CS 410- QL Database App Dev Assignment: Relational Algebra - Core Operators Under Set Semantics

I, Baba Avinash Puppala (bpuppala), declare that I have completed this assignment completely and entirely on my own, without any consultation with others. I understand that any breach of the UAB Academic Honor Code may result in severe penalties.

Q1: Natural Join of R(A, B, C) and S(B, C, D)

Theory:

A natural join combines two relations by matching tuples where the values in all common columns (attributes) are equal. It eliminates duplicate columns in the result. In this case, we perform the join on attributes B and C, which are common to both relations R and S.

Given:

Relation $R(A, B, C)$:

A	B	C
3	3	2
6	4	3
2	4	1
3	5	1
7	1	2

Relation $S(B, C, D)$:

B	C	D
5	1	6
1	5	8
4	3	9

Explanation:

The natural join is performed by finding matching pairs of B and C from both relations R and S. For each matching tuple, the respective values from the columns A (from R) and D (from S) are combined in the result. If there is no match, that tuple is not included in the output.

Natural Join Result (Schema: (A, B, C, D)):

A	B	C	D
6	4	3	9
3	5	1	6

Only tuples with matching B and C values appear in the final result.

Q2: Theta-Join of R(A, B) and S(B, C, D)

Theory:

A theta-join is a more generalized form of join that allows for arbitrary conditions (theta conditions) between attributes of the two relations being joined. In this case, we apply two conditions: 1. $R.B = S.B$ (join on attribute B). 2. $R.A > S.D$ (the value of A in R must be greater than the value of D in S).

Given:

Relation $R(A, B)$:

A	B
1	a
7	t
2	g
4	c
10	t

Relation $S(B, C, D)$:

B	C	D
c	5	6
a	7	8
t	8	9

Explanation:

In the theta-join, we first match the tuples where $R.B = S.B$, and then we further filter out the tuples where $R.A$ is not greater than $S.D$. Only the tuples that satisfy both conditions appear in the result.

Theta-Join Result (Condition: $R.B = S.B$ and $R.A > S.D$, Schema: (A, B, C, D)):

A	B	C	D
4	c	5	6
10	t	8	9

The result shows the rows that meet both conditions.

Q3: Value of t for Natural Join

Theory:

The number of tuples in a natural join t depends on the number of matching tuples between the two relations. The maximum number of tuples in a natural join occurs when every tuple in R matches with a tuple in S. The minimum value of t is 0, which occurs when there are no matching tuples between R and S.

Answer:

- The maximum value of t is $\min(r, s)$, where r is the number of tuples in R and s is the number of tuples in S. This occurs if every tuple in R matches with a tuple in S.
- The minimum value of t is 0, if no matching tuples are found between R and S.
- For $R \bowtie R$ (natural join of R with itself), the value of t is r since every tuple in R will match with itself.

Q4: Projection $\pi_{B,A}(R)$

Theory:

A projection in relational algebra extracts certain columns (attributes) from a relation. It eliminates duplicate rows, returning only distinct values in the specified columns. Here, we are projecting attributes B and A from relation R.

Given:

Relation $R(A, B, C)$:

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

Explanation:

We project the attributes B and A from the relation R and eliminate duplicate rows. The result contains only unique combinations of values in the B and A columns.

Projection Result $\pi_{B,A}(R)$ (Schema: (B, A)):

B	A
2	1
2	4
5	4
5	2

Q5: Set Operations on R(A, B, C) and S(A, B, C)

Theory:

In set theory, the core operations are union, intersection, and difference: - **Union** $R \cup S$: Combines all tuples from R and S, removing duplicates. - **Intersection** $R \cap S$: Includes only the tuples that are present in both R and S. - **Difference** $R - S$ and $S - R$: Returns the tuples that are in one relation but not in the other.

Given:

Relation $R(A, B, C)$:

A	B	C
a	b	c
d	b	c
d	e	f
b	e	c
a	b	f

Relation $S(A, B, C)$:

A	B	C
b	e	c
b	e	d
d	e	f
a	b	c

Explanation:

We perform the union, intersection, and set differences on the relations R and S, using set semantics (which means duplicates are removed automatically in the union and intersection).

Union $R \cup S$:

A	B	C
a	b	c
d	b	c
d	e	f
b	e	c
a	b	f
b	e	d

Intersection $R \cap S$:

A	B	C
a	b	c
d	e	f
b	e	c

Difference $R - S$:

A	B	C
d	b	c
a	b	f

Difference $S - R$:

A	B	C
b	e	d