Data and Its Applications (CS4.301)

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Relational Data Model

Closures (contd.)

A set F of FDs is redundant if it includes some $X \to Y$ such that $F^+ = (F - \{X \to Y\})^+$, *i.e.*, such that removing it does not reduce the closure of F. Otherwise, it is nonredundant.

Functional dependencies are said to be in canonical form if they are of the form $X \to Y$, where Y is a single attribute and $\nexists A \mid X - A \to Y$ (X is minimal). A set F of FDs is in canonical form if all $F' \in F$ are of the form $X \to Y$, where Y is a single attribute, $\nexists A \mid X - A \to Y$ (X is minimal) and $(F - F')^+ \neq F^+$.

Decompositions

When a relation R is decomposed into some relations R_i, these relations have some properties:

- all attributes of R occur in some R_i
- (dependency preservation property) each FD associated with R appears in, or is derivable from, the FDs of one or more R_i. Formally,

$$\left(\bigcup_i \pi_{R_i}(F)\right)^+ = F^+.$$

- (lossless join property) for every relation instance r of R,

$$\bowtie_i \pi_{R_i}(r) = r.$$

  We can also say that a decomposition R_1, R_2 has this property if either $R_1 \cap R_2 \to R_1 - R_2$ or $R_1 \cap R_2 \to R_2 - R_1$.

Tuple Relational Calculus

The form of an expression in the tuple relational calculus is that of a set in set-builder form: $\{L \mid R\}$, where L is a set of variables and R is a set of conditions on these variables. For example,

$$\{t \mid \text{Employer}(t) \wedge (t.\text{Salary} > 5000)\}$$

Conditions have various forms: $R(t_i)$ identifies R as the rangle of t_i; $t_i.A$ op $t_j.B$, where op is a comparison operator; or one or more conditions joined by connectives.