Database Technology

Assignment – 3

Task 1

Consider the relation schema R(A, B, C, D, E, F) and the following three FDs:

FD1: {A} → {B, C} **FD2:** {C} → {A, D} **FD3:** {D, E} → {F}

Use the Armstrong rules to derive each of the following two FDs. In both cases, describe the derivation process step by step (i.e., which rule did you apply to which FDs).

a) {C} → {B} **b)** {A, E} → {F}

a) {C} → {B}

Solution:

FD4:	C → A	Decomposition FD2
FD5:	C → B, C	Transitivity FD4 & FD1
FD6:	C → B	Decomposition Rule of FD5

b) {A, E} → {F}

Solution:

FD4:	A → C	Decomposition FD1
FD5:	C → D	Decomposition FD2
FD6:	A → D	Transitivity FD4 and FD5
FD7:	A, E → F	Pseudo-Transitivity FD3

Task 2

For the aforementioned relation schema with its functional dependencies, compute the attribute closure X^+ for each of the following two sets of attributes.

a) $X = \{A\}$ **b)** $X = \{C, E\}$

a) **$X = \{A\}$**

Solution:

$X^+ = \{A\}$

$X^+ = \{A, B, C\}$ from FD1

$X^+ = \{A, B, C, D\}$ from FD2

a) **$X = \{C, E\}$**

Solution:

$X^+ = \{C, E\}$

$X^+ = \{C, A, D, E\}$ from FD2

$X^+ = \{C, A, D, E, F\}$ from FD3

$X^+ = \{A, B, C, D, E, F\}$ from FD1

Task 3

Consider the relation schema R(A, B, C, D, E, F) with the following FDs

FD1: {A, B} → {C, D, E, F}

FD2: {E} → {F}

FD3: {D} → {B}

a) Determine the candidate key(s) for R.

b) Note that R is not in BCNF. Which FD(s) violate the BCNF condition?

c) Decompose R into a set of BCNF relations, and describe the process step by step (don't forget to determine the FDs and the candidate key(s) for all of the relation schemas along the way).

a)

Solution:

A is not on the right-hand side, so A must be a part of the candidate key.

$\{A, B\}^+ = \{A, B, C, D, E, F\}$

$\{A, E\}^+ = \{A, E, F\}$

$\{A, D\}^+ = \{A, D, B\}$

$= \{A, D, B, C, E, F\}$

So {A, B} and {A, D} is the candidate key for this relation.

b)

Solution:

Both **FD2** and **FD3** violates BCNF condition. As **E → F** and **D → B** do not contain all the attributes of R.

c)

Solution:

• Decompose R using FD2

- R1(A, B, C, D, E)
- R2(E, F)

• From R2(E, F) with FD2, **E** is a candidate key.

• Decompose R1(A, B, C, D, E) with FD1 ⇒ **FD4: {A, B} → {C, D, E}**, with {A, B} as candidate key.

• FD3 is not in BCNF so considering R1(A, B, C, D, E). Decompose R1 based on FD3 ⇒ R1(a) (A, C, D, E) and R1(b) (B, D).

• From R1(b) (B, D) we have FD3 with {D} being the candidate key.

• Transit FD3 and FD4 we get **FD5: {A, D} → {C, D, E}** with candidate key **{A, D}** for R1(a) (A, C, D, E). And {A, B} is no more candidate key for R1(a) (A, C, D, E).

Task 4

Consider the relation schema R(A, B, C, D, E) with the following FDs

FD1: {A, B, C} → {D, E}

FD2: {B, C, D} → {A, E}

FD3: {C} → {D}

a) Show that R is not in BCNF.

b) Decompose R into a set of BCNF relations (describe the process step by step).

a)

Solution:

$\{A, B, C\}^+$ = {A, B, C, D, E}, where **{A, B, C}** is a superkey.

$\{B, C, D\}^+$ = {A, B, C, D, E}, where **{B, C, D}** is a superkey.

$\{C\}^+$ = {C, D}, where **C** is not a superkey.

So, **FD1** and **FD2** is in BCNF but **FD3** is not in BCNF.

b)

Solution:

- Decompose R based on FD3 ⇒ R1(A, B, C, E) and R2(C, D).
- Decompose R1 based on FD1 and we have FD4: {A, B, C} → {E} for R1(A, B, C, E), where {A, B, C} is a candidate key.
- From R2 we have FD3, where {C} is a candidate key.