Tuple Relational Calculus

Based on first order logic

- Declarative language: (non-procedural)

- Use tuple variables: $t, u, \ldots$
- Use $t[A]$ to denote value of attribute A in tuple 't'.

Query specified as

$\{t \mid P(t)\}$ where P is a predicate and t a tuple variable.

t is called an output tuple.

Consider:

accounts (acct#, bal, br-name)
Customer (cust-name, street, cust-city)
deposit (cust-name, acct#)
branch (br-name, assets, br-city)
loans (loan#, amount, br-name)
borrow (cust-name, loan# ~~acct#~~)

Examples:

1 — $\{ t \mid t \in accounts \wedge t[balance] > 1000 \}$

- all account tuples with balance > 1000

2- Retrieve names of customers having an account with balance > 1000.

Use existential quantifiers.

$\{ t \mid \exists u \in deposit \; \exists v \in accounts$

$(u[acct\#] = v[acct\#] \wedge$

$v[balance] > 1000 \wedge$

$t[cust\text{-}name] = u[cust\text{-}name] \}$

t is the output tuple.

It has only one attribute cust-name

3. Retrieve names of customers and their cities, for those customers having an account with bal > 1000.

$\{ t \mid \exists c \in Customer, \exists u \in deposit, \forall v \in accounts$
$(t[cust\text{-}name] = c[cust\text{-}name] \wedge t[cust\text{-}city] =$
$c[cust\text{-}city] \wedge$
$c[cust\text{-}name] = u[cust\text{-}name] \wedge$
$u[acct\#] = v[acct\#] \wedge$
$v[balance] > 1000 \}$.

t has more than one attribute – cust-name, cust-city

4. Find names of customers having an account or a loan.

$\{ t \mid \exists u \in deposit (t[cust\text{-}name] = u[cust\text{-}name]$
$\vee \exists v \in borrow (t[cust\text{-}name] = v[cust\text{-}name])$
$\vee$ operator)

(we use

5. Find names of customers having an account but not a loan

$$\{ t \mid \exists u \in deposit \; (u[cust\text{-}name] = t[cust\text{-}name]) \wedge \neg (\exists v \in \overset{borrow}{\cancel{deposit}} \; (t[cust\text{-}name] = v[cust\text{-}name])) \}$$

(use '¬' operator)

6. (use $\Rightarrow$)

remember $p \Rightarrow q \equiv \neg p \vee q$

Find names of customers having an account in every branch located in Chicago.

$$\{ t \mid \forall b \in branch \; (b[br\text{-}city] = \text{'Chicago'} \Rightarrow (\exists u \in deposit \; \exists v \in accounts \; (v[br\text{-}name] = b[br\text{-}name] \wedge u[acct\#] = v[acct\#] \wedge u[cust\text{-}name] = t[cust\text{-}name])) \}$$

Formal Defn:

Query - $\{t \mid P(t)\}$

$P(t)$ is a formula built from atoms of the form:

$s \in r$, (s is a tuple variable, r is a relation)

$s[x] \ \theta \ u[y]$ (s, u - tuple variables, x, y - attributes, θ - comparison)

$s[x] \ \theta \ c$ c - Constant.

Complex formula P is

- an atom

or is of the form

$\neg P_1$, $P_1 \vee P_2$, $P_1 \wedge P_2$, $P_1 \Rightarrow P_2$

$\exists s \in r \ (P_1(s))$, $\forall s \in r \ (P_1(s))$

where P_1, P_2 are formulas.