

Division Operator (\div) in Relational Algebra

The **division operator** (\div) is a relational algebra operation used when dealing with queries that require finding entities associated with **all/every** values of another set. It is particularly useful for queries like "Find all students who have taken all courses."

Conditions for Applying Division ($A \div B$)

The division operation $A \div B$ is valid only if:

1. The **attributes of B** are a **proper subset** of the **attributes of A**.
2. The resulting relation contains **attributes of A that are not in B**.
3. The result includes **only those tuples from A that match every tuple in B**.

Example

Given Relations:

Relation A

x	y
a	1
b	2
a	2
d	4

Relation B

y
1
2

Result of $A \div B$:

x
a

Explanation:

To compute $A \div B$, we need to find **all x values in A that appear with every y value in B**.

❖ **Step 1:** Identify all x values in A:

➤ {a, b, d}

❖ **Step 2:** Find x values that appear with **every y in B** (i.e., both 1 and 2).

➤ a appears with 1 and 2 ✓

➤ b appears only with 2 ✗

➤ d appears only with 4 ✗

Thus, **only "a" qualifies**, giving the final result {a}.

Mathematical Expression

Division can be expressed using **cross product**, **set difference**, and **projection**:

$$A/B = \pi_x(A) - \pi_x((\pi_x(A) \times B) - A)$$

Conclusion

The **division operator** is a powerful tool in relational algebra, allowing us to retrieve entities that are associated with **all** values of another relation. It is widely used in queries that require **"for all"** conditions, such as finding students who have completed all required courses.