1. Find the closure of attributes of the following relation R and set of functional

dependencies FD

1.1. R( A,B,C,D,E)

FD={CE→D, D→B, C→A}

CE+,CD+?

FIND CE+:

* We start with {C, E}.
* What columns can we determine, given C and E? We have CE -> D, so we can add D to {C, E}+.
* So, we now have C, E and D. What else can we add? We have D -> B AND C->A, so we can add B,A to {C, E}+.
* Thus, {C,E }+ is {C,E,D,B,A}.

FIND CD+

* We start with {C, D}.
* What columns can we determine, given C and D? We have C -> A AND D->B so we can add A AND B to {C, D}+.
* Thus, {C, D}+ is {C,D,B,A}

1.2. R(A,B,C,D,E)

FD={BC→ADE, D→B}

BC+, BCD+?

FIND BC+:

* We start with {B, C}.
* What columns can we determine, given B and C? We have BC -> ADE, so we can add A,D,E to {B,C}+.
* Thus, {C,B }+ is {B,C,A,D,E}.

FIND BCD+:

* We start with {B, C,D}.
* What columns can We determine, given B ,C and D? We have BC -> ADE, so we can add A,D,E to {B,C,D}+.
* Thus, {C,B }+ is {B,C,A,D,E}.

1.3. R(A,B,C,D,E)

FD={BD→E, A→C}

BD+?,BDA+?

FIND BD+:

* We start with {B, D}.
* What columns can we determine, given B and D? We have BD -> E, so we can add E to {B, D}+.
* Now {B, D}+ is {B, D, E}. Can we add anything else? No. We have one more functional dependency in our set that we did not use: A -> C. We can’t use this dependency because A is not in {B,D}+
* Thus, {B,D }+ is {B,D,E}.

FIND BDA+:

* We start with {B, D,A}.
* What columns can we determine, given B ,D and A? We have BD -> E, so we can add E to {B, D,A}+.
* So, we now have B,D,A and E. What else can we add? We have A -> C, so we can add C to { B,D,A}+.
* Thus, {B,D }+ is {B,D,A,E,C}.

1.4.R(A,B,C,D,E,G)

FD={AB→C, AB→D,D→A, BC→D,BC→E}

AB+, BC+?

FIND AB+:

* We start with {A, B}.
* What columns can we determine, given A and B? We have AB -> C AND AB->D so we can add C AND D to {A, B}+.
* So, we now have A, B, C, and D. What else can we add? We have D -> E, so we can add E to {A, B}+.
* Thus, {A, B}+ is {A, B, C, D, E}.

FIND BC+:

* We start with {B,C}.
* What columns can we determine, given B and C? We have BC -> D AND BC->E so we can add D AND E to {B, C}+.
* So, we now have B, C, ,E and D. What else can we add? We have D -> A, so we can add A to {B, C}+.
* Thus, {B,C}+ is {B, C, E, D, A}.

1.5. R = (A, B, C, D, E)

FD={A → B,ED→ A, BC → E}

ABC+,ED+?

FIND ABC+:

* We start with {A, B ,C}.
* What columns can we determine, given A ,B and C? We have BC -> E so we can add E to {A, B,C}+.
* Now {A, B,C}+ is {A, B, C, E}. Can we add anything else? No. We have one more functional dependency in our set that we did not use: ED -> A. We can’t use this dependency because E AND D is not in {A, B,C}+.
* Thus, {A, B,C}+ is {A, B, C, E}.

FIND ED+:

* We start with {E,D}.
* What columns can we determine, given E and D? We have ED -> A so we can add A to {E,D}+.
* So, we now have E,D and A. What else can we add? We have A -> B, so we can add B to {E, D}+.
* Now {E,D}+ is {E, D, A, B}. Can we add anything else? No. We have one more functional dependency in our set that we did not use: BC -> E. We can’t use this dependency because C is not in {E,D}+.
* Thus, {E,D}+ is {E , D ,A , B}.

1.6. R = (A, B, C, D)

FD= {D → B , AB → D ,AB → C , C →A}

AB+, ABD+?

FIND AB+:

* We start with {A, B}.
* What columns can we determine, given A ,B and C? We have AB -> C AND AB->D so we can add C,D to {A, B}+.
* Thus, {A, B}+ is {A, B, C, D}.

FIND ABD+:

* We start with {A, B,D}.
* What columns can we determine, given A ,B and C? We have AB -> C so we can add C to {A, B,D}+.
* Thus, {A, B,}+ is {A, B, C, D}.

2. Find all the candidate keys of the following relation R and set of functional dependencies

FD

2.1. R( A,B,C,D,E)

FD={CE→D, D→B, C→A}

+Find candidate keys:

The attribute in the left hand side of FD:

CED

CE CD ED

Calculating the attribute closure:

CE+={C,E,D,A,B}->KEY

CD+={C,D,A,B}

ED+={E,D,B}

=>candidate keys= {CE}

=> non-key attributes: A,B,D

+set of FD:

Because CE are candidate keys

CE->A CE->B CE->D

CHECK partial alepenolent :

C->A C-X>B C-X>D

E-X>A E-X>B E-X>D

=>we not have FD, IT IS VIOLATE

2.2. R(A,B,C,D,E)

FD={BC→ADE, D→B}

+Find candidate keys:

The attribute in the left hand side of FD:

BCD

BC CD BD

Calculating the attribute closure:

BC+={B,C,D,A,E}->KEY

CD+={C,D,B,A.E}->KEY

BD+={B,D}

=>candidate keys= {BC,CD}

=> non-key attributes: A,E

+set of FD:

Because CE are candidate keys

BC->A BC->E CD->A CD->E

CHECK partial alepenolent :

B-X>A C-X>A D-X>A

B-X>E C-X>E D-X>E

=>NOT FD

2.3. R(A,B,C,D,E)

FD={BD→E, A→C}

SOURCE:A,B,D

MID:E,C

=>CANDIDATE KEY: ECA,ECB,ECD

2.4.R(A,B,C,D,E,G)

FD={AB→C, AB→D,D→A, BC→D,BC→E}

SOURCE:B

MID:ACDE

->CANDIDATE KEY: ACDEB

2.5. R = (A, B, C, D, E)

FD={A → B,ED→ A, BC → E}

Source:C,D

MID:A,B,E

Candidate KEY=ABEC+,ABED+

2.6. R = (A, B, C, D)

FD= {D → B, AB → D ,AB → C , C →A}

Source RỖNG

MID=A,B,C,D

->CANDIDATE KEY ABCD

3. Find the highest normal form of the following relation and set of FD

3.1 Find the highest normal form of a relation R(P, Q, R, S, T) with Functional dependency set as

FD={QR →S, PR →QT, Q →T}

+find key :

QPR

QR PR QP

QPR +=Q P R S T PR+=P R Q T S ->KEY

QR+=Q R S T QP+=Q P T

=>Candidate key :{PR}

+Check highest NF:

1NF->OK

2NF:

Non-key :Q S T

Because PR are keys

PR->Q PR->S PR->T

+Check partial dependent

P-X>Q P-X>S P-X>T

R-X>Q R-X>S R-X>T

->2NF

3.2 Find the highest normal form of a relation R (P, Q, R, S, T) with Functional Dependency set

FD={Q →P, P →R, QR →S, PR →QT}

+find key :

QPR

QR PR QP

QPR +=Q P R S T PR+=P R Q T S

QR+=Q R S P T QP+=Q P R S T

* KEY= Q,P

WHEN ky contain only one attribute =>2nf

+check 3NF:

Non-key :R,S,T

Q-> ? ->R Q->?->S Q->?->T P->?->R P->?->S P->?->T

\*the relation is in 3NF because the LHS of all FD’s is super keys

LHS

Q,P are keys

QR+=QRSPT |=> SUPER KEYS

PR+= PRQTS |

=>3NF

3.3. Find the highest normal form of a relation R (P, Q, R, S, T) with Functional Dependency set

FD={P →S, Q →P, QR →S, PR →QT}

+find key :

QPR

QR PR QP

QPR +=Q P R S T PR+=P R Q T S ->KEY

QR+=Q R S P T ->KEY QP+=Q P S

=>Candidate key :{PR,QR}

+Check highest NF:

1NF->OK

2NF:

Non-key :T,S

Because PR,QR are keys

PR->T PR->S QR->T QR->S

+Check partial dependent

P->S R-X>S Q-X>S

P-X>T R-X>T Q-X>T

->NOT 2NF

3.4. Find the highest normal form of a relation R (A, B, C, D, E) with Functional Dependency set

FD={BC →D,AC →BE, B →E}

+find key :

ABC

AB BC AC

ABC +=A B C D E AB+=A B E

BC += B C D E AC+=A C B E D ->KEY

=>Candidate key :{AC}

+Check highest NF:

1NF->OK

2NF:

Non-key :B,D,E

Because AC are keys

AC->B AC->D AC->E

+Check partial dependent

A-X>B A-X>D A-X>E

C-X>B C-X>D C-X>E

->2NF

3.5. Find the highest normal form of a relation R (A, B, C, D, E) with Functional Dependency set

FD={AB →CE,E →AB, C →D}

3.6. Find the highest normal form of a relation R (A, B, C, D) with Functional Dependency set

FD={D →B,C →A,B →ACD}

+find key :

BCD

BC BD CD

BCD +=B C D A ->key BD+=B D A C ->key

BC += B C A D ->key CD+=C D B A ->key

* KEY= B,D

WHEN key contain only one attribute =>2nf

+check 3NF:

Non-key :A,C

B-X>A D-X>A

B-X>C D-X>C

\*the relation is in 3NF because the LHS of all FD’s is super keys

LHS

B,D are keys

BC+=BCAD |=> SUPER KEYS

DC+=DCBA |

=>3NF