CS3DB3/SE4DB3/SE6M03 TUTORIAL

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Outline

- Exercise 1: find all keys
  - Armstrong's Axioms
  - Exercise 1
- Exercise 2: Compute B^+
  - Closure Test
  - Exercise 2
- Exercise 3: Minimal(Canonical) Cover
  - Properties of F_c
  - Compute minimal cover
  - Exercise 3

Armstrong's Axioms

X, Y, Z are set of attributes

- **Reflexivity**: if $X \supseteq Y$, then $X \rightarrow Y$
- **Augmentation**: if $X \rightarrow Y$, then $XZ \rightarrow YZ$ for any Z
- **Transitivity**: if $X \rightarrow Y$ and $Y \rightarrow Z$, then $X \rightarrow Z$
- **Union**: if $X \rightarrow Y$ and $X \rightarrow Z$, then $X \rightarrow YZ$
- **Decomposition**: if $X \rightarrow YZ$, then $X \rightarrow Y$ and $X \rightarrow Z$

Exercise 1: Find all keys

- Relation R(A,B,C,D,E) with FDs:
- {A→BC, CD→E, B→D, E→A}
- Show E and BC are keys

Armstrong's Axioms

1. **Reflexivity**: if X⊇Y, then X→Y
2. **Augmentation**: if X→Y, then XZ→YZ for any Z
3. **Transitivity**: if X→Y and Y→Z, then X→Z
4. **Union**: if X→Y and X→Z, then X→YZ
5. **Decomposition**: if X→YZ, then X→Y and X→Z

Closure Test

- Compute the closure of the attributes B denoted B^+
  - **Base case**: $B^+=B$.
  - **Induction**: Look for an FD's left side X that is a subset of the current B^+. If the FD is $X \rightarrow Y$, add Y to B^+.
  - If Z is in B^+, then $B \rightarrow Z$ holds.

Exercise 2: Compute B^+

- Consider the following set F of functional dependencies on the relation schema r (A,B,C,D,E,F):

$$A \rightarrow BCD$$

$$BC \rightarrow DE$$

$$B \rightarrow D$$

$$D \rightarrow A$$

Q: Compute B^+

Minimal(Canonical) Cover

- A minimal cover F_c must have the following properties:
  - No functional dependency in F_c contains an extraneous attribute.
    - e.g. Given AB→C and B→C, then A is extraneous in AB→C because B→C logically implies AB→C.
  - Each left side of a functional dependency in F_c is unique. That is, there are no two dependencies α1→β1 and α2→β2 in F_c such that α1= α2.
    - e.g. Given A→BC and A→B, then we can replace these two with A→BC.

Compute Minimal Cover

$F_c = F$

Repeat

Use the union rule to replace any dependencies in F_c of the form $\alpha 1 \rightarrow \beta 1$ and $\alpha 1 \rightarrow \beta 2$ with $\alpha 1 \rightarrow \beta 1 \beta 2$.

Find a functional dependency $\alpha \rightarrow \beta$ in F_c with an extraneous attribute either in α or in β.

If an extraneous attribute is found, delete it from $\alpha \rightarrow \beta$.

Until

Fc does not change.

Exercise 3: Compute Minimal Cover

- Consider the following set F of functional dependencies on the relation schema r (A,B,C,D,E,F):

$$A \rightarrow BCD$$
$$BC \rightarrow DE$$
$$B \rightarrow D$$
$$D \rightarrow A$$

Q: Compute a minimal cover for the above set of functional dependencies F; give each step of your derivation with an explanation.