RELATIONAL DATABASE SCHEMA

**EMPLOYEE**

| FNAME | MINIT | LNAME | SSN | BDATE | ADDRESS | SEX | SALARY | SUPERSSN | DNO |
|-------|-------|-------|-----|-------|---------|-----|--------|----------|-----|

**DEPARTMENT**

| DNAME | DNUMBER | MGRSSN | MGRSTARTDATE |
|-------|---------|--------|--------------|

**DEPT_LOCATIONS**

| DNUMBER | DLOCATION |
|---------|-----------|

**PROJECT**

| PNAME | PNUMBER | PLOCATION | DNUM |
|-------|---------|-----------|------|

**WORKS_ON**

| ESSN | PNO | HOURS |
|------|-----|-------|

**DEPENDENT**

| ESSN | DEPENDENT_NAME | SEX | BDATE | RELATIONSHIP |
|------|----------------|-----|-------|--------------|

# SIMPLE SQL QUERIES

Retrieve the details of employees who work under the supervision of employee with id=333445555

```
SELECT        *
FROM          EMPLOYEE
WHERE         Super_ssn = 333445555
```

"selection"

$$\sigma_{Super\_SSN = 333445555} (EMPLOYEE)$$

**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 |

# SIMPLE SQL QUERIES

Retrieve the birthdate and address of the employee whose name is 'John Smith'.

SELECT          BDATE, ADDRESS
FROM            EMPLOYEE
WHERE           FNAME='John' AND LNAME='Smith'

"selection" and "projection"

$\pi_{\text{BDATE, ADDRESS}} (\sigma_{\text{FNAME='John' AND LNAME='Smith'}}(\text{EMPLOYEE}))$

**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 |

# SQL QUERIES

- In SQL, the result can have **duplicate tuples**
  - SQL relation is a *multi-set* **(bag)** of tuples; *not* a set of tuples

| SELECT Salary |
|---|
| FROM Employee |

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

# ELIMINATING DUPLICATES

SELECT   Salary
FROM    Employee

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

SELECT DISTINCT Salary
FROM     Employee

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

**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 |
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| 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 |

# JOIN OPERATION

Retrieve the name of all projects

**SELECT** PNAME
**FROM** PROJECT **JOIN** DEPARTMENT **ON** DNUM=DNUMBER

DEPT_MGR ← $\pi$ PNAME (PROJECT $\bowtie$ DNUM=DNUMBER DEPARTMENT)

**DEPARTMENT**

| Dname | Dnumber | Mgr_ssn | Mgr_start_da |
|---|---|---|---|
| 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 |

# JOIN OPERATION

Retrieve the name of all projects **that are offered by 'Research' department.**

| | |
|---|---|
| **SELECT** | PNAME |
| **FROM** | PROJECT **JOIN** DEPARTMENT **ON** DNUM=DNUMBER |
| **WHERE** | **DNAME='Research'** |

D_MGR ← π $_{PNAME}$ (PROJECT ⋈ $_{DNUM=DNUMBER}$ (σ $_{DNAME='Research'}$( DEPARTMENT))

**DEPARTMENT**

| Dname | Dnumber | Mgr_ssn | Mgr_start_da |
|---|---|---|---|
| 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 |

# JOIN OPERATION

Retrieve the name of all projects that are offered by 'Research' department.

**SELECT** PNAME
**FROM** **PROJECT , DEPARTMENT**
**WHERE** DNAME='Research' **and** DNUM=DNUMBER

join condition

**DEPARTMENT**

| Dname | Dnumber | Mgr_ssn | Mgr_start_date |
|---|---|---|---|
| Research | 5 | 333445555 | 1988-( |
| Administration | 4 | 987654321 | 1995-( |
| Headquarters | 1 | 888665555 | 1981-( |

**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 |

# DIFFERENT JOINS IN SQL

**SELECT** PNAME
**FROM** PROJECT **JOIN** DEPARTMENT **ON** DNUM=DNUMBER
**WHERE** DNAME='Research'

**SELECT** PNAME
**FROM** **PROJECT , DEPARTMENT**
**WHERE** DNAME='Research' **and DNUM=DNUMBER**

## No Natural Join in T-SQL

# UNSPECIFIED WHERE-clause

Retrieve the SSN values for all employees.

- **SELECT**       **SSN**
- **FROM**       **EMPLOYEE**

*Missing WHERE-clause*

- indicates there is no condition and is same as  WHERE TRUE

If there is no join condition, then we get *CARTESIAN PRODUCT*

- **SELECT**       **SSN, DNAME**
- **FROM**       **EMPLOYEE, DEPARTMENT**

| Ssn | Dname |
|-----|-------|
| 123456789 | Research |
| 333445555 | Research |
| 999887777 | Research |
| 987654321 | Research |
| 666884444 | Research |
| 453453453 | Research |
| 987987987 | Research |
| 888665555 | Research |
| 123456789 | Administration |
| 333445555 | Administration |
| 999887777 | Administration |
| 987654321 | Administration |
| 666884444 | Administration |
| 453453453 | Administration |
| 987987987 | Administration |
| 888665555 | Administration |
| 123456789 | Headquarters |
| 333445555 | Headquarters |
| 999887777 | Headquarters |
| 987654321 | Headquarters |
| 666884444 | Headquarters |
| 453453453 | Headquarters |
| 987987987 | Headquarters |
| 888665555 | Headquarters |

# Example Queries

List the employees name and the department name that they manage.

**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 |

**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 | | | | | | | | 4321 | 4 |
| Jennifer | | | | | | | | 5555 | 4 |
| Ramesh | | | | | | | | 5555 | 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 |

$$\text{Temp} \leftarrow (\text{Employee} \bowtie_{Ssn=Mgr\_Ssn} \text{Department})$$

$$\text{Result} \leftarrow \pi_{Fname, Minit, Lname, Dname}(\text{Temp})$$

# Example Queries

List the employees name and the department name that they manage.

**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 |

**SELECT Fname, Lname, Dname**
**FROM Employee Join Department ON Ssn=Mgr_ssn**

| 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 |
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| James | E | Borg | 888665555 | 1937-11-10 | 450 Stone, Houston, TX | M | 55000 | NULL | 1 |

# JOIN OPERATION

For projects located in 'Stafford', list the project no, the controlling department no, and the department manager's last name, address and birthdate.

$SP \leftarrow \sigma_{PLOCATION='Stanfford'} PROJECT)$

$R1 \leftarrow EMPLOYEE \bowtie_{SSN=Mgr\_ssn} (SP \bowtie_{Dnum=Dnumber} Department)$

$Result \leftarrow \pi_{FPnumber, Dnumber, Lname, Address, Bdate} (R1)$

**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, Ho | | | | |
| Alicia | J | Zelaya | 999887777 | 1968-01-19 | 3321 Castle, | | | | |
| Jennifer | S | Wallace | 987654321 | 1941-06-20 | 291 Berry, Be | | | | |

**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 |

**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 |

# JOIN OPERATION

For projects located in 'Stafford', list the project no, the controlling department no, and the department manager's last name, address and birthdate.

**SELECT** PNUMBER, DNUM, LNAME, ADDRESS, BDATE
**FROM** ((PROJECT **JOIN** DEPARTMENT **ON** DNUM=DNUMBER)
**JOIN** EMPLOYEE **ON** MGRSSN=SSN)
**WHERE** PLOCATION = 'Stafford'

## 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, Ho | | | | |
| Alicia | J | Zelaya | 999887777 | 1968-01-19 | 3321 Castle, | | | | |
| Jennifer | S | Wallace | 987654321 | 1941-06-20 | 291 Berry, Be | | | | |

## 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 |

# JOIN OPERATION

For projects located in 'Stafford', list the project no, the controlling department no, and the department manager's last name, address and birthdate.

| | |
|---|---|
| **SELECT** | PNUMBER, DNUM, LNAME, ADDRESS, BDATE |
| **FROM** | ((PROJECT **JOIN** DEPARTMENT **ON** DNUM=DNUMBER) **JOIN** EMPLOYEE **ON** MGRSSN=SSN ) |
| **WHERE** | PLOCATION='Stafford' |

EMPLOY

| Fname |
|---|
| John |
| Franklin |
| Alicia |
| Jennifer |

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

DEPART

| Dn | | | |
|---|---|---|---|
| Research | 5 | 333445555 | 1988-05-22 |
| Administration | 4 | 987654321 | 1995-01-01 |
| Headquarters | 1 | 888665555 | 1981-06-19 |

| | | | Dnum |
|---|---|---|---|
| | | | 5 |
| | | | 5 |
| | | | 5 |
| Computerization | 10 | Stafford | 4 |
| Reorganization | 20 | Houston | 1 |
| Newbenefits | 30 | Stafford | 4 |