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

1. For each of the four relational algebra queries below:
   1. 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**.
   2. 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.  term = 'Spring 20' ( COURSE \_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 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. course\_no ( term = 'Spring 20' (COURSE \_TAKEN ))

|T2| =1

T2(course\_no)

min |r(T2)| = 0; max |r(T2)| = |r(COURSE)|

**T2**

|  |
| --- |
| course\_no |
| CS1550 |
| CS2550 |
| CS1520 |

c. T3   COURSE\_TAKEN.course\_no = COURSE.course\_no ( COURSE \_TAKEN X COURSE )

|T3| =7

T4(COURSE \_TAKEN.course\_no, term, sid, grade, COURSE.course\_no, course\_name, course\_level)

|r(T3)| = |r(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 COURSE \_TAKEN ▷◁COURSE\_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.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 🡨 πcourse\_no, grade(σSID=124(COURSE\_TAKEN))