Module - I

Relational Databases

Lecture-11

RELATIONAL CALCULUS

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- Tuple Relational Calculus
- Domain Relational Calculus

Domain Relational Calculus (DRC)

- DRC is a nonprocedural query language equivalent in power to the tuple relational calculus.
- Each query is an expression of the form:

$$\{< x_1, x_2, \ldots, x_n > \mid P(x_1, x_2, \ldots, x_n)\}$$

where $x_1, x_2, \ldots, x_n$ represent domain variables.

P represents a formula similar to that of the predicate calculus.

Examples of Domain Relational Calculus (DRC) Queries

1. Find the *ID, name, dept_name, salary* for instructors whose salary is greater than $80,000

- Query:

$$\{\langle i, n, d, s\rangle \mid \langle i, n, d, s\rangle \in instructor \wedge s > 80000\}$$

2. As in the previous query, but output only the *ID* attribute value

$$\{\langle i\rangle \mid \langle i, n, d, s\rangle \in instructor \wedge s > 80000\}$$

Examples of Domain Relational Calculus (DRC) Queries

3. Find the names of all instructors whose department is in the Watson building

- Query:

$$\{\langle n \rangle \mid \exists i, d, s(\langle i, n, d, s \rangle \in instructor \wedge \exists b, a (\langle d, b, a \rangle \in department \wedge b = \text{“Watson”}))\}$$

Examples of Domain Relational Calculus (DRC) Queries

4. Find the set of all courses taught in the Fall 2009 semester, or in the Spring 2010 semester, or both

- Query:

$$\{<c> \mid \exists a, s, y, b, r, t(<c, a, s, y, b, r, t> \in section \wedge s = \text{“Fall”} \wedge y = 2009) \vee \exists a, s, y, b, r, t(<c, a, s, y, b, r, t> \in section] \wedge s = \text{“Spring”} \wedge y = 2010)\}$$

This case can also be written as

$$\{<c> \mid \exists\ a, s, y, b, r, t(<c, a, s, y, b, r, t> \in section \wedge((s = \text{“Fall”} \wedge y = 2009) \vee (s = \text{“Spring”} \wedge y = 2010))\}$$

Examples of Domain Relational Calculus (DRC) Queries

5. Find the set of all courses taught in the Fall 2009 semester, and in the Spring 2010 semester

- Query:

$$\{<c> \mid \exists\, a, s, y, b, r, t\ (<c, a, s, y, b, r, t> \in section \wedge s = \text{“Fall”} \wedge y = 2009) \wedge \exists\, a, s, y, b, r, t\ (<c, a, s, y, b, r, t> \in section] \wedge s = \text{“Spring”} \wedge y = 2010)\}$$

Safety of Expressions

The expression:

$\{<x_1, x_2, \ldots, x_n> \mid P(x_1, x_2, \ldots, x_n)\}$

is safe if all of the following hold:

1. All values that appear in tuples of the expression are values from $dom(P)$ (that is, the values appear either in P or in a tuple of a relation mentioned in P).
2. For every "there exists" subformula of the form $\exists x(P_1(x))$, the subformula is true if and only if there is a value of x in $dom(P1)$ such that $P_1(x)$ is true.
3. For every "for all" subformula of the form $\forall_x(P_1(x))$, the subformula is true if and only if $P_1(x)$ is true for all values x from $dom(P1)$.

Universal Quantification

Find all students who have taken all courses offered in the Biology department

- Query:

$$\{< i > \mid \exists\, n, d, tc\ (< i, n, d, tc > \in student\ \wedge$$
$$(\forall\, ci, ti, dn, cr\ (< ci, ti, dn, cr > \in course \wedge dn = \text{“Biology”}$$
$$\Rightarrow\ \exists\, si, se, y, g\ (<i, ci, si, se, y, g> \in takes\ ))\}$$

Note that without the existential quantification on student, the above query would be ***unsafe*** if the Biology department has not offered any courses.