

CS1555 Recitation 4 Solution

Objective: To practice relational algebra

Consider the following relation schemas and states:

STUDENT (sid, name, class, major)
STUDENT_DIR (sid, address, phone)
FK: (sid) → STUDENT (sid)
COURSE_TAKEN (course_no, term, sid, grade)
FK: (course_no) → COURSE (course_no)
FK: (sid) → STUDENT (sid)
COURSE (course_no, name, level)

STUDENT

sid	name	class	major
123	John	3	CS
124	Mary	3	CS
126	Sam	2	CS
129	Julie	2	Math

STUDENT_DIR

sid	address	phone
123	333 Library St	555-535-5263
124	219 Library St	555-963-9635
129	555 Library St	555-123-4567

COURSE

course_no	name	course_level
CS1520	Web Programming	UGrad
CS1555	Database Management Systems	UGrad
CS1550	Operating Systems	UGrad
CS1655	Secure Data Management and Web Applications	Ugrad
CS2550	Database Management Systems	Grad

COURSE_TAKEN

course_no	term	sid	grade
CS1520	Fall 19	123	3.75
CS1520	Fall 19	124	4
CS1520	Fall 19	126	3
CS1555	Fall 19	123	4
CS1555	Fall 19	124	NULL
CS1550	Spring 20	123	NULL
CS1550	Spring 20	124	NULL
CS1550	Spring 20	126	NULL
CS1550	Spring 20	129	NULL
CS2550	Spring 20	124	NULL
CS1520	Spring 20	126	NULL

PART 1:

1. Identify the arity and cardinality of the 4 given relations.

STUDENT: arity = 4, cardinality = 4
STUDENT_DIR: arity = 3, cardinality = 3
COURSE: arity = 3, cardinality = 5
COURSE_TAKEN: arity = 4, cardinality = 11

2. For each of the four relational algebra queries below:
- Identify the expected arity, schema, and min/max cardinality of the relation resulted from the below queries, **without actually evaluating the query and based only on the schemas and cardinalities of the 4 given relations.**
 - Find the resulted relation given the above states of the 4 relations.

(Note: we are using $|T|$ notation to denote the Arity of relation T and $|r(T)|$ notation to denote the cardinality of relation T)

- a. $T1 \leftarrow \sigma_{\text{term} = \text{'Spring 20'}} (\text{COURSE_TAKEN})$

$|T1| = 4;$

$T1(\text{course_no}, \text{term}, \text{sid}, \text{grade})$

$\min |r(T1)| = 0; \quad \max |r(T1)| = |r(\text{COURSE_TAKEN})|$

T1

course_no	term	sid	grade
CS1550	Spring 20	123	NULL
CS1550	Spring 20	124	NULL
CS1550	Spring 20	126	NULL
CS1550	Spring 20	129	NULL
CS2550	Spring 20	124	NULL
CS1520	Spring 20	126	NULL

b. $T2 \leftarrow \pi_{\text{course_no}} (\sigma_{\text{term} = \text{'Spring 20'}} (\text{COURSE_TAKEN}))$

$|T2| = 1$

$T2(\text{course_no})$

$\min |r(T2)| = 0; \quad \max |r(T2)| = |r(\text{COURSE})|$

T2

course_no
CS1550
CS2550
CS1520

c. $T3 \leftarrow \sigma_{\text{COURSE_TAKEN.course_no} = \text{COURSE.course_no}} (\text{COURSE_TAKEN} \times \text{COURSE})$

$|T3| = 7$

$T4(\text{COURSE_TAKEN.course_no}, \text{term}, \text{sid}, \text{grade}, \text{COURSE.course_no}, \text{course_name}, \text{course_level})$

$|r(T3)| = |r(\text{COURSE_TAKEN})|$

T3

COURSE_TAKEN. course_no	term	sid	grade	COURSE. course_no	course_name	course_level
CS1520	Fall 19	123	3.75	CS1520	Web Programming	UGrad
CS1520	Fall 17	124	4	CS1520	Web Programming	UGrad
CS1520	Fall 19	126	3	CS1520	Web Programming	UGrad
CS1555	Fall 19	123	4	CS1555	Database management System	UGrad
CS1555	Fall 19	124	NULL	CS1555	Database management System	UGrad
CS1550	Spring 20	123	NULL	CS1550	Operating Systems	UGrad
CS1550	Spring 20	124	NULL	CS1550	Operating Systems	UGrad
CS1550	Spring 20	126	NULL	CS1550	Operating Systems	UGrad
CS1550	Spring 20	129	NULL	CS1550	Operating Systems	UGrad
CS2550	Spring 20	124	NULL	CS2550	Database Management System	Grad
CS1520	Spring 20	126	NULL	CS1520	Web Programming	UGrad

d. $T4 \leftarrow \text{COURSE_TAKEN} \bowtie_{\text{COURSE_TAKEN.course_no} = \text{COURSE.course_no}} \text{COURSE}$

$|T4| = 7$

$T4(\text{COURSE_TAKEN.course_no}, \text{term}, \text{sid}, \text{grade}, \text{COURSE.course_no}, \text{course_name}, \text{course_level})$

$|r(T4)| = |r(\text{COURSE_TAKEN})|$

T4

COURSE_TAKEN. course_no	term	sid	grade	COURSE. course_no	course_name	course_level
CS1520	Fall 19	123	3.75	CS1520	Web Programming	UGrad
CS1520	Fall 17	124	4	CS1520	Web Programming	UGrad
CS1520	Fall 19	126	3	CS1520	Web Programming	UGrad
CS1555	Fall 19	123	4	CS1555	Database management System	UGrad
CS1555	Fall 19	124	NULL	CS1555	Database management System	UGrad
CS1550	Spring 20	123	NULL	CS1550	Operating Systems	UGrad
CS1550	Spring 20	124	NULL	CS1550	Operating Systems	UGrad
CS1550	Spring 20	126	NULL	CS1550	Operating Systems	UGrad
CS1550	Spring 20	129	NULL	CS1550	Operating Systems	UGrad
CS2550	Spring 20	124	NULL	CS2550	Database Management System	Grad
CS1520	Spring 20	126	NULL	CS1520	Web Programming	UGrad

PART 2: Write a relational algebra query for each of the queries below and analyze the efficiency of each query.

1. List the *course_no* and *grade* of all the courses that were taken by the student whose *sid* is 124.

$L1 \leftarrow \pi_{\text{course_no}, \text{grade}}(\sigma_{\text{SID}=124}(\text{COURSE_TAKEN}))$