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CS 442 B
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Assignment 4: Schema Refinement

1. $R(A, B, C, D, E)$
   $FD = \{AB \rightarrow C, CD \rightarrow E, C \rightarrow A, C \rightarrow D, D \rightarrow B\}$

Determine all the keys of R. Do not list super keys.

L	M	R
	A B C D	E

$A^+ = A$ $AB^+ = ABCDE$

$B^+ = B$ $CD^+ = CDE AB$

$C^+ = CADBE$

$D^+ = DB$

$\boxed{C, CD, AB \text{ are candidate keys}}$

2. $R(A, B, C, D, E, F)$
   $FD = \{AB \rightarrow C, AD \rightarrow B, C \rightarrow B, F \rightarrow AD, F \rightarrow E\}$

   a) use Armstrong's Axioms to prove F is superkey.

   $F \rightarrow A$ $(F \rightarrow AD = F \rightarrow A, F \rightarrow D)$

   $F \rightarrow B$ $(F \rightarrow AD, AD \rightarrow B)$

   $F \rightarrow C$ $(F \rightarrow A, F \rightarrow B, AB \rightarrow C)$

   $F \rightarrow D$ $(F \rightarrow AD = F \rightarrow A, F \rightarrow D)$

   $F \rightarrow E$ $(F \rightarrow E)$

   $\therefore \boxed{F \rightarrow ABCDE}$

   b) Construct BCNF decomp for R. Show work. Argue decomp is lossless. Is it dependency preserving? $* F = $ ~~Both~~ super key
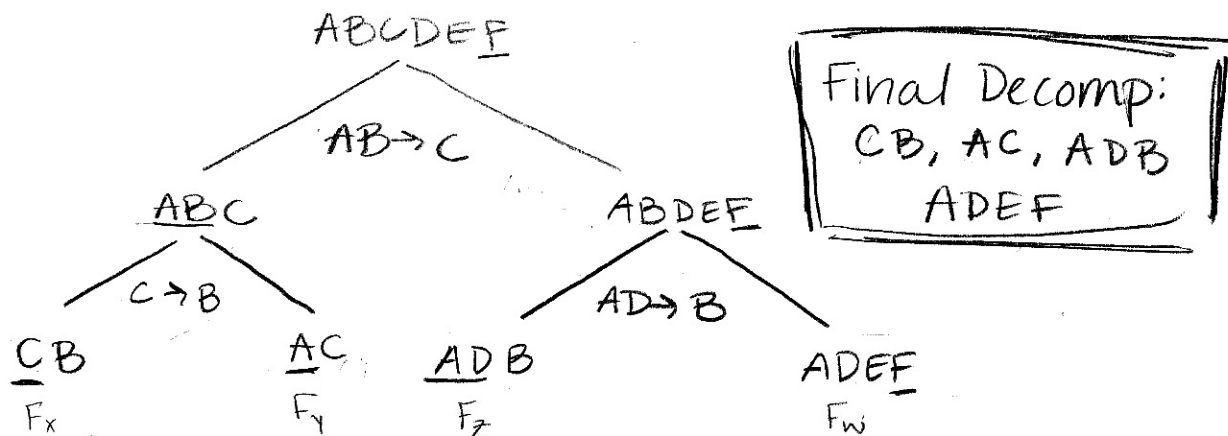
   Step 1: check BCNF violations

   $AB^+ = \{ABC\}$ X

   $AD^+ = \{ADBC\}$ X

   $C^+ = \{CB\}$ X

   $F^+ = \{FADEBC\}$ ✓

   $FD^+ = \{AB \rightarrow C, AD \rightarrow B, C \rightarrow B, F \rightarrow A, F \rightarrow D, F \rightarrow E\}$

ABCDE$\underline{F}$

$AB \rightarrow C$

A$\underline{BC}$ AB$\underline{DE F}$

$C \rightarrow B$ $AD \rightarrow B$

$\underline{CB}$ $\underline{AC}$ $\underline{AD}B$ A$\underline{DEF}$
F_x F_y F_z F_w

(Final Decomp box, top right):

Final Decomp:
CB, AC, ADB
ADEF

is decomp lossless : Yes.
  ABC ∩ ABDEF = AB ∴ AB → (A$\underline{B}$C) or (ABDEF) ✓
  ADB ∩ ADEF = AD ∴ AD → (A$\underline{D}$B) or (ADEF) ✓

is decomp dependency Preserving   NO

$(F_x \cup F_y \cup F_z \cup F_w)^+ = \{C \rightarrow B, AD \rightarrow B, F \rightarrow D, F \rightarrow A, F \rightarrow E\} \neq F^+$

        ¡NOT dependency Preserving

c) Produce lossless, Dependency Preserving 3NF decomp
   for R. Show work.   FD = $\{AB \rightarrow C, AD \rightarrow B, C \rightarrow B, F \rightarrow AD, F \rightarrow E\}$

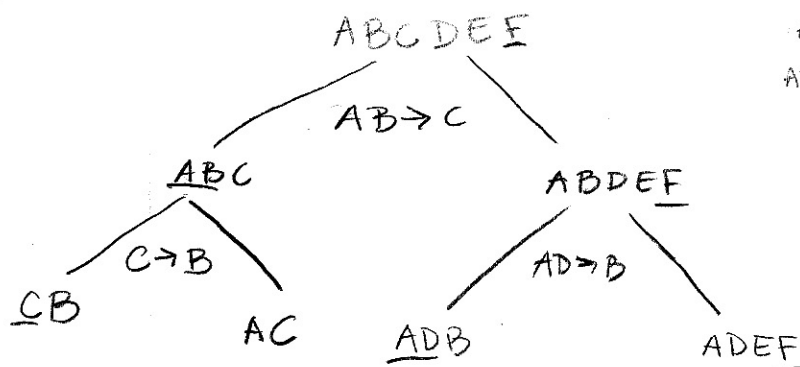Step1: Minimal Cover

   a. Minimize RHS
      FD = $\{AB \rightarrow C, AD \rightarrow B, C \rightarrow B, F \rightarrow A, F \rightarrow D, F \rightarrow E\}$

   b. Minimize LHS
      FD = $\{AB \rightarrow C, AD \rightarrow B, C \rightarrow B, F \rightarrow A, F \rightarrow D, F \rightarrow E\}$

   c. Minimize Redundancies.
      FD = $\{AB \rightarrow C, AD \rightarrow B, C \rightarrow B, F \rightarrow A, F \rightarrow D, F \rightarrow E\}$

      ABCDE$\underline{F}$

              $AB \rightarrow C$

      A$\underline{BC}$ AB$\underline{DEF}$

      $C \rightarrow B$ $AD \rightarrow B$

   $\underline{CB}$ AC $\underline{ADB}$ A$\underline{DEF}$

NOT preserved:
   $AB \rightarrow C$

$AB^+ = \{ABC\}$ ✗
$AD^+ = \{ADBC\}$ ✗
$C^+ = \{CB\}$ ✗
$F^+ = \{ABCDEF\}$ ✓

$\left.\begin{array}{l}AB \rightarrow C \\ AD \rightarrow B \\ C \rightarrow B\end{array}\right\}$ violate BCNF

Final Decomp:
CB, AC, ADB, ADEF, ABC