Tuple Relational Calculus (TRC) in DBMS:

Tuple Relational Calculus (TRC) is a non-procedural query language used in relational database management systems (RDBMS) to retrieve data from tables. TRC is based on the concept of tuples, which are ordered sets of attribute values that represent a single row or record in a database table.

TRC is a declarative language, meaning that it specifies what data is required from the database, rather than how to retrieve it. TRC queries are expressed as logical formulas that describe the desired tuples.

Syntax: The basic syntax of TRC is as follows:

{ t | P(t) }

where t is a **tuple variable** and P(t) is a **logical formula** that describes the conditions that the tuples in the result must satisfy. The **curly braces {}** are used to indicate that the expression is a set of tuples.

For example, let's say we have a table called "Employees" with the following attributes:

Employee ID
Name
Salary
Department ID

To retrieve the names of all employees who earn more than $50,000 per year, we can use the following TRC query:

{ t | Employees(t) ∧ t.Salary > 50000 }

In this query, the "Employees(t)" expression specifies that the tuple variable t represents a row in the "Employees" table. The "∧" symbol is the logical AND operator, which is used to combine the condition "t.Salary > 50000" with the table selection.

The result of this query will be a set of tuples, where each tuple contains the Name attribute of an employee who earns more than $50,000 per year.

TRC can also be used to perform more complex queries, such as joins and nested queries, by using additional logical operators and expressions.

While TRC is a powerful query language, it can be more difficult to write and understand than other SQL-based query languages, such as Structured Query Language (SQL). However, it is useful in certain applications, such as in the formal verification of database schemas and in academic research.

Tuple Relational Calculus is a **non-procedural query language,** unlike relational algebra. Tuple Calculus provides only the description of the query but it does not provide the methods to solve it. Thus, it explains what to do but not how to do it.

Tuple Relational Query

In Tuple Calculus, a query is expressed as

{t| P(t)}

where t = resulting tuples,
P(t) = known as Predicate and these are the conditions that are used to fetch t. Thus, it generates a set of all tuples t, such that Predicate P(t) is true for t.

P(t) may have various conditions logically combined with OR (∨), AND (∧), NOT(¬).
It also uses quantifiers:
∃ t ∈ r (Q(t)) = ”there exists” a tuple in t in relation r such that predicate Q(t) is true.
∀ t ∈ r (Q(t)) = Q(t) is true “for all” tuples in relation r.

Domain Relational Calculus (DRC)

Domain Relational Calculus is similar to Tuple Relational Calculus, where it makes a list of the attributes that are to be chosen from the relations as per the conditions.

{<a1,a2,a3,.....an> | P(a1,a2,a3,.....an)}

where a1,a2,…an are the attributes of the relation and P is the condition.

Tuple Relational Calculus Examples

Table Customer

Customer name	Street	City
Saurabh	A7	Patiala
Mehak	B6	Jalandhar
Sumiti	D9	Ludhiana

Customer name	Street	City
Ria	A5	Patiala

Table Branch

Branch name	Branch City
ABC	Patiala
DEF	Ludhiana
GHI	Jalandhar

Table Account

Account number	Branch name	Balance
1111	ABC	50000
1112	DEF	10000
1113	GHI	9000
1114	ABC	7000

Table Loan

Loan number	Branch name	Amount
L33	ABC	10000

Loan number	Branch name	Amount
L35	DEF	15000
L49	GHI	9000
L98	DEF	65000

Table Borrower

Customer name	Loan number
Saurabh	L33
Mehak	L49
Ria	L98

Table Depositor

Customer name	Account number
Saurabh	1111
Mehak	1113
Suniti	1114

Example 1: Find the loan number, branch, and amount of loans greater than or equal to 10000 amount.

$\{t|\ t \in loan\ \wedge t[amount]>=10000\}$

Resulting relation:

Loan number	Branch name	Amount
L33	ABC	10000
L35	DEF	15000
L98	DEF	65000

In the above query, t[amount] is known as a tuple variable.

Example 2: Find the loan number for each loan of an amount greater or equal to 10000.

{t| ∃ s ∈ loan(t[loan number] = s[loan number]

∧ s[amount]>=10000)}

Resulting relation:

Loan number
L33
L35
L98

Example 3: Find the names of all customers who have a loan and an account at the bank.

{t | ∃ s ∈ borrower(t[customer-name] = s[customer-name])

∧ ∃ u ∈ depositor(t[customer-name] = u[customer-name])}

Resulting relation:

Customer name
Saurabh

Customer name
Mehak

Example 4: Find the names of all customers having a loan at the “ABC” branch.

{t | ∃ s ∈ borrower(t[customer-name] = s[customer-name]

∧ ∃ u ∈ loan(u[branch-name] = “ABC” ∧ u[loan-number] = s[loan-number]))}

Resulting relation:

Customer name
Saurabh