Relational Calculus

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Relational Calculus:

- Relational Calculus is the formal query language. It also known as **Declarative language**.
- In Relational Calculus, The order is not specified in which the operation have to be performed.
- Relational Calculus means what result we have to obtain.

Relational Calculus has two variations:

1. Tuple Relational Calculus (TRC), which was originally proposed by Codd in the year 1972
2. Domain Relational Calculus (DRC), which was proposed by Lacroix and Pirotte in the year 1977

Difference between Relational Algebra and Relational Calculus:

S.NO	Relational Algebra	Relational Calculus
1.	It is a Procedural language.	While Relational Calculus is Declarative language.
2.	Relational Algebra means how to obtain the result.	While Relational Calculus means what result we have to obtain.
3.	In Relational Algebra, The order is specified in which the operations have to be performed.	While in Relational Calculus, The order is not specified.

Tuple Relational Calculus

TRC 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.

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 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.

EXAMPLE

Table-1: Customer (Customer name , Street, City)

Table-2: Branch (Branch name, Branch city)

Table-3: Account (Account number, Branch name, Balance)

Table-4: Loan (Loan number, Branch name, Amount)

Table-5: Borrower (Customer name, Loan number)

Table-6: Depositor (Customer name, Account number)

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

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

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

$\{t \mid \exists\ s \in loan(t[loan\ number] = s[loan\ number] \wedge s[amount] >= 10000)\}$

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

$\{t \mid \exists s \in borrower(t[customer\text{-}name] = s[customer\text{-}name]) \wedge \exists u \in depositor(t[customer\text{-}name] = u[customer\text{-}name])\}$

Query-4: Find the names of all customers having a loan at the "ABC" branch.

$\{t \mid \exists s \in borrower(t[customer\text{-}name] = s[customer\text{-}name] \wedge \exists u \in loan(u[branch\text{-}name] = \text{“ABC”} \wedge u[loan\text{-}number] = s[lo$

Domain Relational Calculus is a non-procedural query language equivalent in power to Tuple Relational Calculus.

Domain Relational Calculus provides only the description of the query but it does not provide the methods to solve it.

In Domain Relational Calculus, a query is expressed as,

$\{ < x_1, x_2, x_3, ..., x_n > | P (x_1, x_2, x_3, ..., x_n) \}$

where, $< x_1, x_2, x_3, \ldots, x_n >$ represents resulting domains variables and

$P (x_1, x_2, x_3, \ldots, x_n)$ represents the condition or formula equivalent to the Predicate calculus.

Table-1: Customer

Customer name	Street	City
Debomit	Kadamtala	Alipurduar
Sayantan	Udaypur	Balurghat
Soumya	Nutanchati	Bankura
Ritu	Juhu	Mumbai

Table-2: Loan

Loan number	Branch name	Amount
L01	Main	200
L03	Main	150
L10	Sub	90
L08	Main	60

Table-3: Borrower

Customer name	Loan number
Ritu	L01
Debomit	L08
Soumya	L03

uery-1: Find the loan number, branch, amount of loans of greater than or equal to 100 amount.

$\{\prec l, b, a\succ \mid \prec l, b, a\succ \in loan \wedge (a \geq 100)\}$

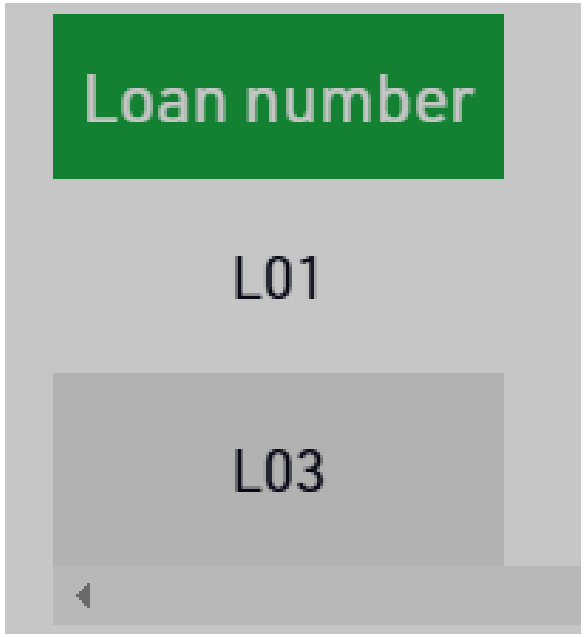
Resulting relation:

Loan number	Branch name	Amount
L01	Main	200
L03	Main	150

Query-2: Find the loan number for each loan of an amount greater or equal to 150.

$\{\prec l \succ \mid \exists\ b, a\ (\prec l, b, a \succ \in loan \wedge (a \geq 150)\}$

Resulting relation:



Query-3: Find the names of all customers having a loan at the “Main” branch and find the loan amount .

$\{\prec c, a\succ \mid \exists\, l\, (\prec c, l\succ \in \text{borrower} \wedge \exists\, b\, (\prec l, b, a\succ \in \text{loan} \wedge (b = \text{“Main”})))\}$

Resulting relation:

Customer Name	Amount
Ritu	200
Debomit	60
Soumya	150

Difference between Tuple Relational Calculus (TRC) and Domain Relational Calculus (DRC) :

Tuple Relational Calculus (TRC)	Domain Relational Calculus (DRC)
In TRS, the variables represent the tuples from specified relation.	In DRS, the variables represent the value drawn from specified domain.
A tuple is a single element of relation. In database term, it is a row.	A domain is equivalent to column data type and any constraints on value of data.
In this filtering variable uses tuple of relation.	In this filtering is done based on the domain of attributes.
Notation : {T | P (T)} or {T | Condition (T)}	Notation : { a1, a2, a3, …, an | P (a1, a2, a3, …, an)}
Example : {T | EMPLOYEE (T) AND T.DEPT_ID = 10}	Example : { | < EMPLOYEE > DEPT_ID = 10 }