Database Management Systems

Module 11: SQL Examples

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Week Recap

- Basic notions of Relational Database Models
    - Attributes and their types
    - Mathematical structure of relational model
    - Schema and Instance
    - Keys, primary as well as foreign
- Relational algebra with operators
- Relational query language
    - DDL (Data Definition)
    - DML (Basic Query Structure)
- Detailed understanding of basic query structure
- Set operations, null values, and aggregation

Module Objectives

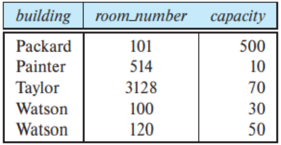
- To recap various basic SQL features through example workout

Module Outline

- Examples of basic SQL

Select distinct

- From the *classroom* relation in the figure, find the names of buildings in which every individual classroom has capacity less than 100 (removing the duplicates).



building	*room_number*	*capacity*
Packard	101	500
Painter	514	10
Taylor	3128	70
Watson	100	30
Watson	120	50

Figure: *classroom* relation

- ○ Query:

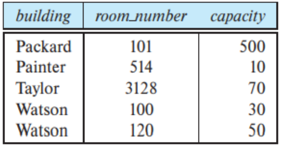
  select distinct *building*
  from *classroom*
  where *capacity* $<$ 100;

- ○ Output :

building
Painter
Taylor
Watson

Select all

- From the *classroom* relation in the figure, find the names of buildings in which every individual classroom has capacity less than 100 (without removing the duplicates).



building	*room_number*	*capacity*
Packard	101	500
Painter	514	10
Taylor	3128	70
Watson	100	30
Watson	120	50

Figure: *classroom* relation

- Query:

  select all *building*
  from *classroom*
  where *capacity* $<$ 100;

- Output:

building
Painter
Taylor
Watson
Watson

- Note that duplicate retention is the default and hence it is a common practice to skip *all* immediately after *select*.

Cartesian Product

- Find the list of all students of departments which have a budget $< \$0.1 million$

```
select name, budget
from student, department
where student.dept_name = department.dept_name and
budget < 100000;
```

- The above query first generates every possible student-department pair, which is the Cartesian product of student and department. Then, it filters all the rows with *student.dept_name* $=$ *department.dept_name* **and** *budget* $<$ 100000.
- The common attribute *dept_name* in the resulting table are renamed using the relation name - *student.dept_name* and *department.dept_name*)

name	*budget*
Brandt	50000.00
Peltier	70000.00
Levy	70000.00
Sanchez	80000.00
Snow	70000.00
Aoi	85000.00
Bourikas	85000.00
Tanaka	90000.00

Rename AS Operation

- The same query in the previous slide can be framed by renaming the tables as shown below.

  select *S.name* **as** *studentname*, *budget* **as** *deptbudget*
  from *student* **as** *S*, *department* **as** *D*
  where $S.dept\_name = D.dept\_name$ **and** $budget < 100000$;

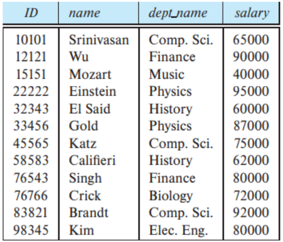
- The above query renames the relation *student* **as** *S* and the relation *department* **as** *D*
- It also displays the attribute *name* as StudentName and *budget* as DeptBudget.
- Note that the budget attribute does not have any prefix because it occurs only in the department relation.

studentname	*deptbudget*
Brandt	50000.00
Peltier	70000.00
Levy	70000.00
Sanchez	80000.00
Snow	70000.00
Aoi	85000.00
Bourikas	85000.00
Tanaka	90000.00

Where: AND and OR

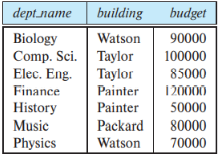
- From the *instructor* and *department* relations in the figure, find out the names of all instructors whose department is Finance or whose department is in any of the following buildings: Watson, Taylor.

instructor



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

department



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

- Query:

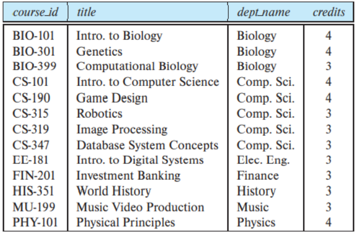
select *name*
from *instructor I*, *department D*
where *D.dept_name* = *I.dept_name*
  and (*I.dept_name* = 'Finance'
    or *building* **in** ('Watson','Taylor'));

- Output:

name
Srinivasan
Wu
Einstein
Gold
Katz
Singh
Crick
Brandt
Kim

String Operations

- From the *course* relation in the figure, find the titles of all courses whose *course_id* has three alphabets indicating the department.



course_id	*title*	*dept_name*	*credits*
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

Figure: *course* relation

- ○ Query:

  select *title*
  from *course*
  where *course_id* **like** '___-%';

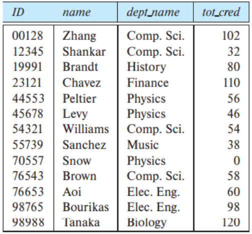
- ○ Output:

title
Intro. to Biology
Genetics
Computational Biology
Investment Banking
World History
Physical Principles

- The *course_id* of each department has either 2 or 3 alphabets in the beginning, followed by a hyphen and then followed by a 3-digit number. The above query returns the names of those departments that have 3 alphabets in the beginning.

Order By

- From the *student* relation in the figure, obtain the list of all students in alphabetic order of departments and within each department, in decreasing order of total credits.



ID	*name*	*dept_name*	*tot_cred*
00128	Zhang	Comp. Sci.	102
12345	Shankar	Comp. Sci.	32
19991	Brandt	History	80
23121	Chavez	Finance	110
44553	Peltier	Physics	56
45678	Levy	Physics	46
54321	Williams	Comp. Sci.	54
55739	Sanchez	Music	38
70557	Snow	Physics	0
76543	Brown	Comp. Sci.	58
76653	Aoi	Elec. Eng.	60
98765	Bourikas	Elec. Eng.	98
98988	Tanaka	Biology	120

Figure: *student* relation

  - The list is first sorted in alphabetic order of dept name.
  - Within each dept, it is sorted in decreasing order of total credits.

  - Query:

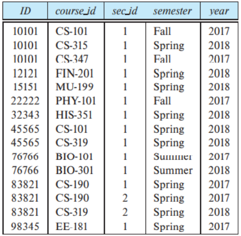
    select *name*, *dept_name*, *tot_cred*
    from *student*
    order by *dept_name* **ASC**, *tot_cred* **DESC**;

  - Output:

name	*dept_name*	*tot_cred*
Tanaka	Biology	120
Zhang	Comp. Sci.	102
Brown	Comp. Sci.	58
Williams	Comp. Sci.	54
Shankar	Comp. Sci.	32
Bourikas	Elec. Eng.	98
Aoi	Elec. Eng.	60
Chavez	Finance	110
Brandt	History	80
Sanchez	Music	38
Peltier	Physics	56
Levy	Physics	46
Snow	Physics	0

In Operator

- From the *teaches* relation in the figure, find the IDs of all courses taught in the Fall or Spring of 2018.



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

Figure: *teaches* relation

- Query:

  select *course_id*
  from *teaches*
  where *semester* **in** (*'Fall'*, *'Spring'*)
  and *year*=2018;

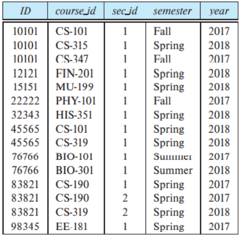
- Output:

course_id
CS-315
FIN-201
MU-199
HIS-351
CS-101
CS-319
CS-319

Note: We can use **distinct** to remove duplicates.

Set Operations: union

- For the same question in the previous slide, we can find the solution using **union** operator as follows.



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

Figure: *teaches* relation

- Note that **union** removes all duplicates. If we use **union all** instead of **union**, we get the same set of tuples as in previous slide.

- Query:

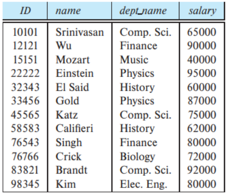
select *course_id*
from *teaches*
where *semester*=‘*Fall*’
  and *year*=2018
union
select *course_id*
from *teaches*
where *semester*=‘*Spring*’
  and *year*=2018

- Output:

course_id
CS-101
CS-315
CS-319
FIN-201
HIS-351
MU-199

Set Operations (2): intersect

- From the *instructor* relation in the figure, find the names of all instructors who taught in either the Computer Science department or the Finance department and whose salary is $<$ 80000.



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

Figure: *instructor* relation

- ○ Query:

  select *name*
  from *instructor*
  where *dept_name* **in** (‘Comp. Sci.’,‘Finance’)
  intersect
  select *name*
  from *instructor*
  where *salary* $<$ 80000;

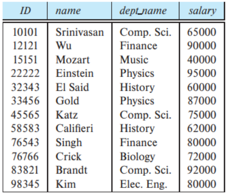
- ○ Output:

name
Srinivasan
Katz

- Note that the same can be achieved using the query:
  select *name* **from** *instructor* **where** *dept_name* **in**(‘Comp. Sci.’, ‘Finance’) **and** *salary* $<$ 80000;

Set Operations (3): except

- From the *instructor* relation in the figure, find the names of all instructors who taught in either the Computer Science department or the Finance department and whose salary is either $\geq$ 90000 or $\leq$ 70000.



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

Figure: *instructor* relation

- Note that the same can be achieved using the query given below:

  select *name* **from** *instructor*
  where *dept_name* **in**('Comp. Sci.', 'Finance')
  and (*salary* >= 90000 or *salary* <= 70000);

- Query:

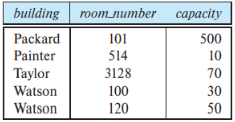
  select *name*
  from *instructor*
  where *dept_name* **in** ('Comp. Sci.','Finance')
  except
  select *name*
  from *instructor*
  where *salary* < 90000 **and** *salary* > 70000;

- Output:

name
Srinivasan
Brandt
Wu

Aggregate functions: avg

- From the *classroom* relation given in the figure, find the names and the average capacity of each building whose average capacity is greater than 25.



building	*room_number*	*capacity*
Packard	101	500
Painter	514	10
Taylor	3128	70
Watson	100	30
Watson	120	50

Figure: *classroom* relation

- ○ Query:

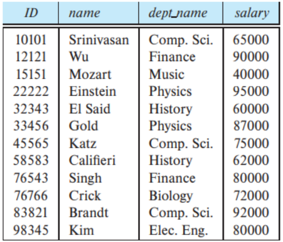
  select *building*, **avg** (*capacity*)
  from *classroom*
  group by *building*
  having avg (*capacity*) > 25;

- ○ Output:

building	*avg*
Taylor	70.00
Packard	500.00
Watson	40.00

Aggregate functions (2): min

- From the *instructor* relation given in the figure, find the least salary drawn by any instructor among all the instructors.



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

Figure: *instructor* relation

- ○ Query:

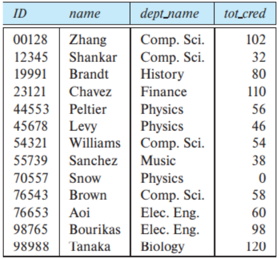
  select min(*salary*) **as** *least_salary*
  from *instructor*;

- ○ Output:

least_salary
40000.00

Aggregate functions (3): max

- From the *student* relation given in the figure, find the maximum credits obtained by any student among all the students.



ID	*name*	*dept_name*	*tot_cred*
00128	Zhang	Comp. Sci.	102
12345	Shankar	Comp. Sci.	32
19991	Brandt	History	80
23121	Chavez	Finance	110
44553	Peltier	Physics	56
45678	Levy	Physics	46
54321	Williams	Comp. Sci.	54
55739	Sanchez	Music	38
70557	Snow	Physics	0
76543	Brown	Comp. Sci.	58
76653	Aoi	Elec. Eng.	60
98765	Bourikas	Elec. Eng.	98
98988	Tanaka	Biology	120

Figure: *student* relation

- ○ Query:

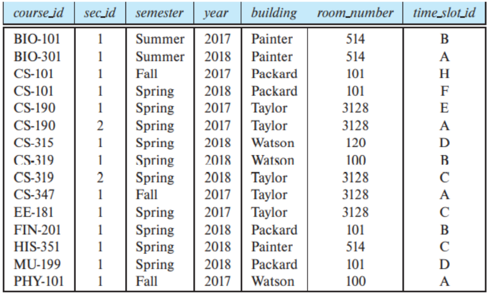
  select max(*tot_cred*) **as** *max_credits*
  from *student*;

- ○ Output:

max_credits
120

Aggregate functions (4): count

- From the *section* relation given in the figure, find the number of courses run in each building.



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

Figure: *section* relation

- ○ Query:

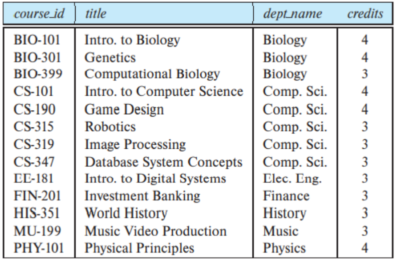
  select *building*,
  count(*course_id*) **as** *course_count*
  from *section*
  group by *building*;

- ○ Output:

building	*course_count*
Taylor	5
Packard	4
Painter	3
Watson	3

Aggregate functions (5): sum

- From the *course* relation given in the figure, find the total credits offered by each department.



course_id	*title*	*dept_name*	*credits*
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

Figure: *course* relation

- Query:

  select *dept_name*,
      sum(*credits*) **as** *sum_credits*
  from *course*
  group by *dept_name*;

- Output:

dept_name	*sum_credits*
Finance	3
History	3
Physics	4
Music	3
Comp. Sci.	17
Biology	11
Elec. Eng.	3

Module Summary

- SQL Examples have been practiced for
  - Select
  - Cartesian Product / as
  - Where: and / or
  - String Matching
  - Order by
  - in
  - Set Operations: union, intersect, except
  - Aggregate Functions: avg, min, max, count, sum

Slides used in this presentation are borrowed from http://db-book.com/ with kind