Database System Tutorial 1

Database TA Team
The University of Auckland

Tutorial Structure

- Covers additional material if needed
- Questions that you can try
- Answering questions

(Top-left corner: QR code of this slide)

Compare SQL Joins

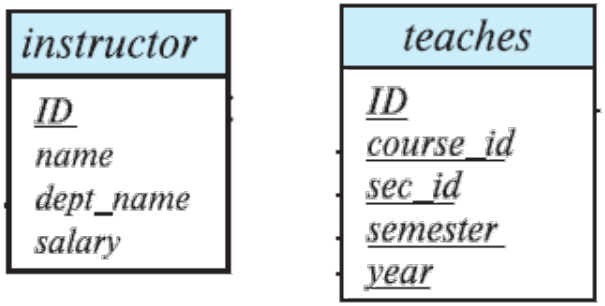
- Cartesian Product ($\times$)
- Theta Join ($\bowtie_\theta$)
- Natural Join ($\bowtie$)
- Key Differences

Cartesian Product (×)

- Join with no condition
  - Yields every combination of values
  - All attributes concatenated

instructor X *teaches*

instructor.ID



teaches.id

instructor.ID	*name*	*dept_name*	*salary*	*teaches.ID*	*course_id*	*sec_id*	*semester*	*year*
10101	Srinivasan	Comp. Sci.	65000	10101	CS-101	1	Fall	2017
10101	Srinivasan	Comp. Sci.	65000	10101	CS-315	1	Spring	2018
10101	Srinivasan	Comp. Sci.	65000	10101	CS-347	1	Fall	2017
10101	Srinivasan	Comp. Sci.	65000	12121	FIN-201	1	Spring	2018
10101	Srinivasan	Comp. Sci.	65000	15151	MU-199	1	Spring	2018
10101	Srinivasan	Comp. Sci.	65000	22222	PHY-101	1	Fall	2017
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
12121	Wu	Finance	90000	10101	CS-101	1	Fall	2017
12121	Wu	Finance	90000	10101	CS-315	1	Spring	2018
12121	Wu	Finance	90000	10101	CS-347	1	Fall	2017
12121	Wu	Finance	90000	12121	FIN-201	1	Spring	2018

Theta Join ($\bowtie_\theta$)

- Cartesian Product, but with extra predicate

$$r \bowtie_\theta s = \sigma_\theta(r \times s)$$

$$\sigma_{\text{instructor.ID=teaches.ID}}(\text{instructor} \times \text{teaches})$$

$$=$$

$$\text{instructor} \bowtie_{\text{instructor.ID=teaches.ID}} \text{teaches}$$

Natural Join (⋈)

- Cartesian Product, but automatically uses = for each column with the same name

$$\text{instructor} \bowtie \text{teaches}$$

$$=$$

$$\sigma_{\text{building=303} \wedge \text{year=2024}} (\text{instructor} \times \text{teaches} \times \text{department})$$

Key differences

- Cartesian Product ($\times$): No condition, pairs all
- Theta Join ($\bowtie_\theta$): plus predicate
- Natural Join ($\bowtie$): automatically join matching cols

Exercises

- *branch*(*branch name*, *branch city, assets*)
- *customer* (*ID*, *customer name*, *customer street, customer city*)
- *loan* (*loan number*, *branch name, amount*)
- *borrower* (*ID*, *loan number*)
- *account* (*account number*, *branch name, balance*)
- *depositor* (*ID*, *account number*)

1. Consider this bank database. Assume that branch names and customer names uniquely identify branches and customers, but loans and accounts can be associated with more than one customer.

- What are the appropriate primary keys?
- Given your choice of primary keys, identify appropriate foreign keys.

Exercises

- *branch*(*branch name*, *branch city, assets*)
- *customer* (*ID*, *customer name*, *customer street, customer city*)
- *loan* (*loan number*, *branch name, amount*)
- *borrower* (*ID*, *loan number*)
- *account* (*account number*, *branch name, balance*)
- *depositor* (*ID*, *account number*)

2. Consider this bank database. Give an expression in the relational algebra for each of the following:

- Find each loan number with a loan amount greater than $10000.
- Find the ID of each depositor who has an account with a balance greater than $6000.
- Find the ID of each depositor who has an account with a balance greater than $6000 at the “Uptown” branch.

Exercises

3. Consider the university database (see Appendix).

Write the following queries in relational algebra:

- Find the ID and name of each instructor in the Physics department.
- Find the ID and name of each instructor in a department located in the building “Watson”.
- Find the ID and name of each student who has taken at least one course in the “Comp. Sci.” department.
- Find the ID and name of each student who has taken at least one course section in the year 2018.
- Find the ID and name of each student who has not taken any course section in the year 2018.

Exercises

4. Write the following queries in SQL, using the university schema:

- Find the titles of courses in the Comp. Sci. department that have 3 credits.
- Find the IDs of all students who were taught by an instructor named Einstein; make sure there are no duplicates in the result.
- Find the highest salary of any instructor.
- Find all instructors earning the highest salary (there may be more than one with the same salary).
- Find the enrollment of each section that was offered in Fall 2017.
- Find the maximum enrollment, across all sections, in Fall 2017.
- Find the sections that had the maximum enrollment in Fall 2017.

Appendix: University Database

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Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

SCIENCE
DEPARTMENT OF COMPUTER SCIENCE

classroom(*building*, *room number*, *capacity*)

department(*dept_name*, *building*, *budget*)

course(*course_id*, *title*, *dept_name*, *credits*)

instructor(*ID*, *name*, *dept_name*, *salary*)

section(*course_id*, *sec_id*, *semester*, *year*, *building*, *room number*, *time_slot_id*)

teaches(*ID*, *course_id*, *sec_id*, *semester*, *year*)

student(*ID*, *name*, *dept_name*, *tot cred*)

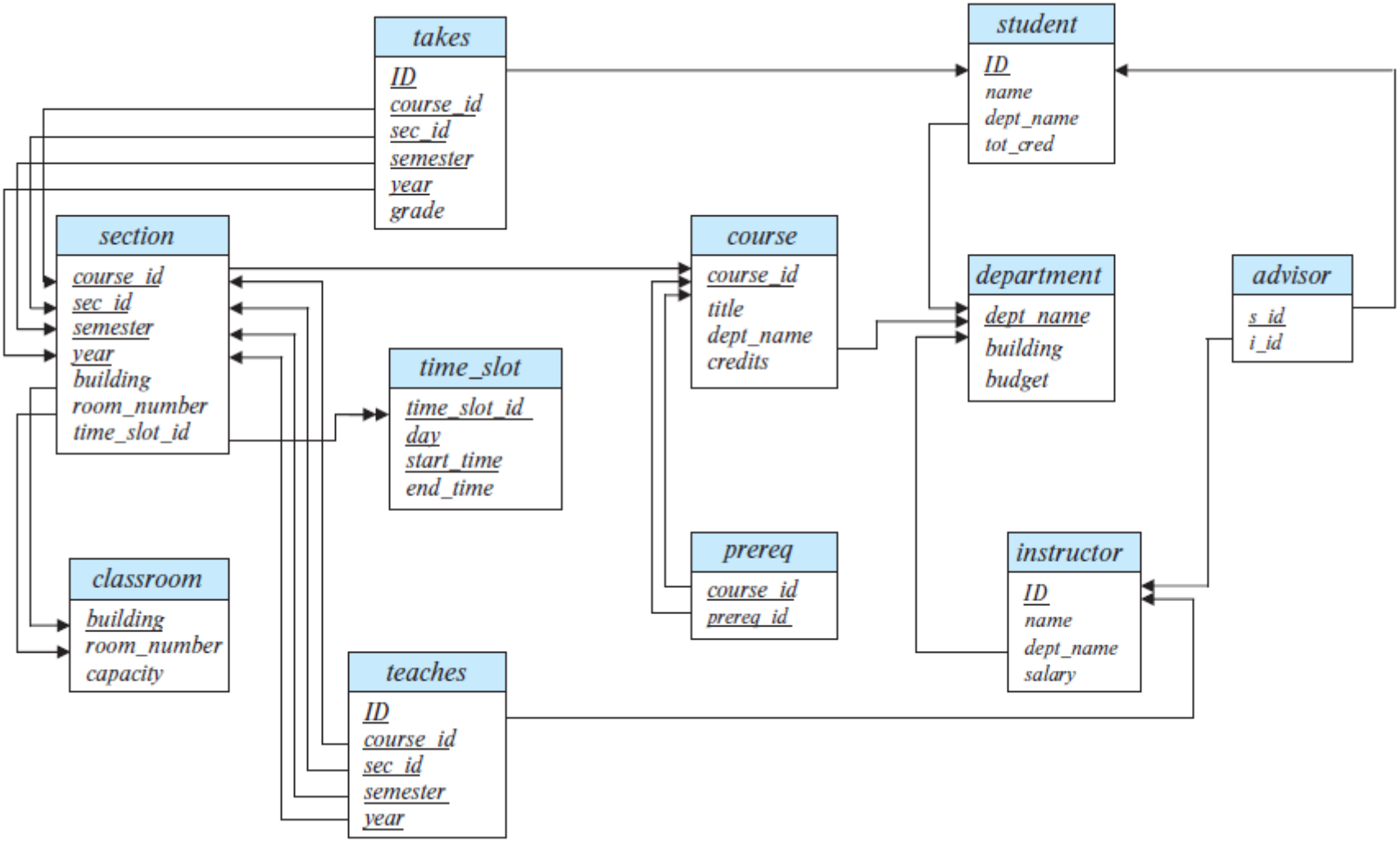
takes(*ID*, *course_id*, *sec_id*, *semester*, *year*, *grade*)

advisor(*s_ID*, *i_ID*)

time_slot(*time_slot_id*, *day*, *start time*, *end time*)

prereq(*course_id*, *prereq_id*)

Appendix: University Database



Appendix: University Database

https://www.db-book.com/university-lab-dir/sqljs.html

<- Online SQL interpreter

University database loaded

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SCIENCE

FIN

Any questions?