CS 425 – Database Organization

Fall 2023

Homework 1.6

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Due Date: 11/3/23

Contributions:
Both members completed all questions together, compared/discussed answers, and then took 1 file as a submission.

CS 425 Homework 1.6

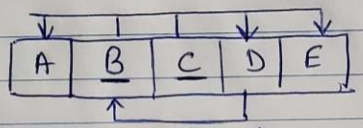
1. $R = (A, B, C, D, E)$

FD's $= \{ BC \rightarrow ADE$
$D \rightarrow B \}$

- use determinent to find all candidate keys:

$BC \rightarrow BCADE$ ✓ Candidate key

$D \rightarrow DB$ ×



nontrivial dependency

- The best normal form for R is 3NF but fails to meet BCNF because:
  - There are no partial dependencies, nor does it contain Transitive dependencies
  - However a nonkey attribute is the determinant of a key attribute.

2. $R = (A, B, C, D, G, H, I)$

FD's = $\{$ $AD \rightarrow C$
$DC \rightarrow B$
$CG \rightarrow I$
$ACG \rightarrow H$
$C \rightarrow BG$

- Use the determinants to find all candidate keys:

$AD \rightarrow ADCBGHI$	✓	candidate key
$DC \rightarrow DCBGI$	x	
$CG \rightarrow CGIB$	x	
$ACG \rightarrow ACGIHB$	x	
$C \rightarrow CBGI$	x	

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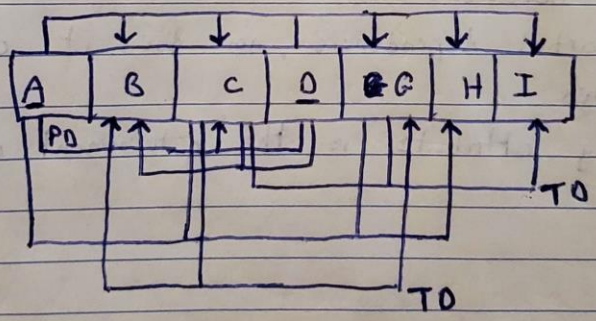

R is in 1NF (First Normal Form) because there are partial and transitive dependencies so it cannot be 2NF, 3NF or BCNF.

- Canonical cover of F.

R(A, B, C, D, G, H, I)

FD's = {
AD → C
DC → B
CG → I
ACG → H
C → BG }

Step 1: Apply decomposition rule on RHS

FD's = {
AD → C
DC → B
CG → I
ACG → H
C → B
C → G }

Step 2: Remove extraneous attribute on LHS:

- For AD → C

To check if A is extraneous, compute $(D)^+$

$(D)^+ = \{D\}$

Since A is not included in $(D)^+$, A is not extraneous.

To check if D is extraneous, compute $(A)^+$

$(A)^+ = \{A\}$

Since D is not included in $(A)^+$, D is not extraneous.

Neither A nor D is extraneous in AD → C

- For $DC \rightarrow B$

To check if D is extraneous, compute $(C)^+$

$$(C)^+ = \{ C B G I \}$$

Since D is not included in $(C)^+$, D is not extraneous.

To check if C is extraneous, compute $(D)^+$

$$(D)^+ = \{ D \}$$

Since C is not included in $(D)^+$, C is not extraneous.

Neither D nor C is extraneous in $DC \rightarrow B$

- For $CG \rightarrow I$

To check if C is extraneous, compute $(G)^+$

$$(G)^+ = \{ G \}$$

Since C is not included in $(G)^+$, C is not extraneous.

To check if G is extraneous, compute $(C)^+$

$$(C)^+ = \{ C B G I \}$$

Since G is included in $(C)^+$, G is extraneous.

G must be removed from $CG \rightarrow I$ to become $C \rightarrow I$

- For $ACG \rightarrow H$

To check if A is extraneous, compute $(CG)^+$

$$(CG)^+ = \{ C G B I \}$$

Since A is not included in $(CG)^+$, A is not extraneous.

To check if C is extraneous, compute $(AG)^+$

$$(AG)^+ = \{ A G \}$$

Since C is not included in $(AG)^+$, C is not extraneous.

To check if G is extraneous, compute $(AC)^+$

$$(AC)^+ = \{ A C B G H I \}$$

Since G is included in $(AC)^+$, G is extraneous

G must be removed from $ACG \rightarrow H$ to become ~~$AC \rightarrow I$~~ $AC \rightarrow H$

New set of FD's = { AD → C
DC → B
C → I
AC → H
C → B
C → G }

Step 3: Eliminate redundant FD's

- Is AD → C redundant?
  Compute $(AD)^+$ excluding FD in question
  $(AD)^+ = \{AD\}$
  Since C is not included in $(AD)^+$, AD → C is not redundant.

- DC → B
  Compute $(DC)^+$ excluding FD in question
  $(DC)^+ = \{DCIBG\}$
  Since B is included in $(DC)^+$, DC → B is redundant

- C → I
  Compute $(C)^+$ excluding FD in question
  $(C)^+ = \{CBG\}$
  Since I is not included in $(C)^+$, C → I is not redundant.

- AC → H
  Compute $(AC)^+$ excluding FD in question
  $(AC)^+ = \{ACIBG\}$
  Since H is not included in $(AC)^+$, AC → H is not redundant.

- $C \rightarrow B$

Compute $(C)^+$ excluding FD in question.

$(C)^+ = \{ C I G \}$

Since B is not included in $(C)^+$, $C \rightarrow B$ is not redundant.

- $C \rightarrow G$

Compute $(C)^+$ excluding FD in question.

$(C)^+ = \{ C I B \}$

Since G is not included in $(C)^+$, $C \rightarrow G$ is not redundant.

Step 4: Return minimal set FDs as canonical cover (F_c)

$$FDs = \{ AD \rightarrow C,\ C \rightarrow I,\ AC \rightarrow H,\ C \rightarrow B,\ C \rightarrow G \}$$

Step 5: Apply union rule to new set (minimal):

$$F_c = \{ AD \rightarrow C,\ C \rightarrow IBG,\ AC \rightarrow H \}$$