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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}

FD4: {C} -> {A} (Decomposition FD2)
FD5: {A} -> {B} (Decomposition FD1)
FD6: {C} -> {B} (Transitivity FD4 & FD5) **Q.E.D.**

b) {A,E} → {F}

FD4: {A} -> {C} (Decomposition FD1)
FD5: {C} -> {D} (Decomposition FD2)
FD6: {A} -> {D} (Transitivity FD4 & FD5)
FD7: {A,E} -> {F} (Pseudo-transitivity FD6 & FD3) **Q.E.D.**

Task 2
For the aforementioned relation schema with its functional dependencies,

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

compute the attribute closure X+ for each of the following two sets of attributes.

a) X = { A }

The attribute closure of X = {A} with FD1-FD3 is {A,B,C,D}

b) X = { C, E }

The attribute closure of X = {C, E} with FD1-FD3 is {A,B,C,D,E,F}

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.

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Our keys are {A,B} and {A,D} because AB+ and AD+ reaches the whole relation in a minimal way

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

FD2 and FD3 violates BCNF due to candidate key not being on the left side

FDs
FD1: {A,B} → {C,D,E,F}
FD2: {E} → {F}
FD3: {D} → {B}
NEW - FD4: {A,B} -> {C,D,E} (Decomposition of FD1)
NEW - FD5: {A, D} -> {C,E} (Decomposition on FD1 gives: {A,B} -> {C,E} and Transitivity with FD3 on this gives new FD)

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)

Step 1: Our candidate keys are AD and AB.

Step 2: FD2 and FD3 are non-BCNF (see b)).

FD2 is non BCNF, we will decompose this first

Step 3: E+ = {EF}

We will decompose this into two relations:

R1 = {ABCDE} FD4 and FD3 belong to this relation -> FD3 is non-BCNF -> decompose R1 again
CK = AB and AD (??)

R2 = {EF} FD2 belongs to this relation. FD2 is BCNF so this is fine!
CK = E

Step 4: D+ = {DB}

We will decompose this into two relations:
R1.1 = {ACDE} FD5 belong to this relation. FD5 is BCNF so this is fine!
CK=AD

R1.2 = {DB} FD3 belongs to this. FD3 is BCNF so this is fine
CK=D

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Answer: R1 ={ACDE} with FD5, R2 = {EF} with FD2, R3={DB} with FD3
Output: [{EF}, {ACDE}, {DB}]

Task 4
FD1: {A,B,C} → {D,E}
FD2: {B,C,D} → {A,E}
FD3: {C} → {D}
NEW - **FD4**: {A,B,C} -> {E} (Decomposition of FD1)
NEW - FD5: {BC} -> {A,E} (Transitivity FD3 on FD2 gives: {B, C} -> {A,E})

a)
Find candidate key.
- E isn't on the left side -> doesn't exist in the candidate key.
- B and C is only on the left side -> must exist in candidate key
- BC+ reaches the whole relation

Candidate key: BC

Check which relations is non-BCNF to show that R is not in BCNF

Answer: FD3 is non-BCNF -> R is not BCNF

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

Step 1: Candidate keys are BC

Step 2: FD3 is non-BCNF. We will decompose this

Step 3: D+ = CD

Decompose into two relations:
R1 = {ABCE} FD5 belongs to this. CK=BC. Is BCNF so this is fine.

R2 = {CD} FD3 belongs to this. Is BCNF so this is fine
CK=C

Answer: Output = [{ABCE} with FD5, {CD} with FD3]