Jacob Alspaw

Assignment 4

EECS 341 – Bebek

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**Question 1**

A) Keys: {C,D,M,P,S,T}

Candidate Keys: CM and DM

M only appears in the left side of our FD’s, therefore it must be a part of our

candidate key. However, M+ = {M}, so we need to pair M with C or D. Doing so we

get the entire set of keys {C,D,M,P,S,T}.

B) Use DM as candidate key and put into canonical form

C 🡪 D : Redundant BCNF

C 🡪 S : Not BCNF R1 = {C,S} C🡪S

DM 🡪 P : BCNF R2 = {D,M,P,C} DM🡪PC

DM 🡪 C : BCNF R3 = {D,T} D🡪T

D 🡪 T : not BCNF

This does not preserve all dependencies because C🡪D is lost.

C) Use DM as candidate key and put into canonical form

C 🡪 D 3NF

C 🡪 S R1 = {C,S,D}

DM 🡪 P R2 = {D,M,P,C}

DM 🡪 C R3 = {D,T}

D 🡪 T

**Question 2**

Aa) {ACE}+ = {A,B,C,D,E}

Ab) R1 is NOT in 3NF. The FD A🡪B isn’t trivial. A isn’t a superkey of R1, and B isn’t

part of a candidate key for R1.

Ac) R1 is NOT in BCNF because it isn’t in 3NF.

A BCNF decomposition:

R1a: {A,B} A🡪B

R1b: {C,D} C🡪D

R1c: {A,C,E} Included to ensure lossless join and avoid losing E entirely.

Ba) {AB}+ = {A,B,F}

Bb) R2 is NOT in 3NF. The FD B🡪F isn’t trivial. B isn’t a superkey of R2, and F isn’t

part of a candidate key for R2.

Bc) R2 is NOT in BCNF because it isn’t in 3NF.

A BCNF decomposition:

R2a: {B,F} B🡪F

R2b: {A,B} Included to ensure lossless join and avoid losing A entirely.

Note that AB🡪F isn’t specifically included because it is trivially derived from B🡪F.

Ca) For R3 {A}+ = {A,B}; For R4 {C}+ = {C,D,E,F}; {AC}+ = {A,B,C,D,E,F}

Cb) R3 is in 3NF. For the FD A->B, A is a superkey of R3. R4 is NOT in 3NF. The FD

D🡪EF isn’t a trivial FD, and D isn’t a superkey of R4, and neither E nor F are part of

a superkey in R4.

Cc) R3 is in BCNF since A is a R3 superkey. R4 is NOT in BCNF because it isn’t in 3NF.

A BCNF decomposition:

R3: {A,B} A🡪B

R4a: {C,D} C🡪D

R4b: {D,E,F} D🡪EF

Da) {CDE}+ = {A,B,C,D,E}

Db) R5 is NOT in 3NF. The FD D🡪B is not trivial and D isn’t a superkey of R5, and B isn’t part of a key in R5.

Dc) R5 is NOT in BCNF because it isn’t in 3NF.

A BCNF decomposition:

R5a: {B,D} D🡪B

R5b: {A,C,E} CE🡪A

Ea) {ACD}+ = {A,B,C,D,E}; {BCD}+ = {A,B,C,D,E}; {CDE}+ = {A,B,C,D,E}

Eb) R6 is in 3NF. For every non-trivial FD, there is a candidate key that includes the “Y”

part of X🡪Y. For example, in A🡪E, CDE is a candidate key, for BC🡪A, ACD is

candidate key, and for DE🡪B, BCD is a candidate key).

Ec) R6 is NOT in BCNF. Example, A🡪E isn’t a trivial FD, and A isn’t a superkey of R6.

A BCNF decomposition:

R6a: {A,E} A🡪E

R6b: {A,B,C} BC🡪A

R6c: {B,D,E} DE🡪B

**Question 3**

A) Attribute closure of AB+ = {ABCDEF}

AB 🡪 A

A 🡪 D

D 🡪 C

D 🡪 F

A 🡪 E

AB 🡪 B

# B) Lossless: After doing table of decomposition (Chase Algorithm), relation ABC has

# row filled with distinguished variables, therefore lossless. Also, R1 ∩ R3 🡪 R3.

# Dependency Preserving: Not dependency preserving, for example lost A 🡪 D.

Answer: This relation is lossless, not dependency preserving.

C) Lossless: After doing table of decomposition (Chase Algorithm), relation ABCE has a

row filled with distinguished variables, therefore lossless. Also, R1 ∩ R2 🡪 R2.

Dependency Preserving: All FD’s can be found in the given relations.

Answer: This relation is lossless and dependency preserving.

**Question 4**

A) The given set of FD’s do not provide a minimum cover because there are a number

of redundant variables on the RHS of the FD’s. One minimal cover is:

A🡪B B🡪C AD🡪E BE🡪F D🡪G

B) F+ is the set of all FD’s entailed by F. So AD🡪BCEFG and all of the FD’s implied by

this FD is the collection of FD’s that make up F+. The implied FD’s include AD🡪A,

AD🡪D, AD🡪AD, AD🡪B, AD🡪BC, and so on. This results in over 2400 FD’s.

C) {B}+ = {B (trivial), C (FD 2)}

{G}+ = {G (trivial)}

{AD}+ = {A (trivial), D (trivial), B (FD 1), C (FD 3), E (FD 3), G (FD 3)}