Assingment 5 Solutions

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We will use the following relation schemas and their respective abbreviations:

Student(sid, sname)	S, S_1, S_2 etc.
Book(bookno, title, price)	B, B_1, B_2, etc.
Buys(sid, bookno)	T, T_1, T_2 etc.
Cites(bookno, citedBookno)	C, C_1, C_2 etc.
Major(sid, major)	M, M_1, M_2 etc.

We now give the RA expressions for a series of queries. We will also express them in "Relational" SQL and sometimes suppress the `DISTINCT` clause where appropriate.

1. a)Develop a general RA expression for the "all-but-two" set semi-join.

   Ans : All but two can be derived but taking a difference between > two and = two for table X

   ref: lecture slides

$$X = (E \times S) - (E \bowtie T)$$
$$\pi_{X1.a}(X1 \bowtie_{X1.a \neq X2.a \wedge X1.b = X2.b} X2)$$
$$-\pi_{X1.a}((X1 \bowtie_{X1.a \neq X2.a \wedge X1.b = X2.b} X2) \bowtie_{X1.a \neq X3.a \wedge X1.b = X3.b} X3)$$

   b) Formulate the RA expression obtained in Problem 1b in SQL with relational operators.

$$SB = \pi_{M.sid,B.bookno}(\sigma_{major='CS'}(M) \times B)$$
$$Table1 = \pi_{SB1.sid,SB1.bookno}(SB1 \bowtie_{(SB1.sid<>SB2.sid \wedge SB1.bookno=SB2.bookno} SB2)$$
$$\bowtie_{SB1.sid<>SB3.sid \wedge SB1.bookno=SB3.bookno} SB3)$$
$$Table2 = \pi_{SB1.sid,SB1.bookno}(SB1 \bowtie_{(SB1.sid<>SB2.sid \wedge SB1.bookno=SB2.bookno} SB2)$$
$$\pi_{bookno,title}(\pi_{B1.bookno,B1.title}(B \bowtie Table1) - \pi_{B2.bookno,B2.title}(B2 \bowtie Table2))$$

2. a-i)Write an RA expression, in function of E1, E2, and F, that expresses this if-then-else statement.

$$\pi_{E1.*}(E1 \times \pi_{()}(F)) \cup \pi_{E2.*}(E2 - (E2 \times \pi_{()}(F)))$$

   b-i)Write an RA expression that expresses the boolean SQL query
   (select exists(select 1 from A) as AisNotEmpty;).

$$(C : True) \times \pi_{()}(A) \cup ((C : False) - (C : False) \times \pi_{()}(A))$$

3. (a) Write an RA expression that computes the function g(o)f.I.e., your expression should compute the binary relation(x,g(o)f(x))|xâA.

$$\pi_{f.A,g.C}(f \bowtie g)$$

(b) Let y be a value in C. Write an RA expression that computes the setxâA|g(o)f(x) =y.I.e., these are the values in A that are mapped by the function g(o)f to the value y.

$$\pi_{f.A}(\sigma_{C=y}(g) \bowtie f)$$

4. Write an RA expression that returns the value true if f(as stored in f) is a one-one-one function, and returns the value false otherwise.

$$(C : True) \times \pi_{()}(f1 \bowtie_{f1.a=f2.a \wedge f1.b \neq f2.b} f2) \cup ((C : False) - (C : False) \times \pi_{()}(f1 \bowtie_{f1.a=f2.a \wedge f1.b \neq f2.b} f2))$$

5. Write an RA expression that returns the value true if f(as stored in f) is an onto function, and returns the value false otherwise.

$$((C : True) \times \pi_{()}(\sigma_{f.B=y \wedge f.A \neq NULL}(f))) \cup ((C : False) - (C : False) \times \pi_{()}(\sigma_{f.B=y \wedge f.A \neq NULL}(f)))$$

6. Write an RA expression that returns the set of pairs (v,w) that are connected by a path of length at most n. (You may assume that n≥1.)

   1) for n= 1

$$\pi_{E.source,E.target}(E)$$

   2) for n = 2

$$\pi_{E.source,E.target}(E) \cup \pi_{E1.source,E2.target}(E1 \bowtie_{E1.target=E2.source} E2)$$

   3) for n = 3

$$\pi_{E.source,E.target}(E) \cup \pi_{E1.source,E2.target}(E1 \bowtie_{E1.target=E2.source} E2) \cup \pi_{E1.source,E3.target}(\pi_{E1.source,E2.target}(E1 \bowtie_{E1.target=E2.source} E2) \bowtie_{E2.target=E3.source} E3)$$

   Similarly if already have values for n-1 as E_{n-1} then the general expression would be

$$\pi_{E_{n-1}.source,E_{n-1}.target}(E_{n-1}) \cup \pi_{En-1.source,En.target}(E_{n-1} \bowtie_{E_{n-1}.target=En.source} En)$$

7. Find the sid and name of each student who majors in CS and who bought a book that cost more than \$10.

$$\pi_{sid,sname}(S \bowtie \pi_{sid}(\sigma_{Major='CS'}(M) \bowtie \pi_{sid}(T \bowtie \pi_{bookno}(\sigma_{Price>10}(B))))).$$

8. Find the bookno, title, and price of each book that cites at least two books that cost less than \$60.

$$\pi_{bookno,title,price}(B \bowtie_{B.bookno=C1.bookno} (\pi_{C1.bookno}(C1 \bowtie_{C1.citedbookno=B1.bookno} \pi_{bookno}(\sigma_{Price<60}(B1))) \bowtie_{C1.bookno=C2.bookno \wedge B1.bookno \neq B2.bookno} (C2 \bowtie_{C2.citedbookno=B2.bookno} \pi_{bookno}(\sigma_{Price<60}(B2))))).$$

9. Find the bookno, title, and price of each book that was not bought by any Math student.

$$\pi_{bookno,title,price}(B - \pi_{bookno,title,price}(B \bowtie \pi_{bookno}(T \bowtie \pi_{sid}(\sigma_{Major='Math'}(M))))).$$

10. Find the sid and name of each student along with the title and price of the most expensive book(s) bought by that student.

$$\pi_{S.sid,S.sname,B1.title,B1.price}(S \bowtie (\pi_{T1.sid,B1.bookno,B1.price,B1.title,}(B1 \bowtie T1) - (\pi_{T1.sid,B1.bookno,B1.price,B1.title,}(B1 \bowtie T1)) \bowtie_{T1.sid=T2.sid \wedge B1.price<B2.price} (\pi_{T2.sid,B2.bookno,B2.price,B2.title,}(B2 \bowtie T2)))).$$

11. Find the booknos and titles of books with the next to highest price.

$$\pi_{B1.bookno,B1.title}((B1 \bowtie_{B1.price>B2.price} B2) - ((B3 \bowtie_{B3.price>B4.price} B4) \bowtie_{B3.price<B5.price} (B5 \bowtie_{B5.price>B6.price} B6)))$$

12. Find the bookno, title, and price of each book that cites a book which is not among the most expensive books.

$$\pi_{B.bookno,B.title,B.price}(B \bowtie \pi_{C.citedbookno,C.bookno}(C \bowtie_{C.citedbookno \neq B1.bookno} \pi_{B1.bookno}(B1 - \pi_{B1.bookno}(B1 \bowtie_{B1.price \not> = B2.price} B2)))).$$

13. Find the sid and name of each student who has a single major and such that none of the book(s) bought by that student cost less than \$40.

$$\pi_{S.sid,S.sname}(S \bowtie \pi_{M.sid}(\pi_{M.sid}(M - \pi_{M1.sid}(M1 \bowtie_{M1.sid=M2.sid \wedge M1.major \neq M2.major} M2)) - \pi_{B.sid}(B \bowtie_{B.bookno=T.bookno \wedge B.price<40} T))$$

14. Find the bookno and title of each book that is bought by all students who major in both CS and in Math.

$$\pi_{B.bookno,B.title}(B \bowtie \pi_{sid,bookno}(T1 \bowtie (\sigma_{M1.major='CS'}(M1) \bowtie_{M1.sid=M2.sid} (\sigma_{M2.major='Math'}(M2)))) \bowtie_{T1.bookno=T2.bookno \wedge T1.sid \neq T2.sid} \pi_{sid,bookno}(T2 \bowtie (\sigma_{M1.major='CS'}(M1) \bowtie_{M1.sid=M2.sid} (\sigma_{M2.major='Math'}(M2))))).$$

15. Find the sid and name of each student who, if he or she bought a book that cost at least than $70, also bought a book that cost less than $30.

$$(\pi_{S.sid,S.sname}(S \bowtie T \bowtie \sigma_{B.price<30}(B)) \cap \pi_{S.sid,S.sname}(S \bowtie T \bowtie \sigma_{B.price>=70}(B))) \cup (\pi_{S.sid,S.sname}(S - \pi_{S.sid}(S \bowtie T))) \cup (\pi_{S.sid,S.sname}(S \bowtie T \bowtie \sigma_{B.price<70}(B)) - \pi_{S.sid,S.sname}(S \bowtie T \bowtie \sigma_{B.price>=70}(B)))$$

16. Find each pair (s1, s2) where s1 and s2 are the sids of students who have a common major but who did not buy the same set of books.

$$\pi_{M1.sid,M2.sid}(M1 \bowtie_{M1.major=M2.major \wedge M1.sid<>M2.sid} M2) \cap (\pi_{T1.sid,T2.sid}(\pi_{sid,bookno}(T1 \times S1) - \pi_{sid,bookno}(T2 \times S2)) \cup \pi_{T2.sid,T1.sid}(\pi_{sid,bookno}(T \times S1) - \pi_{sid,bookno}(T2 \times S2)))$$