CS1555 Recitation 6 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 (Course_No, Name, Level)
Courses_taken (Course_No, Term, SID, Grade)
FK: (Course_No) → Course (Course_No)
FK: (SID) → Student (SID)

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	Course_Name	Course_level
CS1520	Web Programming	UGrad
CS1555	Database Management Systems	UGrad
CS1550	Operating Systems	UGrad
CS 1655	Secure Data Management and Web Applications	UGrad
CS2550	Database Management Systems	Grad

Course_taken

Course_No	Term	SID	Grade
CS1520	Fall 17	123	3.75
CS1520	Fall 17	124	4
CS1520	Fall 17	126	3
CS1555	Fall 17	123	4
CS1555	Fall 17	124	NULL
CS1550	Spring 18	123	NULL
CS1550	Spring 18	124	NULL
CS1550	Spring 18	126	NULL
CS1550	Spring 18	129	NULL
CS2550	Spring 18	124	NULL
CS1520	Spring 18	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:
   a. 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.
   b. 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. $T1 \leftarrow \sigma_{Term = 'Spring\ 18'}(Courses\_taken)$

|T1| =4;

T1(Course_No, Term, SID, Grade)

min|r(T1)|=0; max|r(T1)| =|r(Course_Taken)|

T1

Course_No	Term	SID	Grade
CS1550	Spring 18	123	NULL
CS1550	Spring 18	124	NULL
CS1550	Spring 18	126	NULL
CS1550	Spring 18	129	NULL
CS2550	Spring 18	124	NULL
CS1520	Spring 18	126	NULL

b. $T2 \leftarrow \pi_{Course\_No} (\sigma_{Term = 'Spring\ 18'} (Courses\_taken))$

|T2| =1

T2(Course_No)

Min|r(T2)| =0; Max|r(T2)| =|r(Course)|

T2

Course_No
CS1555
CS2550
CS1520

c. $T3 \leftarrow Courses\_taken * Course$

|T3| =6

T3(Course_No, Term, SID, Grade, Course_name, Course_level)

|r(T3)| = |r(Course_taken)|

T3

Course_No	Term	SID	Grade	Course_Name	Course_Level
CS1520	Fall 17	123	3.75	Web Programming	UGrad
CS1520	Fall 17	124	4	Web Programming	UGrad
CS1520	Fall 17	126	3	Web Programming	UGrad
CS1555	Fall 17	123	4	Database management System	UGrad
CS1555	Fall 17	124	NULL	Database management System	UGrad
CS1550	Spring 18	123	NULL	Operating Systems	UGrad
CS1550	Spring 18	124	NULL	Operating Systems	UGrad
CS1550	Spring 18	126	NULL	Operating Systems	UGrad
CS1550	Spring 18	129	NULL	Operating Systems	UGrad
CS2550	Spring 18	124	NULL	Database Management System	Grad
CS1520	Spring 18	126	NULL	Web Programming	UGrad

d. $T4 \leftarrow Courses\_taken \bowtie_{Courses\_taken.Course\_No = Course.Course\_No} Course$

|T4| =7

T4(Course_Taken.Course_No, Term, SID, Grade, Course.Course_No, Course_Name, Course_Level)

|r(t4)| =|r(Course_Taken)|

T4

Course_Taken .Course_No	Term	SID	Grade	Course.C ourse_No	Course_Name	Course_Level
CS1520	Fall 17	123	3.75	CS1520	Web Programming	UGrad
CS1520	Fall 17	124	4	CS1520	Web Programming	UGrad
CS1520	Fall 17	126	3	CS1520	Web Programming	UGrad
CS1555	Fall 17	123	4	CS1555	Database management System	UGrad
CS1555	Fall 17	124	NULL	CS1555	Database management System	UGrad
CS1550	Spring 18	123	NULL	CS1550	Operating Systems	UGrad
CS1550	Spring 18	124	NULL	CS1550	Operating Systems	UGrad
CS1550	Spring 18	126	NULL	CS1550	Operating Systems	UGrad
CS1550	Spring 18	129	NULL	CS1550	Operating Systems	UGrad
CS2550	Spring 18	124	NULL	CS2550	Database Management System	Grad
CS1520	Spring 18	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.

   $L1 \leftarrow \pi_{Course\_No,\ Grade}(\sigma_{SID=124}(Course\_taken))$

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2. List the course_no and grade for all the courses that were taken by Mary.

   $L2 \leftarrow \pi_{Course\_No,Grade}(\sigma_{Name="mary"}(Course\_taken * Student))$

   Or

   $L2 \leftarrow \pi_{Course\_No,Grade}(Course\_taken * (\sigma_{Name="mary"}(Student)))$

   The second query is more efficient, because the selection is executed first.

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3. List the course_no, course name, level, and grade for all the courses that were taken by Mary.

   $L3 \leftarrow \pi_{Course.Course\_No,\ Course\_Name,\ Course\_Level,\ Grade}$
   $(\sigma_{name="mary"}(Course\_taken * Student * Course))$

   Or

   $L3 \leftarrow \pi_{Course.Course\_No,\ Course\_Name,\ Course\_Level,\ Grade}$
   $(Course\_taken * Course * (\sigma_{name="mary"}(Student)))$

   The second query is more efficient, because the selection is executed first.

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4. Find the students (SID's) who have enrolled in the course "Operating Systems".

   $L4 \leftarrow \pi_{SID}\ (\sigma_{Course\_Name="Operating\ Systems"}\ (Course\_Taken * Course)\ )$

   Or

   $L4 \leftarrow \pi_{SID}\ (Course\_Taken * (\sigma_{Course\_Name="Operating\ Systems"}\ (Course)\ )$

   The second query is more efficient, because the selection is executed first.
