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Assignment 5

**Problem 1.a**

{A}+ = trivial {B}+ = BCD {C}+ = trivial {D}+ = trivial

{E}+ = trivial {AB}+ = ABCDE {AC}+ = trivial {AD}+ = trivial

{AE}+ = trivial {BC}+ = BCD {BD}+ = BCD {BE}+ = ABCDE

{CD}+ = trivial {CE}+ = ACE {DE}+ = trivial {ABC}+ = ABCDE

{ABD}+ = ABCDE {ABE}+ = ABCDE {ACD}+ = trivial {ACE}+ = trivial

{ADE}+ = trivial {BCD}+ = trivial {BCE}+ = ABCDE {BDE}+ = ABCDE

{CDE}+ = ACDE {ABCD}+ = ABCDE {ABCE}+ =ABCDE {ABDE}+ = ABCDE

{ACDE}+ = ACDE {BCDE}+ = ABCDE

Candidate Keys: AB, BE

**Problem 1.b**

AB🡪E: AB is a super key so does NOT violate

B🡪C: B is not a super key and C is not in the candidate keys so VIOLATES

B🡪D: B is not a super key and D is not in any candidate keys so VIOLATES

CE🡪A: CE is not a super key but A is part of a candidate key so does NOT violate

Violators: B🡪C and B🡪D

**Problem 1.c**

Try to remove AB🡪E. {AB}+ = ABCD not E so cannot remove

Try to remove B🡪C. {B}+ = BD not C so cannot remove

Try to remove B🡪D. {B}+ = BC not D so cannot remove

Try to remove CE🡪A. {CE}+ = trivial not A so cannot remove

Try to remove attributes from AB🡪E

Try to remove A so B🡪E. {A}+ = trivial not E so cannot remove

Try to remove B so A🡪E. {B}+ = BCD not E so cannot remove

Try to remove attributes from CE🡪A

Try to remove C so E🡪A. {C}+ = trivial not A so cannot remove

Try to remove E so C🡪A. {E}+ = trivial not A so cannot remove

Note: I see that the above is unnecessary because we know it is a minimal basis, but I still wanted to practice.

Combine B🡪C and B🡪D into B🡪CD.

R1(A,B,E) R2(B,C,D) R3(A,C,E)

Since R1 contains the candidate key, do not need to add another relation.

R1(A,B,E) R2(B,C,D) R3(A,C,E)

**Problem 1.d**

B🡪C, B🡪D, and CE🡪A all violate BCNF because they do not have super keys on the left

**Problem 1.e**

Use B🡪C for violation

{B}+ = BCD

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

Closures for R1

{B}+ = BCD {C}+ = trivial {D}+ = trivial {BC}+ = BCD

{BD}+ = BCD {CD}+ = trivial

Candidate key: B

Functional Dependencies for R1

B🡪C

B🡪D

Simplify to B🡪CD which is NOT in violation because it B is the super key

Closures for R2

{A}+ = trivial {B}+ = trivial {E}+ = trivial {AB}+ = ABE

{AE}+ = trivial {BE}+ = trivial

Candidate key: AB

Functional Dependencies for R2

AB🡪E

NOT in violation because AB is super key

Therefore, the final relations are

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

**Problem 2.a**

{A}+ = trivial {B}+ = ABE {C}+ = trivial {D}+ = BD

{E}+ = trivial {AB}+ = ABE {AC}+ = trivial {AD}+ = ABDE

{AE}+ = trivial {BC}+ = ABCDE {BD}+ = ABDE {BE}+ = ABE

{CD}+ = ABCDE {CE}+ = ABCDE {DE}+ = ABDE {ABC}+ = ABCDE

{ABD}+ = ABDE {ABE}+ = trivial {ACD}+ = ABCDE {ACE}+ = ABCDE

{ADE}+ = ABDE {BCD}+ = ABCDE {BCE}+ = ABCDE {BDE}+ = ABDE

{CDE}+ = ABCDE {ABCD}+ = ABCDE {ABCE}+ =ABCDE {ABDE}+ = trivial

{ACDE}+ = ABCDE {BCDE}+ = ABCDE

Candidate Keys: BC, CD, CE

**Problem 2.b**

B🡪A: B is a not super key so VIOLATES

B🡪E: B is not a super key so VIOLATES

CE🡪D: CE is a super key so does NOT violate

D🡪B: D is not a super key so VIOLATES

Violators: B🡪A, B🡪E, and D🡪B

**Problem 2.c**

B🡪A is in violation

{B}+ = ABE

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

Closures for R1

{A}+ = trivial {B}+ = ABE {E}+ = trivial {AB}+ = ABE

{AE}+ = trivial {BE}+ = ABE

Candidate key: B

Functional Dependencies for R1

B🡪A

B🡪E

Simplify to B🡪AE which is NOT in violation because B is super key

Closures for R2

{B}+ = trivial {C}+ = trivial {D}+ = BD {BC}+ = trivial

{BD}+ = trivial {CD}+ = BCD

Candidate key: CD

Functional Dependencies for R2

D🡪B

VIOLATES because D is not super key

{D}+ = BD

R3(B,D) R4(C,D)

Therefore, the final relations are

R1(A,B,E) R3(B,D) R4(C,D)

**Problem 2.d**

B🡪A: B is not a super key and A is not in the candidate keys so VIOLATES

B🡪E: B is not a super key but E is part of a candidate key so does NOT violate

CE🡪D: CE is a super key so does NOT violate

D🡪B: D is not a super key but B is part of a candidate key so does NOT violate

Violator: B🡪A

Try to remove B🡪A. {B}+ = BE not A so cannot remove

Try to remove B🡪E. {B}+ = BA not E so cannot remove

Try to remove CE🡪D. {CE}+ = trivial not D so cannot remove

Try to remove D🡪B. {D}+ = trivial not B so cannot remove

Try to remove attributes from CE🡪D

Try to remove C so E🡪D. {C}+ = trivial not D so cannot remove

Try to remove E so C🡪D. {E}+ = trivial not D so cannot remove

Combine B🡪A and B🡪E into B🡪AE

Minimal Basis: G={B🡪AE, CE🡪D, D🡪B}

R1(A,B,E) R2(C,D,E) R3(B,D)

Since R2 contains candidate key CD so do not need to add a relation.

R1(A,B,E) R2(C,D,E) R3(B,D)

**Problem 3.1.a**

This would be lossless because the foreign key connecting these two tables is Artwork, which is a candidate key of R.

**Problem 3.1.b**

This would be lossy because on natural join Britto would have artwork Garden of Eden AND Radiant Baby because they are both in the Miami Beach gallery. Britto with Radiant Baby was not in the original table, but it is in the natural join of R1 and R2, so the decomposition is lossy.

**Problem 3.2**

Functional Dependencies of R

Artist 🡪 Address

Gallery 🡪 Address

Artwork 🡪 Artist

Artwork 🡪 Gallery

Artwork 🡪 Address

Artist, Gallery 🡪 Artwork

Artist, Gallery, Address 🡪 Artwork

**Problem 3.2.a**

Functional Dependencies of R1

Gallery 🡪 Address

Artist 🡪 Address

Functional Dependencies of R2

Artwork 🡪 Artist

Since the functional dependencies in R1 and R2 combined are not the same as those of R, the functional dependencies are not preserved.

**Problem 3.2.b**

Functional Dependencies of R1

None

Functional Dependencies of R2

Artist 🡪 Address

Artwork 🡪Artist

Artwork 🡪 Address

Since the functional dependencies in R1 and R2 combined are not the same as those of R, the functional dependencies are not preserved.