Homework (database design) 參考答案

1. Consider a relation schema R with attributes ABCDEF GH with functional dependencies F:

    F = {B → CD, BF → H, C → AG, CEH → F, CH → B}

1) Which of these functional dependencies violate BCNF?

    Ans: {B → CD, BF → H, C → AG, CH → B}

    B^+ = BCDAG, BF^+ = BFHCDAG, C^+ = CAG, CEH^+ = CEHAGFBD, CH^+ = CHAGBD

    只有 CEH 是 R 的 superkey

2) Employ the BCNF decomposition algorithm to obtain a lossless decomposition of R into a collection of relations that are in BCNF. Make sure it is clear which relations are in the final decomposition and project the dependencies onto each relation in that final decomposition.

    根據 B → CD 將 R 拆解成 R1(B, C, D), R2(A, B, E, F, G, H)

    F1 = { B → CD }, F2 = { B →AG, BF → H}

    B → AG 讓 R2 違反 BCNF, 將 R2 拆解成 R3(A, B, G), R4(B, E, F, H)

    F3 = { B → AG }, F4 = {BF → H}

    BF→ H 讓 R4 違反 BCNF, 將 R4 拆解成 R5(B, F, H), R6(B, E, F)

    F5 = { BF → H }, F6 = {}

    最後拆解結果為

    (B, C, D), (A, B, G), (B, F, H), (B, E, F)

3) Is your decomposition dependency-preserving?

    不是

    F = {B → CD, BF → H, C → AG, CEH → F, CH → B}

    F'={B → CD}∪{B→ AG }∪{BF → H }

    $F^+ \neq F'^+$

2. Consider a relation R with attributes ABCDEFGH and functional dependencies S:

$F = \{A \rightarrow CD, ACF \rightarrow G, AD \rightarrow BEF, BCG \rightarrow D, CF \rightarrow AH, CH \rightarrow G, D \rightarrow B,$
$\quad H \rightarrow DEG\}$

1) Compute all keys for R.

$A^+ = ACDBEFHG$ 所以 A 是 candidate key

$CF^+ = CFAHGDEB$ 所以 CF 也是 candidate key

2) Compute a minimal basis (canonical cover) for F. In your final answer, put the FDs into alphabetical order.

- 去掉右邊多餘的 attribute B: $AD \rightarrow BEF \Rightarrow AD \rightarrow EF$
  (因為結合 $D \rightarrow B$ 可推導出 $AD \rightarrow B$)
  F 留下
  $\{A \rightarrow CD, ACF \rightarrow G, AD \rightarrow EF, BCG \rightarrow D, CF \rightarrow AH, CH \rightarrow G, D \rightarrow B, H \rightarrow DEG\}$
- 去掉左邊多餘的 attribute H : $CH \rightarrow G \Rightarrow H \rightarrow G$
  (由 $H \rightarrow DEG$, $H \rightarrow G$ 是可被推導出來的)
  F 留下
  $\{A \rightarrow CD, ACF \rightarrow G, AD \rightarrow EF, BCG \rightarrow D, CF \rightarrow AH, D \rightarrow B, H \rightarrow DEG\}$
- 去掉左邊多餘的 attribute A: $ACF \rightarrow G \Rightarrow CF \rightarrow G,$
  (由 $CF \rightarrow AH$ 及 $H \rightarrow DEG$，$CF \rightarrow G$ 是可被推導出來的)
  F 留下 $\{A \rightarrow CD, AD \rightarrow EF, BCG \rightarrow D, CF \rightarrow AHG, D \rightarrow B, H \rightarrow DEG\}$
- 去掉右邊多餘的 attribute G: $CF \rightarrow AHG \Rightarrow CF \rightarrow AH$
  (因為結合 $H \rightarrow DEG$ 可推導出 $CF \rightarrow G$)
  F 留下 $\{A \rightarrow CD, AD \rightarrow EF, BCG \rightarrow D, CF \rightarrow AHG, D \rightarrow B, H \rightarrow DEG\}$
- 去掉右邊多餘的 attribute E: $AD \rightarrow EF \Rightarrow AD \rightarrow F$
  (因為 $A \rightarrow CD, AD \rightarrow F$ 所以 $AD \rightarrow CDF$；再加上 $CF \rightarrow AH, H \rightarrow DEG$, 可推導出 $AD \rightarrow E$)
  F 留下 $\{A \rightarrow CD, AD \rightarrow F, BCG \rightarrow D, CF \rightarrow AH, D \rightarrow B, H \rightarrow DEG\}$
- 去掉左邊多餘的 attribute D: $AD \rightarrow F \Rightarrow A \rightarrow F$
  (因為 $A \rightarrow CDF$, 所以 $A \rightarrow F$ 是可被推導出來的)
- 去掉右邊多餘的 attribute D: $A \rightarrow CDF \Rightarrow A \rightarrow CF$
  (因為 $A \rightarrow CF, CF \rightarrow AH, H \rightarrow DEG$, 可推導出 $A \rightarrow D$)

$F_C = \{A \rightarrow CF, BCG \rightarrow D, CF \rightarrow AH, D \rightarrow B, H \rightarrow DEG\}$

3) Using the minimal basis from part (b), employ the 3NF synthesis algorithm to obtain a lossless and dependency-preserving decomposition of relation R into a collection of relations that are in 3NF.
   分解成 R1(A, C, F), R2(B, C, D, G), R3(A, C, F, H), R4(B, D), R5(D, E, G, H)
   R4 被 R2 包含 所以去掉, R1 被 R3 包含 所以去掉
   Candidate keys 已被包在其中，所以結果為(B, C, D, G), (A, C, F, H), 及(D, E, G, H)。

4) Does your schema allow redundancy?

$F2 = \{BCG \rightarrow D, D \rightarrow B\}, F3 = \{CF \rightarrow AH, A \rightarrow CF\}, F5 = \{H \rightarrow DEG\}$

其中 $D \rightarrow B$ 但 D 不是 R2 的 superkey, 所以 R2 不滿足 BCNF，會有 redundancy。

此狀況滿足 3NF，且 dependency preservation，但不滿足 BCNF。

3. Questions about functional dependency:

1) Consider relation R(A,B,C,D,E) with functional dependencies:

  AB→C, BC→D, CD→E, DE→A, AE→B

  Which of the following FDs is guaranteed to be satisfied by R?

  a) D→C   b) CE→B   c) AC→D   d) ACD→B

  Ans: d

    $D^+ = D$, $CE^+ = CE$, $AC^+ = AC$, $ACD^+ = ACDEB$

2) Let relation R(A,B,C,D) satisfy the following functional dependencies:

  A→B, B→C, C→A

  Call this set S1. A different set S2 of functional dependencies is equivalent to S1 if exactly the same FDs follow from S1 and S2. Which of the following sets of FDs is equivalent to the set above?

a)   B→A, B→C, C→B

b)   C→B, B→A, A→C

c)   A→B, B→A, B→C

d)   A→BC, C→AB

Ans: b

在兩組 functional dependencies: A^+皆為 ABC, B^+皆為 ABC, C^+皆為 ABC

3) Suppose relation R(A,B,C) currently has only the tuple (0,0,0), and it must always satisfy the functional dependencies A→B and B→C. Which of the following tuples may be inserted into R legally?

  a) (1,0,2)   b) (0,1,2)   c) (2,0,1)   d) (1,2,3)

Ans: d

  a) 違反 B→C,   b) 違反 A→B,   c) 違反 B→C