$$\Sigma = \begin{Bmatrix} D \to A \\ F \to B \\ DF \to E \\ B \to C \end{Bmatrix}$$

$U = ABCDEF$

Find a lossless BCNF decomposition

Is it dependency-preserving?

A relation with FDs F is in BCNF if for every $X \to Y$ in F

- $Y \subseteq X$ (the FD is trivial), or
- X is a key

$S = (U, \Sigma)$

$(U_1, \Sigma_1) \quad (U_2, \Sigma_2)$

Given a set of attributes U and a set of FDs F,
a decomposition of (U, F) is a set

$$(U_1, F_1), \ldots, (U_n, F_n)$$

such that $U = \bigcup_{i=1}^{n} U_i$ and F_i is a set of FDs over U_i

BCNF decomposition if each (U_i, F_i) is in BCNF

$$\Sigma = \left\{ \begin{array}{l} D \to A \\ F \to B \\ DF \to E \\ B \to C \end{array} \right\}$$

$U = ABCDEF$

Find a lossless BCNF decomposition

Is it dependency-preserving?

$F \models Y \to Z$ **if and only if** $Z \subseteq C_F(Y)$

The **projection** of F on $V \subseteq U$

$F \models X \to Y$

$$\pi_V(F) = \{X \to Y \mid X, Y \subseteq V,\ \underline{Y \subseteq C_F(X)}\}$$

is the set of all FDs over V that are implied by F

$\pi_V(\Sigma)$

Can be often represented compactly as a set of FDs F' such that

$$\forall X, Y \subseteq V \quad F' \models X \to Y \iff F \models X \to Y$$

$$\pi_{\{\underline{FBC}\}}(\Sigma) = \{B \to C,\ F \to B\}$$

$F \to C$

$FC \to C$ .... by aug

all trivial dept.

e.g. $FB \to B$

Essential axioms

Reflexivity: If $Y \subseteq X$, then $X \to Y$

Augmentation: If $X \to Y$, then $XZ \to YZ$ for any Z

Transitivity: If $X \to Y$ and $Y \to Z$, then $X \to Z$

Other axioms

Union: If $X \to Y$ and $X \to Z$, then $X \to YZ$

Decomposition: If $X \to YZ$, then $X \to Y$ and $X \to Z$

$$\overline{Z} = \begin{cases} D \to A \\ F \to B \\ DF \to E \\ B \to C \end{cases}$$

$U = ABCDEF$

Find a lossless BCNF decomposition

Is it dependency-preserving?

1. $S := \{(U, F)\}$
2. While there is $(U_i, F_i) \in S$ not in BCNF:

   Replace (U_i, F_i) by **decompose**(U_i, F_i)
3. Remove any (U_i, F_i) for which there is (U_j, F_j) with $U_i \subseteq U_j$
4. Return S

remove smaller tables

Subprocedure **decompose**(U, F):

1. Choose $(X \to Y) \in F$ that violates BCNF
2. Set $V := C_F(X)$ and $Z := U - V$
3. Return $(V, \pi_V(F))$ and $(XZ, \pi_{XZ}(F))$

$F \to B$

attr. closure of LHS

FBC

"what is left"

$F\,\boxed{ADE}$

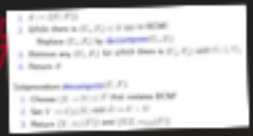
$A\cancel{B}\cancel{C}DE\cancel{F} - FBC = ADE$

$\Sigma = \begin{Bmatrix} D \to A \\ F \to B \\ DF \to E \\ B \to C \end{Bmatrix}$

$U = ABCDEF$

Find a lossless BCNF decomposition

Is it dependency-preserving?



$S = (ABCDEF, \Sigma)$

– not in BCNF

$\Rightarrow$ decompose

$C_{\Sigma}(F) = FBC$

$F \to B$

$X \to Y$

$S_1 = (\underbrace{FBC}_{V}, \underbrace{\{F \to B, B \to C\}}_{\Sigma_1 = \Pi_V(\Sigma)})$

$S_2 = (\underbrace{F}_{X}\underbrace{ADE}_{U-V}, \underbrace{\{D \to A, DF \to E\}}_{\Sigma_2 = \Pi_{X,(U-V)}(\Sigma)})$

$B \to C$

$B \to C$ violates BCNF

$C_{\Sigma_1}(B) = BC$

$S_{11} = (BC, \{B \to C\})$

$S_{12} = (B\underbrace{F}, \{F \to B\})$

$D \to A$

$S_{21} = (DA, \{D \to A\})$

$S_{22} = (DEF, \{DF \to E\})$