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Assignment 3: Functional Dependencies and Normalization

1. a)

   FD4: {C} -> {A} by decomposition of FD2.
   FD5: {C} -> {BC} by transitivity with FD1 and FD4.
   FD6: {C} -> {B} by decomposition of FD5.

   b)

   FD7: {A,E} -> {B,C,E} by augmentation of FD1.
   FD8: {A,E} -> {C,E} by decomposition of FD7.
   FD9: {C.E} -> {A,D,E} by augmentation of FD2.
   FD10: {A,E} -> {A,D,E} by transitivity of FD8 and FD9.
   FD11: {A,E} -> {D,E} by decomposition of FD10.
   FD12: {A,E} -> {F} by transitivity of FD3 and FD11.

2. a)
   - Initially X+ = {A}
   - By using FD1: X+ = {A,B,C}
   - By using FD2: X+ = {A,B,C,D}

   b)
   - Initially X+ = {C,E}
   - By using FD2: X+ = {C,E,A,D}
   - By using FD1: X+ = {C,E,A,D,B}
   - By using FD3: X+ = {C,E,A,D,B,F}

3. a)
   - {A}+ = {A} no a CK
   - {A,B}+ = {A,B,C,D,E,F} , {A,B} is a CK
   - {A,C}+ = {A,C}
   - {A,D}+ = {A,D,B,C,E,F}, {A,D} is a CK
   - {A,E}+ = {A,E,F} , is not a CK
   - {A,F}+ = {A, F}, is not a CK

   - **Candidate keys are {A,B} and {A,D}**

   b)
   - FD2 since {E} is not a super key
   - FD3 since {D} is not a super key

   c)
   Since FD2 violates BCNF for R, we decompose R into R1 and R2 where:
   R1(E, F) with FD2, CK: {E}
   R2(A,B,C,D,E) with FD4: {A,B} -> {C,D,E} (decomposition of FD1)

Candidate keys are the same as in a). {A,B} and {A,D}

Since FD3 violates BCNF for R2 we use it to decompose R2 into:
R2X(D,B) with FD3, CK: {D}
R2Y(A,C,D,E) with FD5: {A,B} -> {C,E} (decomposition of FD1)
Candidate key is {A,D}. {A,B} is not a candidate key any more since FD1 is not preserved, but FD1 can be derived from FD3 and FD5.

Finally, the result of decomposing R consists of R1, R2X and R2Y.

4. a)
    - FD1 and FD2 are in BCNF since:
        - {A,B,C}+ = {A,B,C,D,E} i.e superkey
        - {B,C,D}+ = {B,C,D,A,E} i.e superkey

    - FD3 are note in BCNF since:
        - {C}+ = {C,D} i.e not a superkey

    b)
    Since FD3 violates BCNF for R we use it to decompose R into:
    R1(C,D) with FD3, CK: {C}
    R2(A,B,C,E) with FD4; {ABC} -> {E} by decomposition of FD1. CK: {ABC}