

IF3111 – Kalkulus Relasional Tuple

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Tuple Relational Calculus

- A nonprocedural query language, where each query is of the form
$$\{t \mid P(t)\}$$
- It is the set of all tuples t such that predicate P is true for t
- t is a *tuple variable*, $t[A]$ denotes the value of tuple t on attribute A
- $t \in r$ denotes that tuple t is in relation r
- P is a *formula* similar to that of the predicate calculus

Predicate Calculus Formula

1. Set of attributes and constants
2. Set of comparison operators: (e.g., $<$, \leq , $=$, \neq , $>$, \geq)
3. Set of connectives: and (\wedge), or (\vee), not (\neg)
4. Implication (\Rightarrow): $x \Rightarrow y$, if x is true, then y is true

$$x \Rightarrow y \equiv \neg x \vee y$$

5. Set of quantifiers:

- $\exists t \in r (Q(t)) \equiv$ "there exists" a tuple in t in relation r such that predicate $Q(t)$ is true
- $\forall t \in r (Q(t)) \equiv Q$ is true "for all" tuples t in relation r



Banking Example

- *branch* (*branch-name*, *branch-city*, *assets*)
- *customer* (*customer-name*, *customer-street*, *customer-city*)
- *account* (*account-number*, *branch-name*, *balance*)
- *loan* (*loan-number*, *branch-name*, *amount*)
- *depositor* (*customer-name*, *account-number*)
- *borrower* (*customer-name*, *loan-number*)

Example Queries

- Find the *loan-number*, *branch-name*, and *amount* for loans of over \$1200

■ Find the loan number for each loan of an amount greater than \$1200

Notice that a relation on schema [*loan-number*] is implicitly defined by the query



Example Queries

- Find the names of all customers having a loan, an account, or both at the bank
- Find the names of all customers who have a loan and an account at the bank



Example Queries

- Find the names of all customers having a loan at the Perryridge branch
- Find the names of all customers who have a loan at the Perryridge branch, but no account at any branch of the bank



Example Queries

- Find the names of all customers having a loan from the Perryridge branch, and the cities they live in

Example Queries

- Find the names of all customers who have an account at all branches located in Brooklyn:

Safety of Expressions

- It is possible to write tuple calculus expressions that generate infinite relations.
- For example, $\{t \mid \neg t \in r\}$ results in an infinite relation if the domain of any attribute of relation r is infinite
- To guard against the problem, we restrict the set of allowable expressions to safe expressions.
- An expression $\{t \mid P(t)\}$ in the tuple relational calculus is *safe* if every component of t appears in one of the relations, tuples, or constants that appear in P
 - NOTE: this is more than just a syntax condition.
 - E.g. $\{t \mid t[A]=5 \vee \mathbf{true}\}$ is not safe --- it defines an infinite set with attribute values that do not appear in any relation or tuples or constants in P .

