

RDBMS and SQL

Madhavan Mukund

<https://www.cmi.ac.in/~madhavan>

Lecture 6, 30 September 2026

Queries in SQL

Combines σ , π

- `select` columns
 `from` table
 `where` condition
 - SQL `select` combines σ and π of relational algebra
- ```
select ID,name
from instructor
where dept_name = "Physics"
and salary > 90000
```

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Queries in SQL

- `select` does not eliminate duplicates

```
select dept_name
from instructor
```

- Explicitly specify that duplicates should be removed — additional computation, so avoid if not needed

```
select distinct dept_name
from instructor
```

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Queries in SQL

- Multiple tables in **from** — cartesian product

```
select *
 from instructor x teaches
```

$\pi(t_1 \bowtie t_2)$

- Use **where** to implement join

```
select *
 from instructor, teaches
 where instructor.ID = teaches.ID
```

- Choose output columns

```
select name, course_id
 from instructor, teaches
 where instructor.ID = teaches.ID
```

| ID    | name       | dept_name  | salary |
|-------|------------|------------|--------|
| 10101 | Srinivasan | Comp. Sci. | 65000  |
| 12121 | Wu         | Finance    | 90000  |
| 15151 | Mozart     | Music      | 40000  |
| 22222 | Einstein   | Physics    | 95000  |
| 32343 | El Said    | History    | 60000  |
| 33456 | Gold       | Physics    | 87000  |
| 45565 | Katz       | Comp. Sci. | 75000  |
| 58583 | Califieri  | History    | 62000  |
| 76543 | Singh      | Finance    | 80000  |
| 76766 | Crick      | Biology    | 72000  |
| 83821 | Brandt     | Comp. Sci. | 92000  |
| 98345 | Kim        | Elec. Eng. | 80000  |

| ID    | course_id | sec_id | semester | year |
|-------|-----------|--------|----------|------|
| 10101 | CS-101    | 1      | Fall     | 2017 |
| 10101 | CS-315    | 1      | Spring   | 2018 |
| 10101 | CS-347    | 1      | Fall     | 2017 |
| 12121 | FIN-201   | 1      | Spring   | 2018 |
| 15151 | MU-199    | 1      | Spring   | 2018 |
| 22222 | PHY-101   | 1      | Fall     | 2017 |
| 32343 | HIS-351   | 1      | Spring   | 2018 |
| 45565 | CS-101    | 1      | Spring   | 2018 |
| 45565 | CS-319    | 1      | Spring   | 2018 |
| 76766 | BIO-101   | 1      | Summer   | 2017 |
| 76766 | BIO-301   | 1      | Summer   | 2018 |
| 83821 | CS-190    | 1      | Spring   | 2017 |
| 83821 | CS-190    | 2      | Spring   | 2017 |
| 83821 | CS-319    | 2      | Spring   | 2018 |
| 98345 | EE-181    | 1      | Spring   | 2017 |

# Queries in SQL

## ■ Renaming for self join

$\rho(r)$

```
select *
 from teaches as T1, teaches as T2
 where T1.ID = T2.ID and
 T1.course_id <> T2.course_id
```

## ■ Filter output

```
select distinct T1.ID as ---
 from teaches as T1, teaches as T2
 where T1.ID = T2.ID and
 T1.course_id <> T2.course_id
```

| ID    | course_id | sec_id | semester | year |
|-------|-----------|--------|----------|------|
| 10101 | CS-101    | 1      | Fall     | 2017 |
| 10101 | CS-315    | 1      | Spring   | 2018 |
| 10101 | CS-347    | 1      | Fall     | 2017 |
| 12121 | FIN-201   | 1      | Spring   | 2018 |
| 15151 | MU-199    | 1      | Spring   | 2018 |
| 22222 | PHY-101   | 1      | Fall     | 2017 |
| 32343 | HIS-351   | 1      | Spring   | 2018 |
| 45565 | CS-101    | 1      | Spring   | 2018 |
| 45565 | CS-319    | 1      | Spring   | 2018 |
| 76766 | BIO-101   | 1      | Summer   | 2017 |
| 76766 | BIO-301   | 1      | Summer   | 2018 |
| 83821 | CS-190    | 1      | Spring   | 2017 |
| 83821 | CS-190    | 2      | Spring   | 2017 |
| 83821 | CS-319    | 2      | Spring   | 2018 |
| 98345 | EE-181    | 1      | Spring   | 2017 |

# Queries in SQL

## ■ Set operations

## ■ Union

```
(select course_id from section
 where sem = "Fall"
 and year = "2017")
```

union

```
(select course_id from section
 where sem = "Spring"
 and year = "2018")
```

| course_id | sec_id | semester | year | building | room_number | time_slot_id |
|-----------|--------|----------|------|----------|-------------|--------------|
| BIO-101   | 1      | Summer   | 2017 | Painter  | 514         | B            |
| BIO-301   | 1      | Summer   | 2018 | Painter  | 514         | A            |
| CS-101    | 1      | Fall     | 2017 | Packard  | 101         | H            |
| CS-101    | 1      | Spring   | 2018 | Packard  | 101         | F            |
| CS-190    | 1      | Spring   | 2017 | Taylor   | 3128        | E            |
| CS-190    | 2      | Spring   | 2017 | Taylor   | 3128        | A            |
| CS-315    | 1      | Spring   | 2018 | Watson   | 120         | D            |
| CS-319    | 1      | Spring   | 2018 | Watson   | 100         | B            |
| CS-319    | 2      | Spring   | 2018 | Taylor   | 3128        | C            |
| CS-347    | 1      | Fall     | 2017 | Taylor   | 3128        | A            |
| EE-181    | 1      | Spring   | 2017 | Taylor   | 3128        | C            |
| FIN-201   | 1      | Spring   | 2018 | Packard  | 101         | B            |
| HIS-351   | 1      | Spring   | 2018 | Painter  | 514         | C            |
| MU-199    | 1      | Spring   | 2018 | Packard  | 101         | D            |
| PHY-101   | 1      | Fall     | 2017 | Watson   | 100         | A            |

# Queries in SQL

- Set operations

- Union

- Intersection

```
(select course_id from section
 where sem = "Fall"
 and year = "2017")
```

**intersect**

```
(select course_id from section
 where sem = "Spring"
 and year = "2018")
```

| course_id | sec_id | semester | year | building | room_number | time_slot_id |
|-----------|--------|----------|------|----------|-------------|--------------|
| BIO-101   | 1      | Summer   | 2017 | Painter  | 514         | B            |
| BIO-301   | 1      | Summer   | 2018 | Painter  | 514         | A            |
| CS-101    | 1      | Fall     | 2017 | Packard  | 101         | H            |
| CS-101    | 1      | Spring   | 2018 | Packard  | 101         | F            |
| CS-190    | 1      | Spring   | 2017 | Taylor   | 3128        | E            |
| CS-190    | 2      | Spring   | 2017 | Taylor   | 3128        | A            |
| CS-315    | 1      | Spring   | 2018 | Watson   | 120         | D            |
| CS-319    | 1      | Spring   | 2018 | Watson   | 100         | B            |
| CS-319    | 2      | Spring   | 2018 | Taylor   | 3128        | C            |
| CS-347    | 1      | Fall     | 2017 | Taylor   | 3128        | A            |
| EE-181    | 1      | Spring   | 2017 | Taylor   | 3128        | C            |
| FIN-201   | 1      | Spring   | 2018 | Packard  | 101         | B            |
| HIS-351   | 1      | Spring   | 2018 | Painter  | 514         | C            |
| MU-199    | 1      | Spring   | 2018 | Packard  | 101         | D            |
| PHY-101   | 1      | Fall     | 2017 | Watson   | 100         | A            |

# Queries in SQL

- Set operations
- Union
- Intersection
- Set difference

*Everything belongs  
a set*

```
(select course_id from section
 where sem = "Fall"
 and year = "2017")
```

except

```
(select course_id from section
 where sem = "Spring"
 and year = "2018")
```

| course_id | sec_id | semester | year | building | room_number | time_slot_id |
|-----------|--------|----------|------|----------|-------------|--------------|
| BIO-101   | 1      | Summer   | 2017 | Painter  | 514         | B            |
| BIO-301   | 1      | Summer   | 2018 | Painter  | 514         | A            |
| CS-101    | 1      | Fall     | 2017 | Packard  | 101         | H            |
| CS-101    | 1      | Spring   | 2018 | Packard  | 101         | F            |
| CS-190    | 1      | Spring   | 2017 | Taylor   | 3128        | E            |
| CS-190    | 2      | Spring   | 2017 | Taylor   | 3128        | A            |
| CS-315    | 1      | Spring   | 2018 | Watson   | 120         | D            |
| CS-319    | 1      | Spring   | 2018 | Watson   | 100         | B            |
| CS-319    | 2      | Spring   | 2018 | Taylor   | 3128        | C            |
| CS-347    | 1      | Fall     | 2017 | Taylor   | 3128        | A            |
| EE-181    | 1      | Spring   | 2017 | Taylor   | 3128        | C            |
| FIN-201   | 1      | Spring   | 2018 | Packard  | 101         | B            |
| HIS-351   | 1      | Spring   | 2018 | Painter  | 514         | C            |
| MU-199    | 1      | Spring   | 2018 | Packard  | 101         | D            |
| PHY-101   | 1      | Fall     | 2017 | Watson   | 100         | A            |

# Nested queries

- Relation in **from** can be output of another query
  - Average salary of instructors with salary above 70,000
  - MariaDB requires inner relation to be named!

```
select avg(salary)
 from (select *
 from instructor
 where salary > 70000)
 as newtable
```

$$\sigma_{\theta_2}(\pi(\sigma_{\theta_1}(r)))$$

| ID    | name       | dept_name  | salary |
|-------|------------|------------|--------|
| 10101 | Srinivasan | Comp. Sci. | 65000  |
| 12121 | Wu         | Finance    | 90000  |
| 15151 | Mozart     | Music      | 40000  |
| 22222 | Einstein   | Physics    | 95000  |
| 32343 | El Said    | History    | 60000  |
| 33456 | Gold       | Physics    | 87000  |
| 45565 | Katz       | Comp. Sci. | 75000  |
| 58583 | Califieri  | History    | 62000  |
| 76543 | Singh      | Finance    | 80000  |
| 76766 | Crick      | Biology    | 72000  |
| 83821 | Brandt     | Comp. Sci. | 92000  |
| 98345 | Kim        | Elec. Eng. | 80000  |

# Local definitions using with

- Use `with` for a local definition

```
with avg_budget(value) as
 (select avg(budget)
 from department)
```

```
select dept_name
from department, avg_budget
where
 department.budget > avg_budget.value
```

avg-budget  
value

v

| dept_name  | building | budget |
|------------|----------|--------|
| Biology    | Watson   | 90000  |
| Comp. Sci. | Taylor   | 100000 |
| Elec. Eng. | Taylor   | 85000  |
| Finance    | Painter  | 120000 |
| History    | Painter  | 50000  |
| Music      | Packard  | 80000  |
| Physics    | Watson   | 70000  |

instructor

Classification A query that produces  
a single value can be directly  
used in place of the value

# Queries in SQL — string comparison

- Can match patterns in strings

```
select name
 from instructor
 where dept_name like "Phy%"
```

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Queries in SQL — string comparison

- Can match patterns in strings

```
select name
 from instructor
 where dept_name like "Phy%"
```

*Handwritten note: "vs =" with a red arrow pointing to the `like` keyword.*

- % matches any substring (zero or more)
- \_ matches any character

*Handwritten note: "Phy\_%" with an orange arrow pointing to the underscore and the text "one more char", and a red arrow pointing to the percent sign and the text "zero or more".*

| ID    | name       | dept_name  | salary |
|-------|------------|------------|--------|
| 10101 | Srinivasan | Comp. Sci. | 65000  |
| 12121 | Wu         | Finance    | 90000  |
| 15151 | Mozart     | Music      | 40000  |
| 22222 | Einstein   | Physics    | 95000  |
| 32343 | El Said    | History    | 60000  |
| 33456 | Gold       | Physics    | 87000  |
| 45565 | Katz       | Comp. Sci. | 75000  |
| 58583 | Califieri  | History    | 62000  |
| 76543 | Singh      | Finance    | 80000  |
| 76766 | Crick      | Biology    | 72000  |
| 83821 | Brandt     | Comp. Sci. | 92000  |
| 98345 | Kim        | Elec. Eng. | 80000  |

# Queries in SQL — string comparison

"%" - use % without spl meaning

- Can match patterns in strings

```
select name
 from instructor
 where dept_name like "Phy%"
```

- % matches any substring (zero or more)

- \_ matches any character

- Name containing ri

```
select name
 from instructor
 where name like "%ri%"
```

%-ri-%

| ID    | name       | dept_name  | salary |
|-------|------------|------------|--------|
| 10101 | Srinivasan | Comp. Sci. | 65000  |
| 12121 | Wu         | Finance    | 90000  |
| 15151 | Mozart     | Music      | 40000  |
| 22222 | Einstein   | Physics    | 95000  |
| 32343 | El Said    | History    | 60000  |
| 33456 | Gold       | Physics    | 87000  |
| 45565 | Katz       | Comp. Sci. | 75000  |
| 58583 | Califleri  | History    | 62000  |
| 76543 | Singh      | Finance    | 80000  |
| 76766 | Crick      | Biology    | 72000  |
| 83821 | Brandt     | Comp. Sci. | 92000  |
| 98345 | Kim        | Elec. Eng. | 80000  |

# Queries in SQL — string comparison

- Can match patterns in strings

```
select name
 from instructor
 where dept_name like "Phy%"
```

- % matches any substring (zero or more)

- \_ matches any character

- Name containing `ri` but not at the end

```
select name
 from instructor
 where name like "%ri_"
```

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Queries in SQL — sorting the output

- Sort in ascending order

```
select name
 from instructor
 where dept_name like "Phy%"
 order by name
```

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Queries in SQL — sorting the output

- Sort in ascending order

```
select name
 from instructor
 where dept_name like "Phy%"
 order by name
```

- Add `desc` for descending order

```
select name
 from instructor
 where dept_name like "Phy%"
 order by name desc
```

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Queries in SQL — aggregate operations

- Extract the average value in a column

```
select avg(salary)
from instructor
```

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Queries in SQL — aggregate operations

- Extract the average value in a column

```
select avg(salary)
 from instructor
```

- Other functions

- `count`
- `sum`
- `min`
- `max`

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Queries in SQL — aggregate operations

- Extract the average value in a column

```
select avg(salary)
 from instructor
```

- Other functions

- `count`

- `sum`

- `min`

- `max`

```
select count(distinct dept_name)
 from instructor
```

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Queries in SQL — grouping

- Extract the average value in each department
  - Group rows by department name
  - Report average in each group of rows

```
select dept_name, avg(salary)
from instructor
group by dept_name
```

*should be an error!*

| ID    | name       | dept_name  | salary |
|-------|------------|------------|--------|
| 10101 | Srinivasan | Comp. Sci. | 65000  |
| 12121 | Wu         | Finance    | 90000  |
| 15151 | Mozart     | Music      | 40000  |
| 22222 | Einstein   | Physics    | 95000  |
| 32343 | El Said    | History    | 60000  |
| 33456 | Gold       | Physics    | 87000  |
| 45565 | Katz       | Comp. Sci. | 75000  |
| 58583 | Califieri  | History    | 62000  |
| 76543 | Singh      | Finance    | 80000  |
| 76766 | Crick      | Biology    | 72000  |
| 83821 | Brandt     | Comp. Sci. | 92000  |
| 98345 | Kim        | Elec. Eng. | 80000  |

# Queries in SQL — grouping

- Extract the average value in each department
  - Group rows by department name
  - Report average in each group of rows

```
select dept_name, avg(salary)
from instructor
group by dept_name
```

- Attributes in `select` must appear in `group by`
  - Should be the same across the entire group

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Queries in SQL — filtering groups

- Use **having** to specify a condition on groups

```
select dept_name, avg(salary)
 from instructor
 group by dept_name
 having max(salary) > 80000
```

*aggregate  
across  
group*

| ID    | name       | dept_name  | salary |
|-------|------------|------------|--------|
| 10101 | Srinivasan | Comp. Sci. | 65000  |
| 12121 | Wu         | Finance    | 90000  |
| 15151 | Mozart     | Music      | 40000  |
| 22222 | Einstein   | Physics    | 95000  |
| 32343 | El Said    | History    | 60000  |
| 33456 | Gold       | Physics    | 87000  |
| 45565 | Katz       | Comp. Sci. | 75000  |
| 58583 | Califieri  | History    | 62000  |
| 76543 | Singh      | Finance    | 80000  |
| 76766 | Crick      | Biology    | 72000  |
| 83821 | Brandt     | Comp. Sci. | 92000  |
| 98345 | Kim        | Elec. Eng. | 80000  |

# Queries in SQL — filtering groups

- Use **having** to specify a condition on groups

```
select dept_name, avg(salary)
 from instructor
 group by dept_name
 having max(salary) > 80000
```

- Condition is evaluated with respect to groups

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# University database

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califleri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

Instructor

| <i>dept_name</i> | <i>building</i> | <i>budget</i> |
|------------------|-----------------|---------------|
| Biology          | Watson          | 90000         |
| Comp. Sci.       | Taylor          | 100000        |
| Elec. Eng.       | Taylor          | 85000         |
| Finance          | Painter         | 120000        |
| History          | Painter         | 50000         |
| Music            | Packard         | 80000         |
| Physics          | Watson          | 70000         |

Department

# University database

| <i>course_id</i> | <i>title</i>               | <i>dept_name</i> | <i>credits</i> |
|------------------|----------------------------|------------------|----------------|
| BIO-101          | Intro. to Biology          | Biology          | 4              |
| BIO-301          | Genetics                   | Biology          | 4              |
| BIO-399          | Computational Biology      | Biology          | 3              |
| CS-101           | Intro. to Computer Science | Comp. Sci.       | 4              |
| CS-190           | Game Design                | Comp. Sci.       | 4              |
| CS-315           | Robotics                   | Comp. Sci.       | 3              |
| CS-319           | Image Processing           | Comp. Sci.       | 3              |
| CS-347           | Database System Concepts   | Comp. Sci.       | 3              |
| EE-181           | Intro. to Digital Systems  | Elec. Eng.       | 3              |
| FIN-201          | Investment Banking         | Finance          | 3              |
| HIS-351          | World History              | History          | 3              |
| MU-199           | Music Video Production     | Music            | 3              |
| PHY-101          | Physical Principles        | Physics          | 4              |

Course

| <i>course_id</i> | <i>sec_id</i> | <i>semester</i> | <i>year</i> | <i>building</i> | <i>room_number</i> | <i>time_slot_id</i> |
|------------------|---------------|-----------------|-------------|-----------------|--------------------|---------------------|
| BIO-101          | 1             | Summer          | 2017        | Painter         | 514                | B                   |
| BIO-301          | 1             | Summer          | 2018        | Painter         | 514                | A                   |
| CS-101           | 1             | Fall            | 2017        | Packard         | 101                | H                   |
| CS-101           | 1             | Spring          | 2018        | Packard         | 101                | F                   |
| CS-190           | 1             | Spring          | 2017        | Taylor          | 3128               | E                   |
| CS-190           | 2             | Spring          | 2017        | Taylor          | 3128               | A                   |
| CS-315           | 1             | Spring          | 2018        | Watson          | 120                | D                   |
| CS-319           | 1             | Spring          | 2018        | Watson          | 100                | B                   |
| CS-319           | 2             | Spring          | 2018        | Taylor          | 3128               | C                   |
| CS-347           | 1             | Fall            | 2017        | Taylor          | 3128               | A                   |
| EE-181           | 1             | Spring          | 2017        | Taylor          | 3128               | C                   |
| FIN-201          | 1             | Spring          | 2018        | Packard         | 101                | B                   |
| HIS-351          | 1             | Spring          | 2018        | Painter         | 514                | C                   |
| MU-199           | 1             | Spring          | 2018        | Packard         | 101                | D                   |
| PHY-101          | 1             | Fall            | 2017        | Watson          | 100                | A                   |

Section

# University database

| <i>ID</i> | <i>course_id</i> | <i>sec_id</i> | <i>semester</i> | <i>year</i> |
|-----------|------------------|---------------|-----------------|-------------|
| 10101     | CS-101           | 1             | Fall            | 2017        |
| 10101     | CS-315           | 1             | Spring          | 2018        |
| 10101     | CS-347           | 1             | Fall            | 2017        |
| 12121     | FIN-201          | 1             | Spring          | 2018        |
| 15151     | MU-199           | 1             | Spring          | 2018        |
| 22222     | PHY-101          | 1             | Fall            | 2017        |
| 32343     | HIS-351          | 1             | Spring          | 2018        |
| 45565     | CS-101           | 1             | Spring          | 2018        |
| 45565     | CS-319           | 1             | Spring          | 2018        |
| 76766     | BIO-101          | 1             | Summer          | 2017        |
| 76766     | BIO-301          | 1             | Summer          | 2018        |
| 83821     | CS-190           | 1             | Spring          | 2017        |
| 83821     | CS-190           | 2             | Spring          | 2017        |
| 83821     | CS-319           | 2             | Spring          | 2018        |
| 98345     | EE-181           | 1             | Spring          | 2017        |

Teaches

| <i>course_id</i> | <i>prereq_id</i> |
|------------------|------------------|
| BIO-301          | BIO-101          |
| BIO-399          | BIO-101          |
| CS-190           | CS-101           |
| CS-315           | CS-101           |
| CS-319           | CS-101           |
| CS-347           | CS-101           |
| EE-181           | PHY-101          |

Prerequisites

# University database

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califleri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

Instructor

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 22222     | Einstein    | Physics          | 95000         |
| 12121     | Wu          | Finance          | 90000         |
| 32343     | El Said     | History          | 60000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 58583     | Califleri   | History          | 62000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 15151     | Mozart      | Music            | 40000         |
| 33456     | Gold        | Physics          | 87000         |
| 76543     | Singh       | Finance          | 80000         |

Instructor, unsorted

# University database

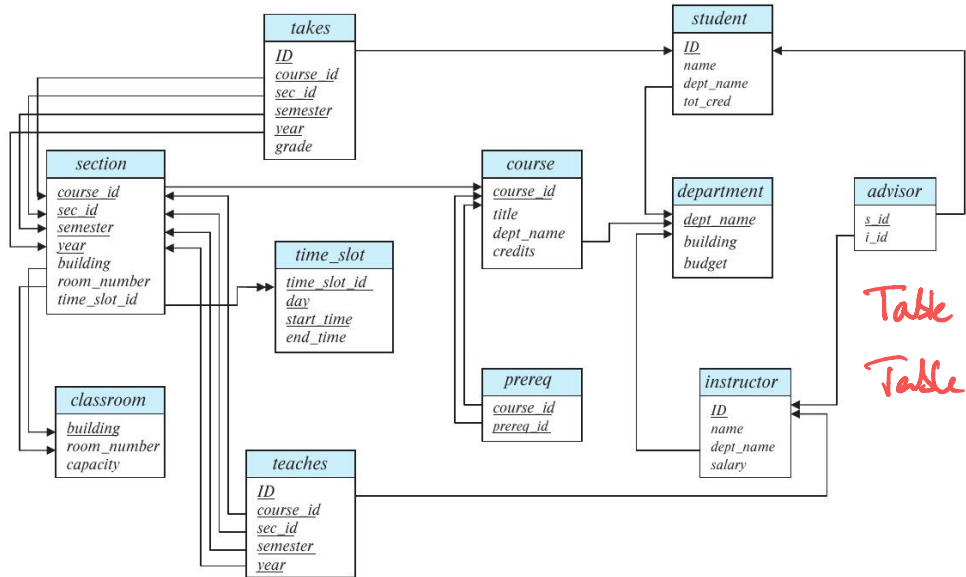


Table Creation  
Table Update

# Data definition in SQL

## ■ `create table` tablename

(column1 type1,  
column2 type2,  
...  
columnk typek)



| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Data definition in SQL

## ■ `create table` tablename

(column1 type1,  
column2 type2,  
...  
columnk typek)

*varchar(20)*

```
create table instructor
(ID char(5),
 name char(20),
 dept_name char(20),
 salary real
)
```

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Data definition in SQL

## ■ Variety of datatypes

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Data definition in SQL

## ■ Variety of datatypes

- `varchar(n)` — varying length character string with upper bound
- `numeric(p,d)` — fixed precision float, `p` digits, `d` after decimal point

```
create table instructor
(ID varchar(5),
 name varchar(20),
 dept_name varchar(20),
 salary numeric(8,2)
)
```

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Data definition in SQL

- Add constraints on values

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Data definition in SQL

- Add constraints on values
  - Force non-`null` name
  - Minimum amount for `salary`

```
create table instructor
(ID varchar(5),
 name varchar(20) not null,
 dept_name varchar(20),
 salary numeric(8,2)
 check (salary > 29000)
)
```

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Data definition in SQL

- Add information about keys

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Data definition in SQL

- Add information about keys

- ID is a primary key

```
create table instructor
(ID varchar(5),
name varchar(20) not null,
dept_name varchar(20),
salary numeric(8,2)
 check (salary > 29000),
primary key (ID),
)
```

implies  
not  
null

No two rows have  
same ID

| ID    | name       | dept_name  | salary |
|-------|------------|------------|--------|
| 10101 | Srinivasan | Comp. Sci. | 65000  |
| 12121 | Wu         | Finance    | 90000  |
| 15151 | Mozart     | Music      | 40000  |
| 22222 | Einstein   | Physics    | 95000  |
| 32343 | El Said    | History    | 60000  |
| 33456 | Gold       | Physics    | 87000  |
| 45565 | Katz       | Comp. Sci. | 75000  |
| 58583 | Califieri  | History    | 62000  |
| 76543 | Singh      | Finance    | 80000  |
| 76766 | Crick      | Biology    | 72000  |
| 83821 | Brandt     | Comp. Sci. | 92000  |
| 98345 | Kim        | Elec. Eng. | 80000  |

# Data definition in SQL

- Add information about keys

- `ID` is a primary key

- `dept_name` is a foreign key

```
create table instructor
(ID varchar(5),
 name varchar(20) not null,
 dept_name varchar(20),
 salary numeric(8,2)
 check (salary > 29000),
 primary key (ID),
 foreign key (dept_name)
 references
 department (dept_name))
```

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Data definition in SQL

```
create table section
```

```
(course_id varchar(8),
```

```
sec_id varchar(8),
```

```
semester varchar(6)
```

('Fall', 'Winter' -- )

```
check (semester in
```

```
('Fall', 'Winter', 'Spring', 'Summer'))),
```

```
year numeric(4,0)
```

```
check (year > 1701 and year < 2100),
```

```
building varchar(15),
```

```
room_number varchar(7),
```

```
time_slot_id varchar(4),
```

```
primary key
```

```
(course_id, sec_id, semester, year),
```

```
foreign key (course_id)
```

```
references course (course_id)
```

```
foreign key (building, room_number)
```

```
references
```

```
classroom (building, room_number)
```

```
);
```

| course_id | sec_id | semester | year | building | room_number | time_slot_id |
|-----------|--------|----------|------|----------|-------------|--------------|
| BIO-101   | 1      | Summer   | 2017 | Painter  | 514         | B            |
| BIO-301   | 1      | Summer   | 2018 | Painter  | 514         | A            |
| CS-101    | 1      | Fall     | 2017 | Packard  | 101         | H            |
| CS-101    | 1      | Spring   | 2018 | Packard  | 101         | F            |
| CS-190    | 1      | Spring   | 2017 | Taylor   | 3128        | E            |
| CS-190    | 2      | Spring   | 2017 | Taylor   | 3128        | A            |
| CS-315    | 1      | Spring   | 2018 | Watson   | 120         | D            |
| CS-319    | 1      | Spring   | 2018 | Watson   | 100         | B            |
| CS-319    | 2      | Spring   | 2018 | Taylor   | 3128        | C            |
| CS-347    | 1      | Fall     | 2017 | Taylor   | 3128        | A            |
| EE-181    | 1      | Spring   | 2017 | Taylor   | 3128        | C            |
| FIN-201   | 1      | Spring   | 2018 | Packard  | 101         | B            |
| HIS-351   | 1      | Spring   | 2018 | Painter  | 514         | C            |
| MU-199    | 1      | Spring   | 2018 | Packard  | 101         | D            |
| PHY-101   | 1      | Fall     | 2017 | Watson   | 100         | A            |

section

# Data definition in SQL

```
create table teaches
(ID varchar(5),
 course_id varchar(8),
 sec_id varchar(8),
 semester varchar(6),
 year numeric(4,0),
 primary key
 (ID, course_id, sec_id, semester, year),
 foreign key
 (course_id, sec_id, semester, year)
 references
 section (course_id, sec_id, semester, year)
 foreign key (ID)
 references instructor (ID)
);
```

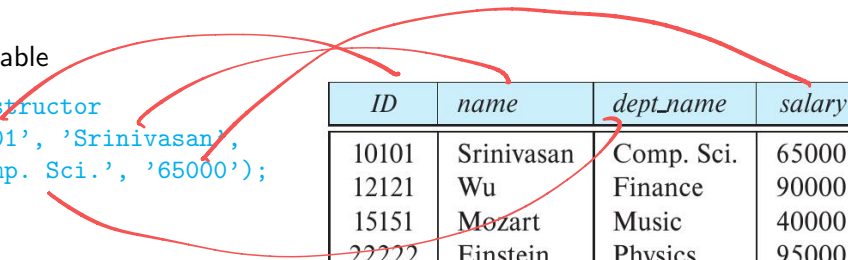
| <i>ID</i> | <i>course_id</i> | <i>sec_id</i> | <i>semester</i> | <i>year</i> |
|-----------|------------------|---------------|-----------------|-------------|
| 10101     | CS-101           | 1             | Fall            | 2017        |
| 10101     | CS-315           | 1             | Spring          | 2018        |
| 10101     | CS-347           | 1             | Fall            | 2017        |
| 12121     | FIN-201          | 1             | Spring          | 2018        |
| 15151     | MU-199           | 1             | Spring          | 2018        |
| 22222     | PHY-101          | 1             | Fall            | 2017        |
| 32343     | HIS-351          | 1             | Spring          | 2018        |
| 45565     | CS-101           | 1             | Spring          | 2018        |
| 45565     | CS-319           | 1             | Spring          | 2018        |
| 76766     | BIO-101          | 1             | Summer          | 2017        |
| 76766     | BIO-301          | 1             | Summer          | 2018        |
| 83821     | CS-190           | 1             | Spring          | 2017        |
| 83821     | CS-190           | 2             | Spring          | 2017        |
| 83821     | CS-319           | 2             | Spring          | 2018        |
| 98345     | EE-181           | 1             | Spring          | 2017        |

teaches

# Updating tables in SQL

- Add a row to a table

```
insert into instructor
values('10101', 'Srinivasan',
 'Comp. Sci.', '65000');
```



| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Updating tables in SQL

- Add a row to a table

```
insert into instructor
 values('10101', 'Srinivasan',
 'Comp. Sci.', '65000');
```

- Without needing to remember column order

```
insert into instructor
 (name, id, salary, dept_name)
 values
 ('Wu', '12121', '90000', 'Finance');
```

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Updating tables in SQL

- Add a row to a table

```
insert into instructor
 values('10101', 'Srinivasan',
 'Comp. Sci.', '65000');
```

- Without needing to remember column order

```
insert into instructor
 (name, id, salary, dept_name)
 values
 ('Wu', '12121', '90000', 'Finance');
```

- Note the quotation marks

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Updating tables in SQL

- Delete all rows

`delete from instructor`

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Updating tables in SQL

- Delete all rows

```
delete from instructor
```

- Delete selected rows

```
delete from instructor
where name = 'Srinivasan'
```

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Updating tables in SQL

- Delete all rows

```
delete from instructor
```

- Delete selected rows

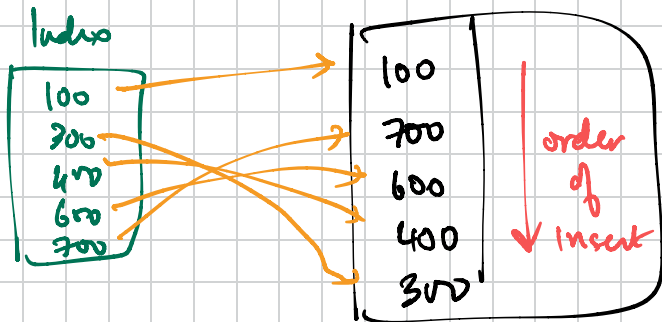
```
delete from instructor
```

```
 where name = 'Srinivasan'
```

```
delete from instructor
```

```
 where dept = 'Physics'
```

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |



# Updating tables in SQL

- Delete all rows

```
delete from instructor
```

- Delete selected rows

```
delete from instructor
```

```
 where name = 'Srinivasan'
```

```
delete from instructor
```

```
 where dept = 'Physics'
```

- Update selected rows

```
update instructor
```

```
 set salary = 1.1 * salary
```

```
 where dept = 'Physics'
```

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 12121     | Wu          | Finance          | 90000         |
| 15151     | Mozart      | Music            | 40000         |
| 22222     | Einstein    | Physics          | 95000         |
| 32343     | El Said     | History          | 60000         |
| 33456     | Gold        | Physics          | 87000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 58583     | Califieri   | History          | 62000         |
| 76543     | Singh       | Finance          | 80000         |
| 76766     | Crick       | Biology          | 72000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |

# Data definition in SQL

- Creating a database

- `create database univdb`

# Data definition in SQL

- Creating a database

- `create database univdb`

- Removing a database

- `drop database univdb`

# Data definition in SQL

- Creating a database
  - `create database univdb`
- Removing a database
  - `drop database univdb`
- Removing a table
  - `drop table instructor`

*alter table* — change schema  
*vs*  
*update table* → modify rows