Gradiance Online Accelerated Learning

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1. Suppose relation R(A,B,C) has the tuples:

A	B	C
1	2	3
4	2	3
4	5	6
2	5	3
1	2	6

and relation S(A,B,C) has the tuples:

A	B	C
2	5	3
2	5	4
4	5	6
1	2	3

Compute (R - S) [union] (S - R), often called the "symmetric difference" of R and S. Then, identify from the list below, one of the tuples in the symmetric difference of R and S.

a) (1,2,3)

b) (2,5,3)

c) (1,2,6)

d) (4,5,3)

Answer submitted: **c)**

You have answered the question correctly.

Question Explanation:

R - S is the tuples that appear in R but not S, namely (4,2,3) and (1,2,6). S - R is the tuples that appear in S but not R, namely (2,5,4). The union of these two sets is the answer: {(4,2,3), (1,2,6), (2,5,4)}.

2. Relation R(a,b) contains the following tuples: (1,2), (1,3), (1,4), (2,3), (3,4), and (4,5). Compute Answer(x,y) defined by:

Answer(x,y) <- R(x,z) AND R(z,y)

Then, demonstrate your knowledge by identifying, from the list below, the tuple in Answer(x,y).

a) (2,3)

b) (4,5)

c) (1,2)

d) (1,3)

Answer submitted: **d)**

You have answered the question correctly.

Question Explanation:

This rule really asks for the natural join of R1(x,z) and R2(z,y), where R1 and R2 are both copies of R. We then have to project the result of the join onto x and y to get the answer. If we look at the tuples in R, we see that:

- (1,2) joins with (2,3) to give (1,2,3).
- (1,3) joins with (3,4) to give (1,3,4).
- (1,4) joins with (4,5) to give (1,4,5).
- (2,3) joins with (3,4) to give (2,3,4).
- (3,4) joins with (4,5) to give (3,4,5).

There are no other pairs of tuples from R that join. If we project each of the five tuples onto their first and third components, we get the five correct answers: {(1,3), (1,4), (1,5), (2,4), (3,5)}.

3. Suppose relation R(A,B,C) has the tuples:

A	B	C
1	2	3
4	2	3
4	5	6
2	5	3
1	2	6

Which of the following is a true statement about the **bag** projection of R?

a) (4,3) appears twice in $\pi_{A,C}$(R).

b) (1,2) appears three times in π(A,B}(R)

c) (1,2) appears twice in π(A,B}(R)

d) (5) appears three times in π_B(R).

Answer submitted: **c)**

You have answered the question correctly.

Question Explanation:

When doing a bag projection, we do not eliminate dupicates. Thus, a tuple *t* appears in the bag projection as many times as there are tuples of R whose projection is *t*. For example, when we compute $\pi_B(R)$, three of the tuples of R have 2 in their B-component, so (2) appears three times in the projection. The other two tuples have 5 in the B-component, so (5) appears twice. As another example, if we project onto {A,B}, there are two tuples (the first and last of R) that have A=1 and B=2. Thus, (1,2) appears twice.

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4. Suppose relation R(A,B) has the tuples:

A	B
1	2
3	4
5	6

and the relation S(B,C,D) has tuples:

B	C	D
2	4	6
4	6	8
4	7	9

Compute the theta-join of R and S with the condition R.A < S.C AND R.B < S.D. Then, identify from the list below one of the tuples in R $|\!\!><\!\!|_{R.A < S.C \text{ AND } R.B < S.D}$ S. You may assume the schema of the result is (A, R.B, S.B, C, D).

a) (5,6,4,6,9)

b) (5,6,4,7,9)

c) (1,2,4,4,6)

d) (5,6,2,4,6)

Answer submitted: **b)**

You have answered the question correctly.

Question Explanation:

Consider tuple (1,2) from R(A,B). In order for a tuple (b,c,d) from S(B,C,D) to satisfy the condition R.A < S.C AND R.B < S.D, we must have 1 < c AND 2 < d. Each of the three tuples from S satisfy that condition. Thus, we get for the resulting join tuples (1,2,2,4,6), (1,2,4,6,8), and (1,2,4,7,9).

Now consider tuple (3,4) from R. This tuple joins with tuples (b,c,d) from S that satisfy 3 < c AND 4 < d. Again all three tuples from S satisfy this condition and yield three more tuples for the result: (3,4,2,4,6), (3,4,4,6,8), and (3,4,4,7,9).

Finally, consider (5,6) from R. The condition for a successful join is 5 < c AND 6 < d. Tuple (2,4,6) from S(B,C,D) does not satisfy the condition; both 5 < 4 and 6 < 6 are false, in fact. However, (4,6,8) and (4,7,9) do satisfy the condition, yielding two more tuples for the result: (5,6,4,6,8) and (5,6,4,7,9).

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5. Let R(A,B,C) and S(A,B,C) be two relations. Which of the following is true if R, S, and all operations are interpreted to be sets and set-operations, but not necessarily true if R, S and all operations are bags and bag-operations?

a) (R - R) = (S - S)

b) (((R - S) [union] (S - R)) ∩ (R ∩ S)) = [emptyset]

c) (R ∩ R) = R

d) (R [union] S) = R

Answer submitted: **b)**

You have answered the question correctly.

Question Explanation:

Since R and S have the same schema, there are some special things we know. First, the natural join of R and S, thought of as sets, is the same as the (set) intersection of R and S. However, as bags, a tuple t appears in R |><| S the product of the number of times it appears in R and in S. That is not the same as the bag intersection of R and S, in which t appears the minimum of the number of times it appears in R and in S. This observation explains three of the correct answers: (R ∩ S) = (R |><| S) and ((R |><| S) - R) = ((R |><| S) - S) = [emptyset].

Another difference between set and bag operations concerns the fourth correct answer: (((R - S) [union] (S - R)) ∩ (R ∩ S)) = [emptyset]. As sets, note that a tuple is in exactly one of R-S, S-R, and R ∩ S. From this observation, we can prove the identity. However, as bags, consider a tuple t that appears twice in R and once in S. Then t appears once in R-S, once in R ∩ S, and not at all in S-R. Therefore, t appears once in (((R - S) [union] (S - R)) ∩ (R ∩ S)), and this expression is not equal to the empty set.

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6. A relational-algebra computation on relations R(a,b) and S(b,c) is described as follows:

T1(d,e) := $\pi_{a,c}$(R   S)
Answer(d) := $\pi_d(\sigma_{d=e}$(T1))

Try to convert the computation of Answer in terms of *R* and *S* into a Datalog rule. There are many possible Datalog rules, because, among other things, the names of the local variables and the order of subgoals are arbitrary. However, at least among those without redundant subgoals, correct rules will be similar except for variable names and order of subgoals. Identify, from the list below, the one Datalog rule that produces the same value for Answer as the relational algebra above.

a) Answer(a) <- S(a,b) AND R(b,a)

b) Answer(d,e) <- R(d,b) AND S(b,e)

c) Answer(a) <- R(a,b) AND S(b,a)

d) Answer(a) <- S(b,b) AND R(a,b)

Answer submitted: **c)**

You have answered the question correctly.

Question Explanation:

The value of T1 can be expressed in Datalog as the a and c components of R(a,b) AND S(b,c). The answer is computed from T1 by equating the two components (which has the effect in the Datalog expression of equating a and c), and then producing only one copy of those components, which could be either the first component of R or the second component of S. Thus, the body of the rule has to be R(a,b) AND S(b,a), while the head is Answer(a). Of course the variables used in the rule are of no consequence, so a and b could be replaced by any other variables. The important things to remember is that the order of the variables is reversed in R and S, and the variable in the head must be whatever is in the first component of R and the second component of S.

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7. Suppose relation R(A,B) has the tuples:

A	B
1	2
3	4
5	6

and the relation S(B,C,D) has tuples:

B	C	D
2	4	6
4	6	8
4	7	9

Compute the outerjoin of R and S, where the condition is: R.A>S.B AND R.B=S.C. Which of the following tuples of R or S is dangling (and therefore needs to be padded in the outerjoin)?

a) (4,7,9) of S.

b) (3,4) of R.

c) (4,6,8) of S.

d) There are no dangling tuples.

Answer submitted: **a)**

You have answered the question correctly.

Question Explanation:

Let us begin by computing the theta-join. Tuple (3,4) from R(A,B) joins with (2,4,6) from S(B,C,D). The reason is that R.A (=3) > S.B (=2) and R.B = S.C (=4). Also, (5,6) from R joins with (4,6,8) from S. The reason is that R.A (=5) > S.B (=4) and R.B = S.C (=6). However, no other tuples from R and S join.

Now, to find the dangling tuples, observe which tuples were not mentioned in a successful join; these are (1,2) from R and (4,7,9) from S. We need to pad (1,2) to make (1,2,null,null,null) and we pad (4,7,9) to make (null,null,4,7,9).

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8. Suppose relation R(A,B) has the tuples:

A	B
1	2
3	4
5	6

and the relation S(B,C,D) has tuples:

B	C	D
2	4	6
4	6	8
4	7	9

Compute the natural join of R and S. Then, identify which of the following tuples is in the natural join R |><| S. You may assume each tuple has schema (A,B,C,D).

a) (3,4,6,8)

b) (3,4,7,8)

c) (1,4,7,9)

d) (1,4,6,8)

Answer submitted: **a)**

You have answered the question correctly.

Question Explanation:

To compute the natural join, we must find tuples from R and S that agree on all common attributes. In this case, B is the only attribute appearing in both schemas, and the tuples in the join will have attributes A, B, C, and D --- the union of the attributes from R and S.

Tuple (1,2) from R(A,B) matches (2,4,6) from S(B,C,D), since they both have 2 in their B attributes. The resulting tuple, with schema (A,B,C,D), is (1,2,4,6). Similarly, (3,4) from S(A,B) matches both (4,6,8) and (4,7,9) from R(B,C,D), and yields tuples (3,4,6,8) and (3,4,7,9) for the result. Tuple (5,6) from R(A,B) matches nothing from S(B,C,D), so there are no more tuples in the result.

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9. Relation R(a,b) contains the following tuples: (1,2), (1,3), (1,4), (2,3), (3,4), and (4,5). Compute the relation Answer(x,y) defined by:

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S(x,z) <- R(x,y) AND R(y,z)
Answer(x,y) <- R(x,y) AND NOT S(x,y)
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Demonstrate your knowledge by identifying, from the list below, the tuple in Answer(x,y).

a) (1,5)

b) (3,2)

c) (1,3)

d) (3,4)

Answer submitted: **d)**

You have answered the question correctly.

Question Explanation:

To begin, note that the program is stratified, with IDB predicate S in stratum 0 and Answer in stratum 1. We thus need to compute S first.

The rule for S really asks for the natural join of R1(x,y) and R2(y,z), where R1 and R2 are both copies of R. We then have to project the result of the join onto x and z to get the answer. If we look at the tuples in R, we see that:

- (1,2) joins with (2,3) to give (1,2,3).
- (1,3) joins with (3,4) to give (1,3,4).
- (1,4) joins with (4,5) to give (1,4,5).
- (2,3) joins with (3,4) to give (2,3,4).
- (3,4) joins with (4,5) to give (3,4,5).

There are no other pairs of tuples from R that join. If we project each of the five tuples onto their first and third components, we get the five tuples in S: {(1,3), (1,4), (1,5), (2,4), (3,5)}.

Then, to compute Answer, we subtract S from R. That leaves tuples (1,2), (2,3), (3,4), and (4,5). Tuples (1,3) and (1,4) of R are not in Answer, because they are also in S.

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10. Suppose relation R(A,B,C) has the tuples:

A	B	C
1	2	3
1	2	3
2	3	1
3	1	2
2	2	3
2	3	3

Using **bag** projection and intersection, compute $\pi_{A,B}(R) \cap \rho_{S(A,B)}(\pi_{B,C}(R))$. Note that the renaming is only to give the two projections the same schema. Which of the following is true about the tuples that appear in the result?

a) (1,2) appears three times in the result.

b) (1,2) appears once in the result.

c) (2,3) appears three times in the result.

d) (1,2) appears twice in the result.

Answer submitted: **b)**

You have answered the question correctly.

Question Explanation:

The bag projection of R onto attributes A and B is {(1,2), (1,2), (2,3), (2,3), (3,1), (2,2)} and the bag projection of R onto B and C is {(1,2), (2,3), (2,3), (2,3), (3,1), (3,3)}. The renaming gives both relations the schema (A,B), so we can take the intersection legally. In the bag intersection, a tuple appears the minimum of the number of times it appears in the two relations whose intersection is taken. Thus, (1,2) appears only once, since it appears once in the second projection and twice in the first. (2,3) appears twice, since it appears that number of times in the first projection and three times in the second. (3,1) appears once in each argument and so appears once in the result. No other tuple appears even once in both arguments. Thus, the result is {(1,2), (2,3), (2,3), (3,1)}.

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11. Suppose relation R(A,B,C) has the tuples:

A	B	C

0	1	2
0	1	3
4	5	6
4	6	3

Compute the bag union of the following three expressions, each of which is the bag projection of a grouping (γ) operation:

1. $\pi_X(\gamma_{A,B,MAX(C)\rightarrow X}(R))$
2. $\pi_X(\gamma_{B,SUM(C)\rightarrow X}(R))$
3. $\pi_X(\gamma_{A,MIN(B)\rightarrow X}(R))$

Demonstrate that you have computed this bag correctly by identifying, from the list below, the correct count of occurrences for one of the elements.

a) 3 appears exactly three times.

b) 3 appears exactly once.

c) 5 appears exactly once.

d) 4 appears exactly twice.

Answer submitted: **a)**

You have answered the question correctly.

Question Explanation:

Let us consider $\pi_X(\gamma_{A,B,MAX(C)\rightarrow X}(R))$ first. The γ operation groups by A and B; that is, tuples are in the same group if and only if they agree on both A and B. Thus, (0,1,2) and (0,1,3) are in one group, but the other two tuples of R(A,B,C) --- (4,5,6) and (4,6,3) --- are each in a group by itself. We take the MAX of C for each group to get the value of X. These MAX's are, respectively, 3, 6, and 3. Thus, we have {3,6,3} so far for our bag result.

Now, consider $\pi_X(\gamma_{B,SUM(C)\rightarrow X}(R))$. Grouping by only B happens to place the tuples of R in the same three groups as grouping by both A and B. We need to take the sums of the C values for each of these groups, which are, respectively 5, 6, and 3. These are also values of X for the bag being assembled, which now has {3,6,3,5,6,3}.

Finally, consider $\pi_X(\gamma_{A,MIN(B)\rightarrow X}(R))$. Grouping by A places tuples (0,1,2) and (0,1,3) in one group, and (4,5,6) and (4,6,3) in another. To get values of X we need to take the MIN's of B for each group, which are 1 and 5, respectively.

Thus, the complete bag for the union of these three expressions is {3,6,3,5,6,3,1,5}. There are three 3's, two 6's, two 5's, and one 1.

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