Assignment 3

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Task 1

Relation schema, R(A, B, C, D, E, F) and FDs:
FD1: $\{A\} \rightarrow \{B, C\}$ FD2: $\{C\} \rightarrow \{A, D\}$ FD3: $\{D, E\} \rightarrow \{F\}$

a)

Derive $\{C\} \rightarrow \{B\}$**:**
Decomposition on FD2, $\{C\} \rightarrow \{A\}$
Decomposition on FD1, $\{A\} \rightarrow \{B\}$
Transitivity on $\{C\} \rightarrow \{A\}$ and $\{A\} \rightarrow \{B\}$ to get $\{C\} \rightarrow \{B\}$

b)

Derive $\{A, E\} \rightarrow \{F\}$**:**
Decomposition on FD1, $\{A\} \rightarrow \{C\}$
Decomposition on FD2, $\{C\} \rightarrow \{D\}$
Transitivity on $\{A\} \rightarrow \{C\}$ and $\{C\} \rightarrow \{D\}$ to get $\{A\} \rightarrow \{D\}$
We lastly use $\{A\} \rightarrow \{D\}$ for pseudo-transitivity on FD3 to get $\{A, E\} \rightarrow \{F\}$

Task 2

Compute the attribute closure X^+**:**

a)

$X = \{A\}$:
We can see from FD1 that A determines B and C. We can also see from FD2 that C determines A and D, therefore we know that the closure of X is the following set below since they are logically implied by X.
$\{A, B, C, D\}$

b)

$X = \{C, E\}$:
From FD2 we can see that C determines A and D, we can with FD1 see with transitivity that C also determines B since A determines B. Further, we can see from decomposition on FD3 that E determines F so the closure of X is therefore the following set below since they are logically implied by X.
$\{A, B, C, D, E, F\}$

Task 3

Relation schema, R(A, B, C, D, E, F) and FDs:
FD1: $\{A, B\} \rightarrow \{C, D, E, F\}$ FD2: $\{E\} \rightarrow \{F\}$ FD3: $\{D\} \rightarrow \{B\}$

a)

Determine the candidate key(s) for R:
From FD1 we can see that $\{A, B\}$ determines all other attributes in R so with A and B included, it is a superkey since it determines all attributes in the schema. If the case were that A or B is removed from the key, all attributes are no longer determined and the key is no longer a superkey. Therefore since $\{A, B\}$ is the smallest subset of the superkey it is a candidate key for R. With the same reasoning as above, $\{A, D\}$ is also a candidate key since from FD3 we can see that D determines B so $\{A, D\}$ determines all attributes in the schema as $\{A, B\}$ does, and it is the smallest subset of that superkey.

b)

Note that R is not in BCNF. Which FD(s) violate the BCNF condition?
FD1 is a superkey for the schema but FD2 and FD3 are not. FD2 and FD3 therefore violate the BCNF condition which states that a relation is in BCNF if, for every functional dependency $X \rightarrow Y$ it has, X is a superkey.

c)

Decompose R into a set of BCNF relations:
Decompose based on $\{E\} \rightarrow \{F\}$, creates the relation schema $R_1\{E, F\}$ with candidate key E.
Decompose based on $\{D\} \rightarrow \{B\}$, creates the relation schema, $R_2\{D, B\}$ with the candidate key D.
And $R_3\{A, C, D, E\}$ with FD4($\{A, D\} \rightarrow \{C, D, E\}$)
R_1, R_2 and R_3 are all in BCNF so R is decomposed into R_1, R_2 and R_3.

Task 4

Relation schema, R(A, B, C, D, E) and FDs:
FD1: $\{A, B, C\} \rightarrow \{D, E\}$ FD2: $\{B, C, D\} \rightarrow \{A, E\}$ FD3: $\{C\} \rightarrow \{D\}$

a)

Show that R is not in BCNF:
$\{A, B, C\}$ and $\{B, C, D\}$ are superkeys, but $\{C\}$ is not. $\{C\}$ is not a superkey since it only determines $\{C, D\}$ and not all the attributes in the relation, while $\{A, B, C\}$ and $\{B, C, D\}$ determine all the attributes in the relation. Therefore the relation schema R is not in BCNF.

b)

Decompose R into a set of BCNF relations:
Decompose based on $\{C\} \rightarrow \{D\}$, creates the relation schema $R_2\{C, D\}$ with FD3. $R_1\{A, B, C, E\}$ with FD3($\{A, B\} \rightarrow \{C, E\}$) and FD4($\{B, C\} \rightarrow \{A, E\}$). R_2 is in BCNF and R_1 is in BCNF. R is therefore decomposed into $R_1\{A, B, C, E\}$, $R_2\{C, D\}$