Introduction to SQL

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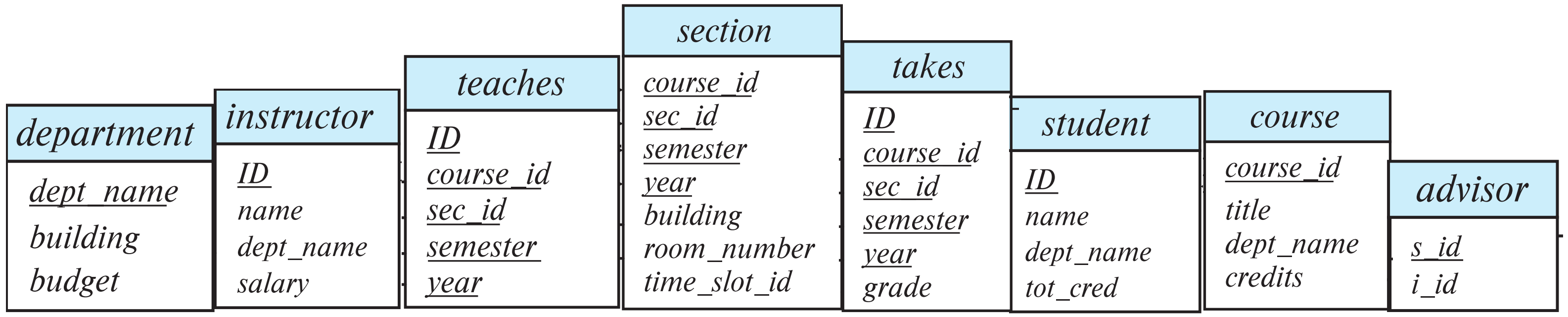
Basic Query Structure

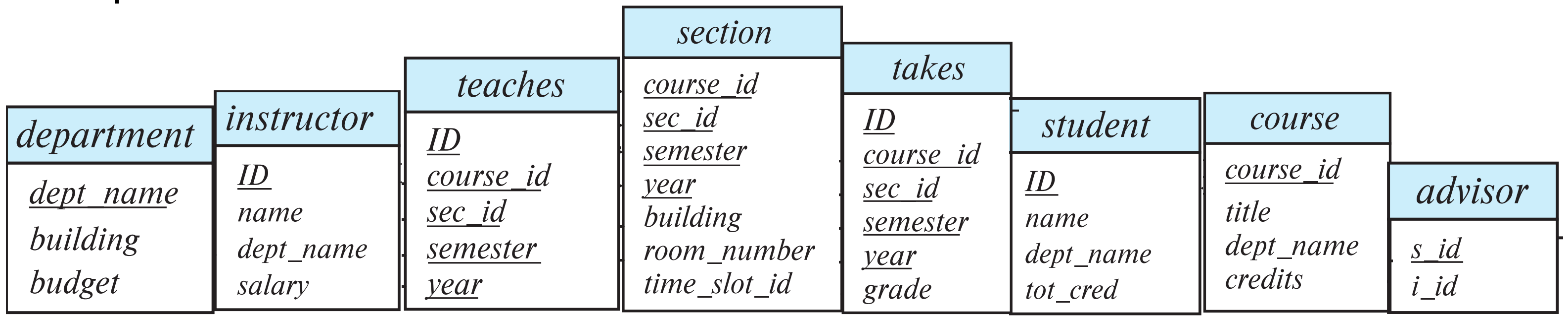
- A typical SQL query has the form:

select $A_1, A_2, ..., A_n$
from $r_1, r_2, ..., r_m$
where P



Basic Query Structure (demo)

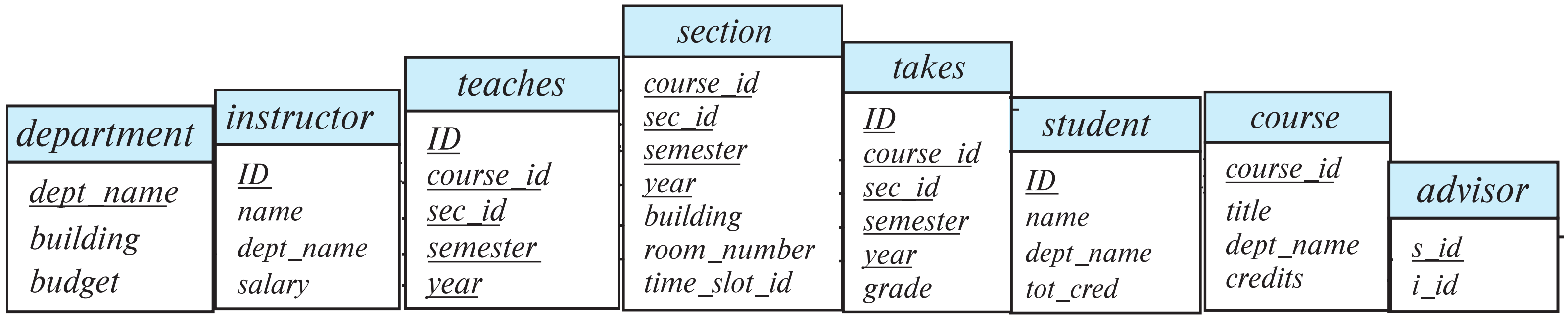
1. Find the names of all instructors
2. Find the department names of all instructors, and remove duplicates
3. Find the department names of all instructors, not removing duplicates
4. Find all attributes of instrctor show the entire instructor table
5. Find a relation that is the same as the *instructor* relation, except that the value of the attribute *salary* is divided by 12
6. Find all instructors in Comp. Sci. dept with salary > 70000
7. Find the names of all instructors who have taught some course and the course_id
8. Find the names of all instructors in the Comp. Sci. department who have taught some course and the course_id
9. Find the names of all instructors who have a higher salary than some instructor in 'Comp. Sci'.



Basic Query Structure (demo)

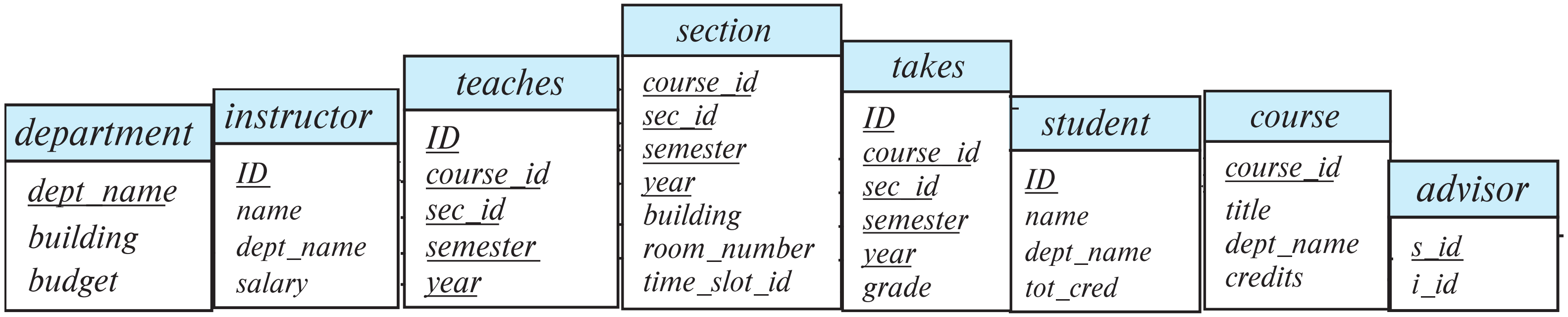
- Find the names of all instructors whose name includes the substring “in”.
- String Operations
  - The operator **like** uses patterns that are described using two special characters:
    - percent (%). The % character matches any substring.
    - underscore (_). The _ character matches any character

- Find the names of all instructors whose name has 4 characters.
- Find the names of all instructors whose name has at leaset 4 characters.



Basic Query Structure (demo)

1. List in alphabetic order the names of all instructors
2. List in descending alphabetic order the names of all instructors
3. List in order of the combination of the names and salary of all instructors
4. Find the names of all instructors with salary between $90,000 and $100,000
5. Find courses that ran in Fall 2017 or in Spring 2018
6. Find courses that ran in Fall 2017 and in Spring 2018
7. Find courses that ran in Fall 2017 but not in Spring 2018
8. Find courses that ran in Fall 2017 or in Spring 2018, retain all duplications
9. Find all instructors whose salary is null
10. Find all instructors whose salary is not null
11. Null under and, or, with true/false



Basic Query Structure (demo)

- These functions operate on the multiset of values of a column of a relation, and return a value

avg:	average value
min:	minimum value
max:	maximum value
sum:	sum of values
count:	number of values

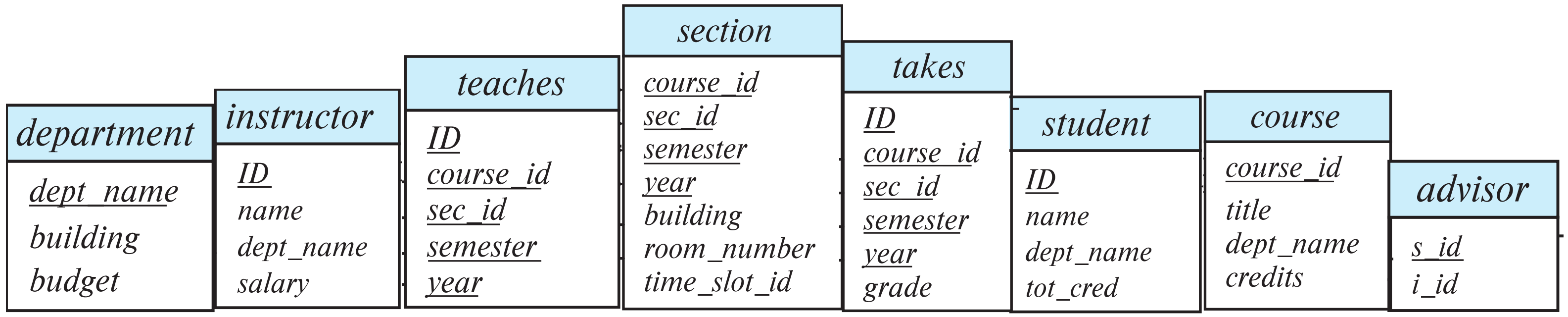
select $A_1, A_2, \ldots, A_n$ ← Aggregation function over values over multiple rows

from $r_1, r_2, \ldots, r_m$

where P

group by columns ← New clauses

having condition ←



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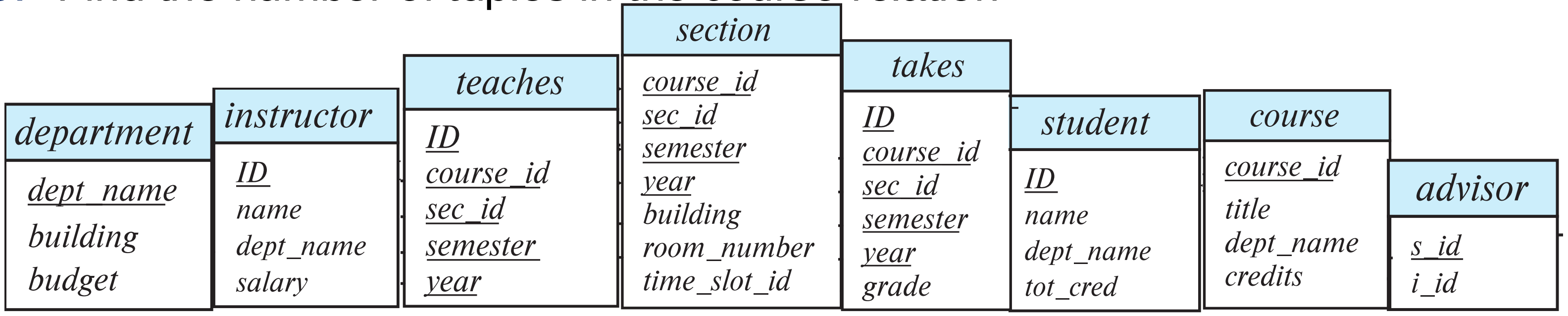
SCIENCE DEPARTMENT OF COMPUTER SCIENCE

Basic Query Structure (demo)

- These functions operate on the multiset of values of a column of a relation, and return a value

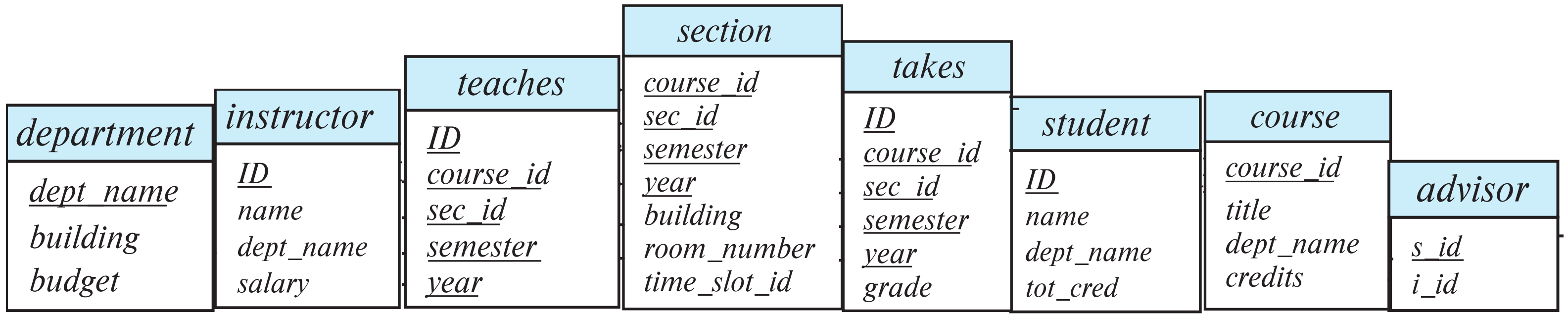
avg: average value
min: minimum value
max: maximum value
sum: sum of values
count: number of values

1. Find the highest salary of any instructor.
2. Find the average salary of instructors in the Computer Science department
3. Find the lowest salary of an instructor who have taught a course
4. Find the total number of instructors who teach a course in the Spring 2018 semester
5. Find the number of tuples in the *course* relation



Aggregate – Group By - Having

1. Find the average salary of instructors in each department
2. Find the names and average salaries of all departments whose average salary is greater than 42000
3. Find the names and average salaries of all departments over instructors whose salary is greater than 7000
4. Find the names and average salaries of all departments whose average salary is greater than 70000
5. Find the average salaries of instructors who have taught a course



Nested Subqueries

- A **subquery** is a **select-from-where** expression that is nested within another query.
- The nesting can be done in the following SQL query

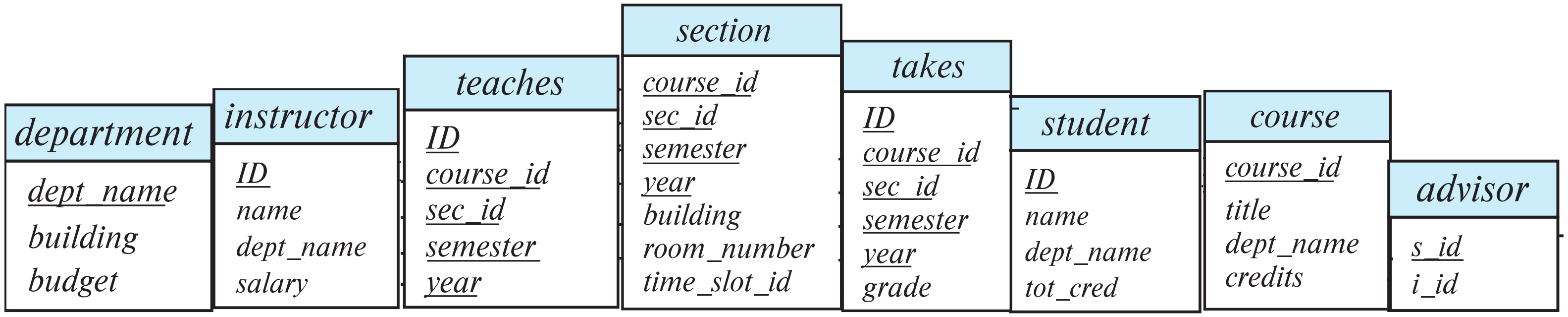
  select A_1, A_2, ..., A_n
  from r_1, r_2, ..., r_m
  where *P*

  as follows:
  - **From clause:** r_i can be replaced by any valid subquery
  - **Where clause:** *P* can be replaced with an expression of the form:

    B <operation> (subquery)

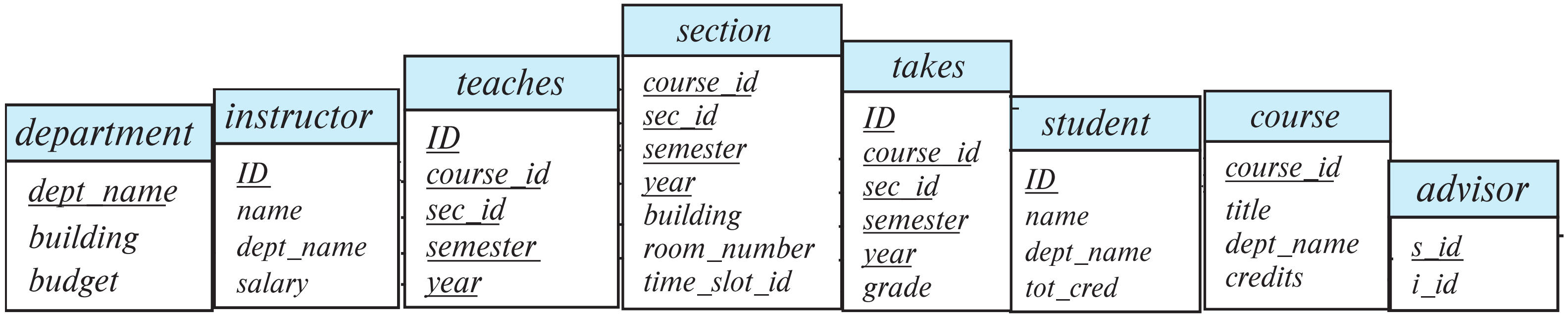
    B is an attribute and <operation> to be defined later.
  - **Select clause:**

    A_i can be replaced be a subquery that generates a single value.



Subquery in Where Clause

1. Name all instructors whose name is either “Mozart” or Einstein”
2. Name all instructors whose name is neither “Mozart” nor Einstein”
3. Find the total number of (distinct) students who have taken course sections taught by the instructor with *ID* 10101 or 12121 or 15151
4. Find names of instructors with salary greater than that of some (at least one) instructor in the Computer Science department.
5. Find all instructors earning the highest salary (there may be more than one with the same salary).
6. Find the names of all instructors whose salary is greater than the salary of all instructors in the Biology department.



Definition of "some" Clause

- F <comp> **some** $r \Leftrightarrow \exists\, t \in r$ such that (F <comp> t)
  Where <comp> can be: $<, \leq, >, =, \neq$

$$(5 < \textbf{some} \begin{array}{|c|}\hline 0\\\hline 5\\\hline 6\\\hline\end{array}) = \text{true}$$

(read: 5 < some tuple in the relation)

$$(5 < \textbf{some} \begin{array}{|c|}\hline 0\\\hline 5\\\hline\end{array}) = \text{false}$$

$$(5 = \textbf{some} \begin{array}{|c|}\hline 0\\\hline 5\\\hline\end{array}) = \text{true}$$

$$(5 \neq \textbf{some} \begin{array}{|c|}\hline 0\\\hline 5\\\hline\end{array}) = \text{true (since } 0 \neq 5)$$

(= **some**) $\equiv$ **in**
However, ($\neq$ **some**) $\not\equiv$ **not in**

Definition of “all” Clause

- F <comp> **all** *r* $\Leftrightarrow \forall\, t \in r$ (F <comp> *t*)

$$(5 < \textbf{all} \begin{array}{|c|}\hline 0\\\hline 5\\\hline 6\\\hline\end{array}) = \text{false}$$

$$(5 < \textbf{all} \begin{array}{|c|}\hline 6\\\hline 10\\\hline\end{array}) = \text{true}$$

$$(5 = \textbf{all} \begin{array}{|c|}\hline 4\\\hline 5\\\hline\end{array}) = \text{false}$$

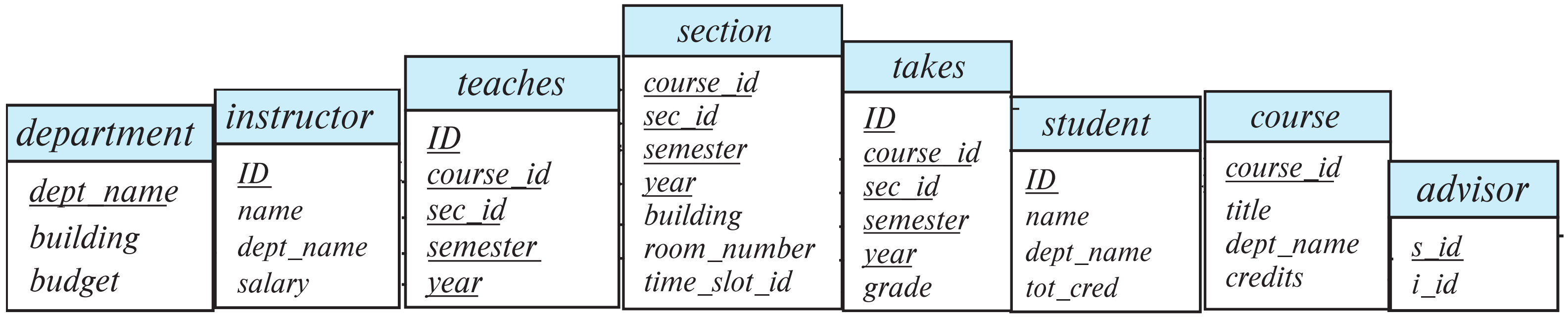
$$(5 \neq \textbf{all} \begin{array}{|c|}\hline 4\\\hline 6\\\hline\end{array}) = \text{true (since } 5 \neq 4 \text{ and } 5 \neq 6)$$

($\neq$ **all**) $\equiv$ **not in**

However, (= **all**) $\not\equiv$ **in**

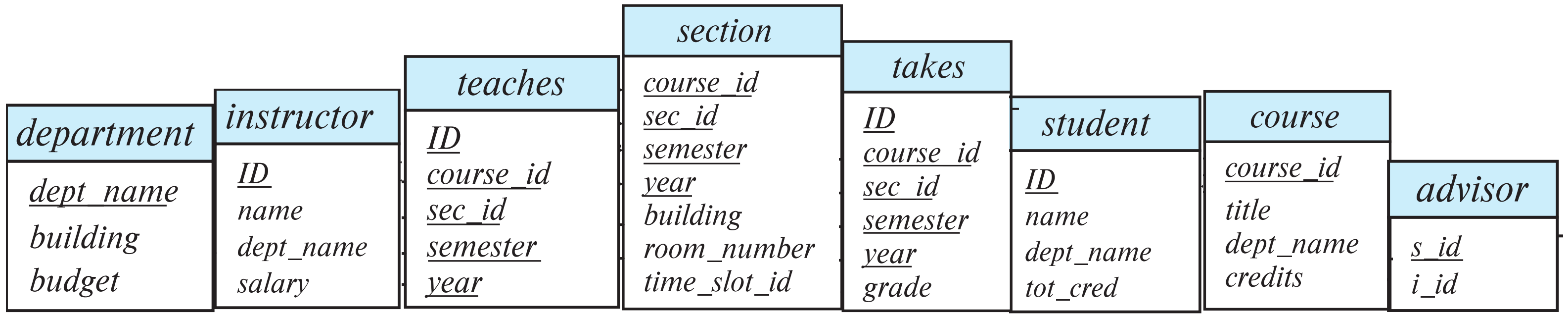
Subquery in Where Clause

- The **exists** construct returns the value **true** if the argument subquery is nonempty.
  - Find all courses taught in both the Fall 2017 semester and in the Spring 2018 semester
- The **unique** construct tests whether a subquery has any duplicate tuples in its result.
- The **unique** construct evaluates to “true” if a given subquery contains no duplicates .
  - Find all courses that were offered at most once in 2017



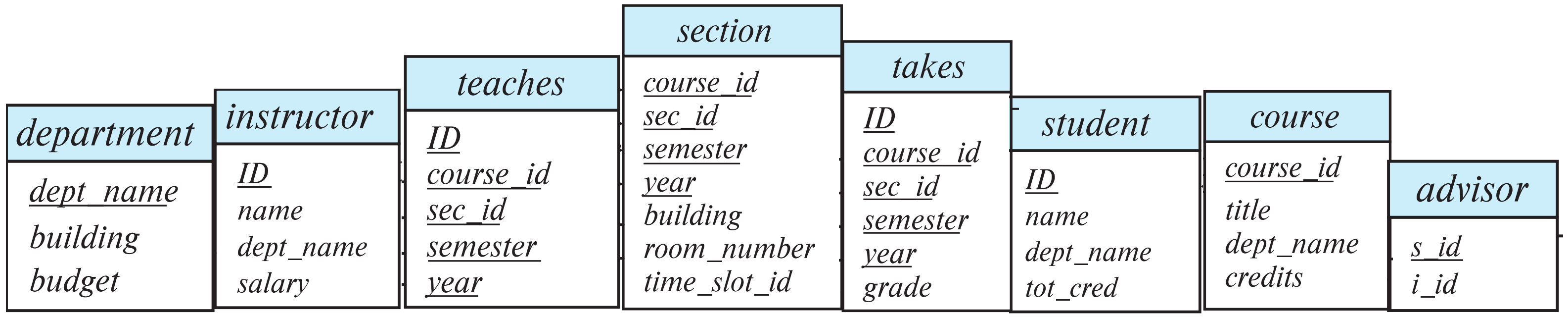
Query Quest

1. Find names of instructors with salary greater than that of some (at least one) instructor in the Computer Science department.
   - Use self-join, some, exists, aggregation
2. Find all instructors earning the highest salary (there may be more than one with the same salary).
   - Use self-join, all, exists, aggregation



Subquery in From and Select Clauses

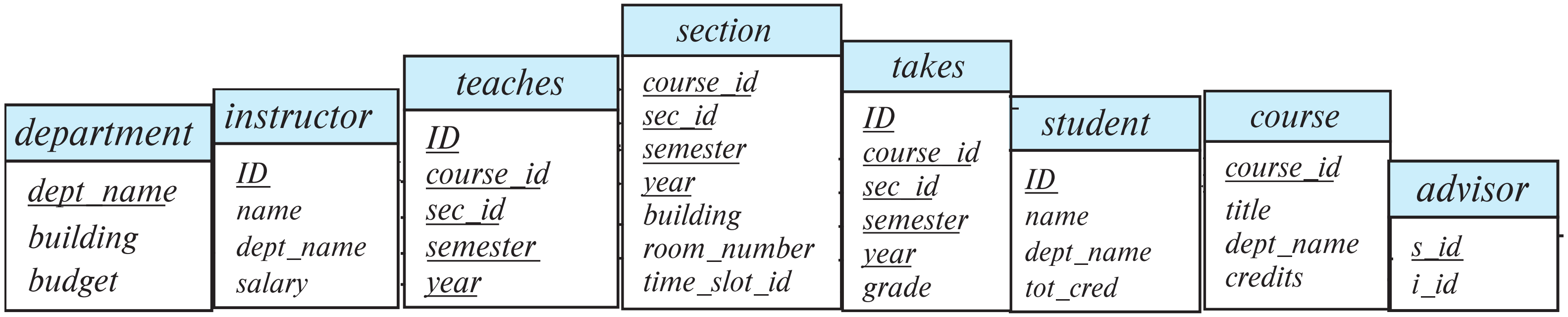
1. Find the average instructors' salaries of those departments where the average salary is greater than $42,000"
2. Find all departments with the maximum budget (with clause)
3. Find all departments where the total salary is greater than the average of the total salary at all departments
4. List all departments along with the number of instructors in each department



With Clause

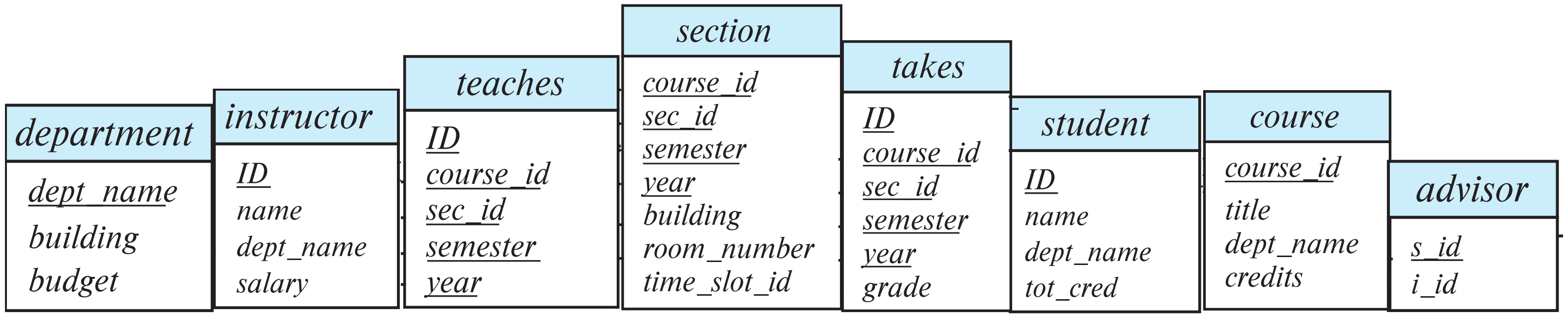
- The **with** clause provides a way of defining a temporary relation whose definition is available only to the query in which the **with** clause occurs.
- Find all departments with the maximum budget

with *max_budget* (*value*) **as**
    (**select max**(*budget*)
     from *department*)
select *department.name*
from *department*, *max_budget*
where *department.budget* = *max_budget.value*;



Query Quest

- Find all departments where the total salary is greater than the average of the total salary at all departments



Modification of the Database

- Deletion of tuples from a given relation.
- Insertion of new tuples into a given relation
- Updating of values in some tuples in a given relation

Deletion

- Delete all instructors

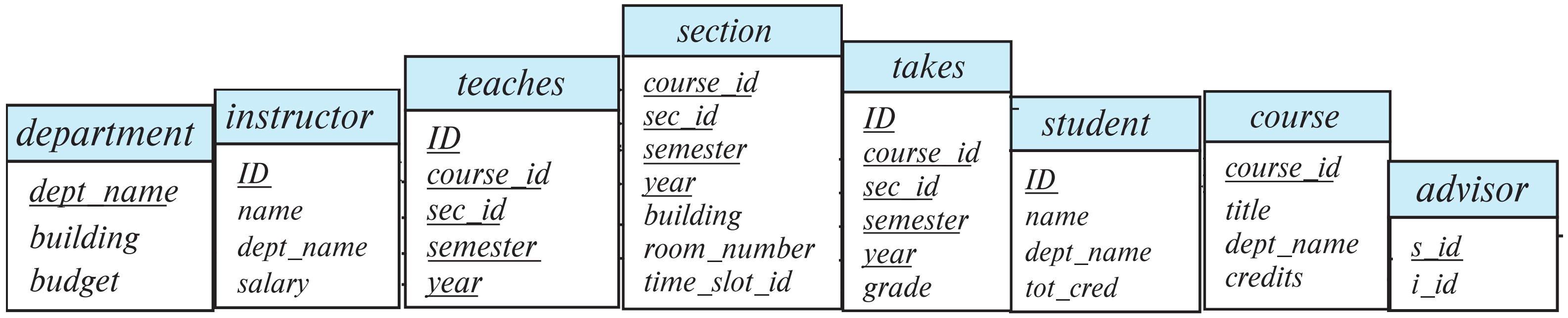
  delete from *instructor*

- Delete all instructors from the Finance department

  delete from *instructor*
  where *dept_name*= 'Finance';

- *Delete all tuples in the instructor relation for those instructors associated with a department located in the Watson building.*

  delete from *instructor*
  where *dept name* **in** (**select** *dept name*
  from *department*
  where *building* = 'Watson');

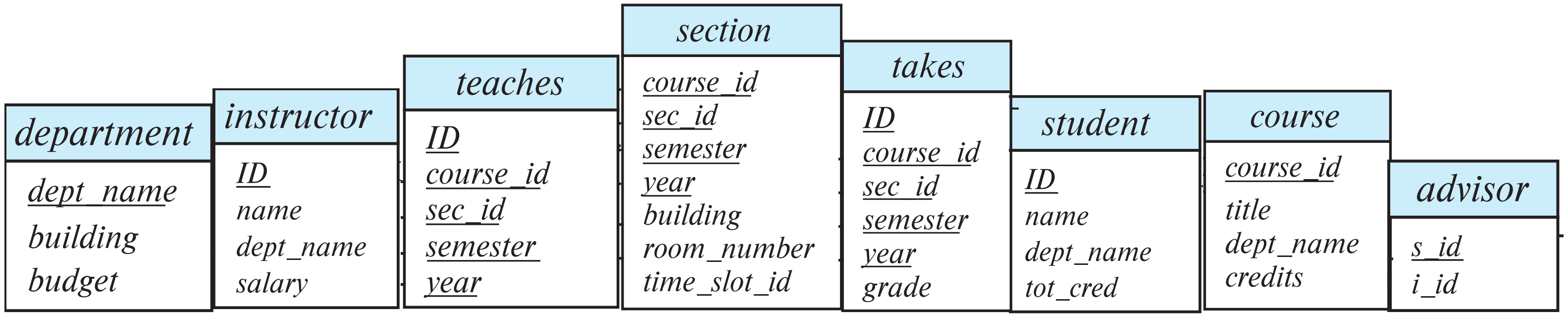


Deletion (Cont.)

- Delete all instructors whose salary is less than the average salary of instructors

  delete from *instructor*
  where *salary* < (**select avg** (*salary*)
                    from *instructor*);

  - Problem: as we delete tuples from *instructor*, the average salary changes
  - Solution used in SQL:
    1. First, compute **avg** (salary) and find all tuples to delete
    2. Next, delete all tuples found above (without recomputing **avg** or retesting the tuples)



Insertion

- Add a new tuple to *course*

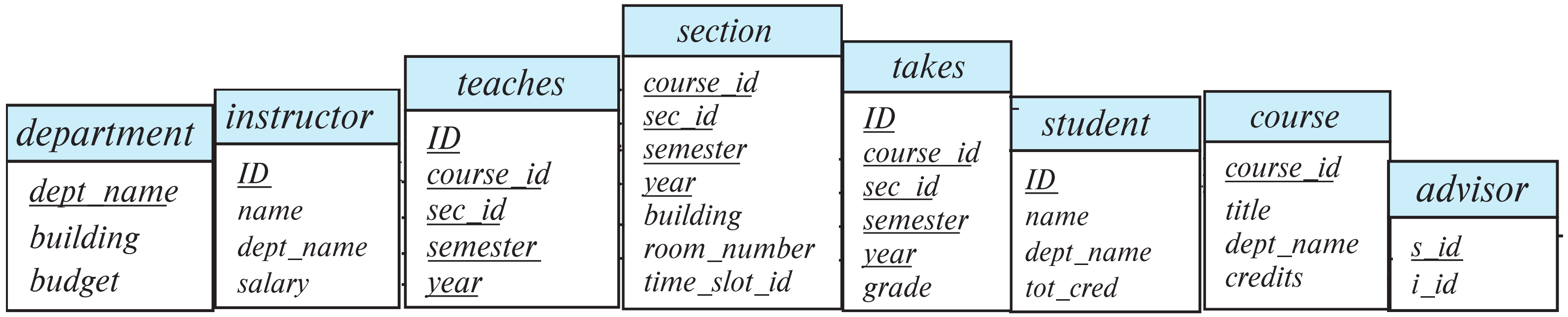
  insert into *course*
    values ('CS-437', 'Database Systems', 'Comp. Sci.', 4);

- or equivalently

  insert into *course* (*course_id*, *title*, *dept_name*, *credits*)
    values ('CS-437', 'Database Systems', 'Comp. Sci.', 4);

- Add a new tuple to *student* with *tot_creds* set to null

  insert into *student*
    values ('3003', 'Green', 'Finance', *null*);



Insertion (Cont.)

- Make each student in the Music department who has earned more than 144 credit hours an instructor in the Music department with a salary of $18,000.

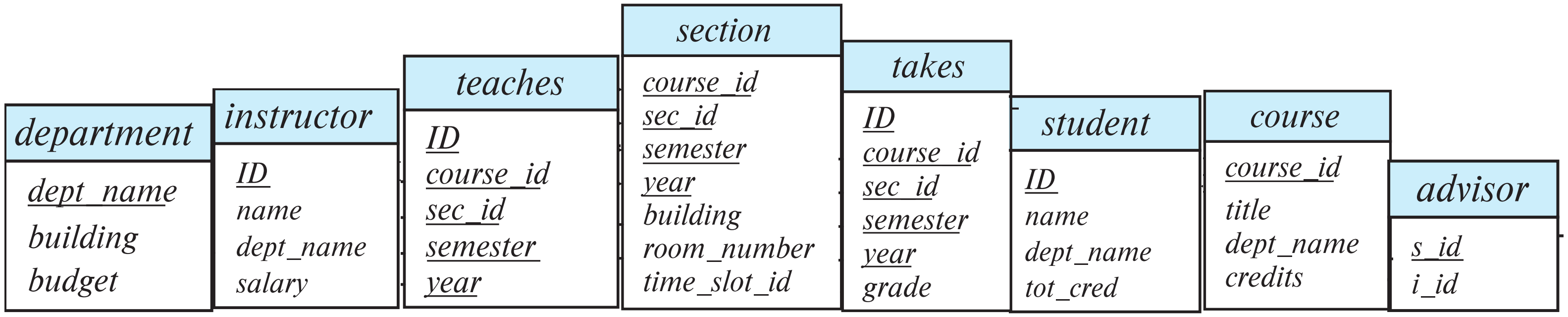
  insert into *instructor*
  select *ID, name, dept_name, 18000*
  from *student*
  where *dept_name* = 'Music' **and** *total_cred* > 144;

- The **select from where** statement is evaluated fully before any of its results are inserted into the relation.

  Otherwise queries like

  insert into *table*1 **select** * **from** *table*1

  would cause problem



Updates

- Give a 5% salary raise to all instructors

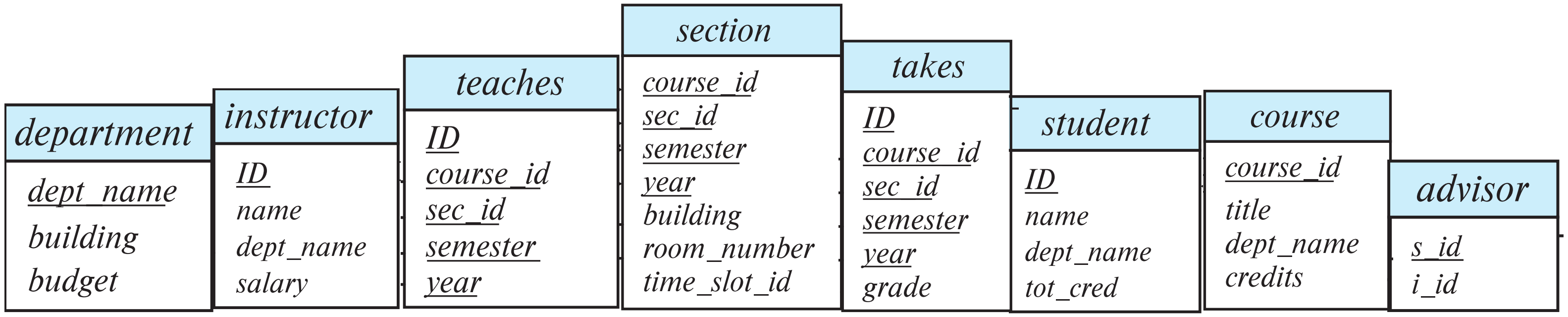
  update *instructor*
  set *salary* = *salary* * 1.05

- Give a 5% salary raise to those instructors who earn less than 70000

  update *instructor*
  set *salary* = *salary* * 1.05
  where *salary* < 70000;

- Give a 5% salary raise to instructors whose salary is less than average

  update *instructor*
  set *salary* = *salary* * 1.05
  where *salary* < (**select avg** (salary)
  from *instructor*);

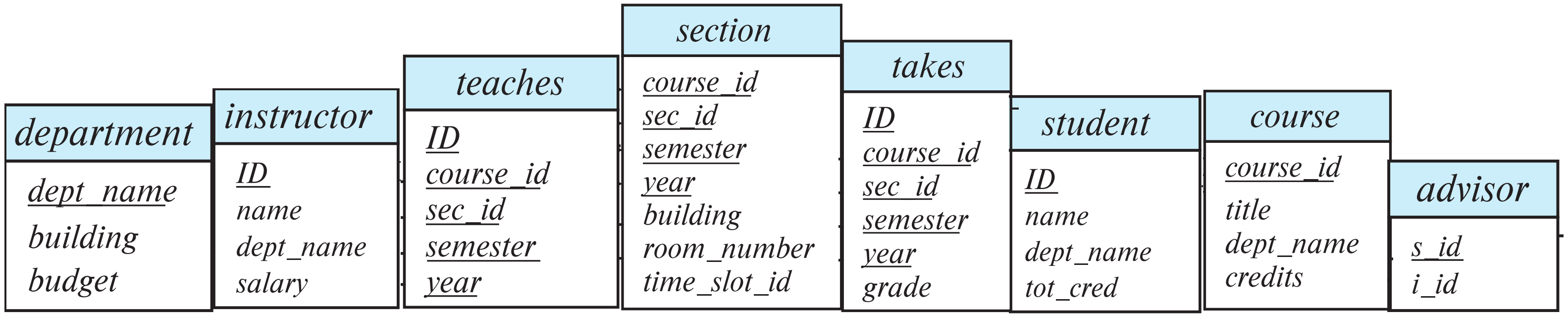


Updates (Cont.)

- Increase salaries of instructors whose salary is over $100,000 by 3%, and all others by a 5%
  - Write two **update** statements:

    update *instructor*
        set *salary* = *salary* * 1.03
        where *salary* > 100000;
    update *instructor*
        set *salary* = *salary* * 1.05
        where *salary* <= 100000;

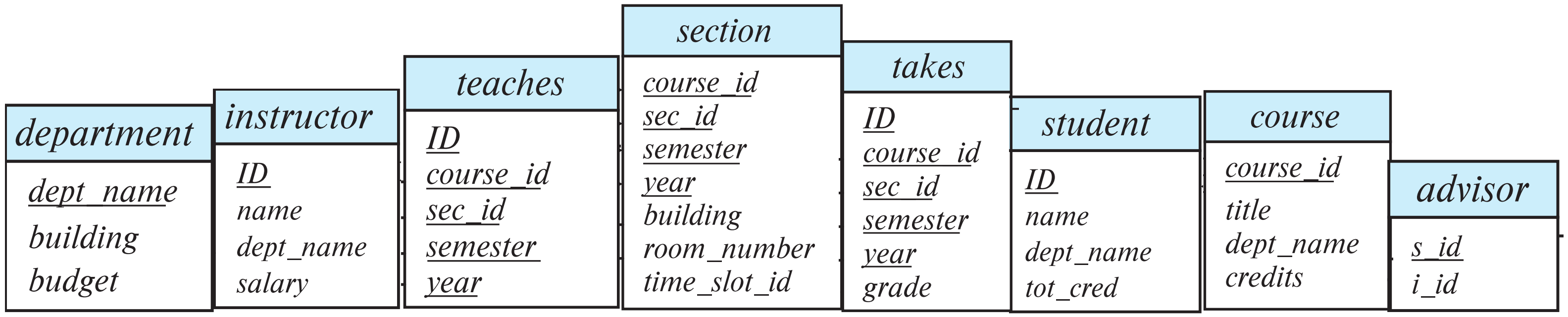
  - The order is important
  - Can be done better using the **case** statement (next slide)



Case Statement for Conditional Updates

- Same query as before but with case statement

```
update instructor
    set salary = case
                    when salary <= 100000 then salary * 1.05
                    else salary * 1.03
                   end
```



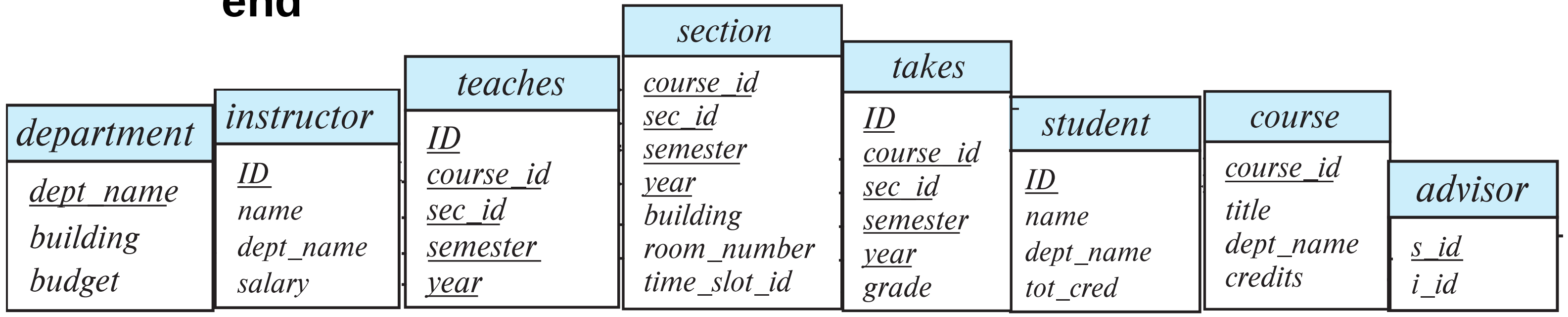
Updates with Scalar Subqueries

- Recompute and update tot_creds value for all students

```
update student S
set tot_cred = (select sum(credits)
                from takes, course
                where takes.course_id = course.course_id  and
                      S.ID= takes.ID.and
                      takes.grade <> 'F' and
                      takes.grade is not null);
```

- Sets *tot_creds* to null for students who have not taken any course
- Instead of **sum**(*credits*), use:

```
case
    when sum(credits) is not null then sum(credits)
    else 0
end
```



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Any questions?