TDDD12 - Lab 3 report

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1 Task 1

Considering the relation *R(A,B,C,D,F)* and the 3 following *FDs*:

- FD1: $\{A\} \rightarrow \{B,C\}$
- FD2: $\{C\} \rightarrow \{A,D\}$
- FD3: $\{D,E\} \rightarrow \{F\}$

1.1 $\{C\} \rightarrow \{B\}$

Looking for *FD'*: $\{C\} \rightarrow \{B\}$

- FD4: $\{C\} \rightarrow \{A\}$ // descomposition of FD2
- FD5: $\{A\} \rightarrow \{B\}$ // descomposition of FD1
- Applying transitivity with FD4 and FD5, then we get that FD6: $\{C\} \rightarrow \{B\}$, which is the FD' that we are trying to look for.

1.2 $\{A,E\} \rightarrow \{F\}$

Looking for *FD'*: $\{A,E\} \rightarrow \{F\}$

- FD4: $\{A\} \rightarrow \{C\}$ // descomposition of FD1
- FD5: $\{C\} \rightarrow \{D\}$ // descomposition of FD2
- FD6: $\{A\} \rightarrow \{D\}$ // transitive rule with FD4 & FD5
- Having FD6 & FD3, applying the "pseudo-transitive" rule, we obtain FD7: $\{E,A\} \rightarrow \{F\}$, which is the same as the FD' that we are looking for.

2 Task 2

Considering the relation *R(A,B,C,D,F)* and the 3 following *FDs*:

- FD1: $\{A\} \rightarrow \{B,C\}$
- FD2: $\{C\} \rightarrow \{A,D\}$
- FD3: $\{D,E\} \rightarrow \{F\}$

```
function ComputeAttrClosure( X, F )
    begin
        X+ := X;
        while F contains an FD Y → Z such that
            (i) Y is a subset of X+, and
            (ii) Z is not a subset of X+ do X+ := X+ U Z;
        end while
    return X+;
end
```

2.1 X = {A}

1. X+ = {A}
2. According to FD1, A (subset of X+) determines B and C (and both are not subset of X+), thus X+ = {A,B,C}
3. According to FD2, C (subset of X+) determines A and D (and D is not subset of X+), thus X+ = {A,B,C,D}
4. According to FD3, D and E determines F, where E is not a subset of X+ while D is, so we finish the applying the algorithm, as there is no more FDs to be taken into consideration.

The attributes of closure {A} are {A,B,C,D}.

2.2 X = {C, E}

1. X+ = {C, E}
2. According to FD1, A (not a subset of X+) determines B (is not subset of X+) and C (is subset of X+), thus X+ = {C, E}
3. According to FD2, C (is subset of X+) determines A and D (both are not subset of X+), thus X+={C,E,A,D}
4. According to FD3, D and E (both are subset of X+) determines F (not subset of X+), thus X+={C,A,E,D,F}
5. Returning to the FDs not accepted at the beginning, in this case, only FD1, A (now is subset of X+) determines B (not subset of X+) and C (is subset of X+), thus X+={C,A,E,D,F,B}
6. We finish the algorithm since there is no more FDs to be taken into consideration.

The attributes of closure of {C,E} are {C,A,E,D,F,B}.

3 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}

3.1 Candidate keys

1. Doing the attribute closure of AB (AB+), being {A,B,C,D,E,F}, determining all the attributes, then, **AB** is a candidate key.
2. Since A is the only attribute that appears to the left, then:
   - E+ = E,F
   - E union A -> EA+ = A,E,F
   - D+ = D,B
   - D union A -> DA+ (proceeding to compute algorithm)
     - X+ = D,A
     - According to FD3, D (subset of X+) determines b (not subset of X+), thus X+ = D,A,B
     - According to FD1, A and B (both are subset of X+) determines C (not subset), E (not subset), F (not subset), D (is subset), thus X+ = D,A,B,C,E,F
     - According to FD2, E (is subset) determines F (subset), so X+ remains as it is.
     - So, attribute closure of {D,A} is {D,A,B,C,E,F}

Thus, we get that the candidate keys are {**A,B**} and {**A,D**}

3.2 BCNF violation

Relation schema R with a set F of functional dependencies is in BCNF if for every non-trivial FD X→Y in F+ we have that X is a superkey.

Having the candidates keys ({**A,B**} and {**A,D**}), then:

- FD1 : A,B is superkey, so no violation is done
- FD2 : E is not superkey, violation is done
- FD3 : D is not superkey, violation is done

3.3 Decomposition of R into a set of BCNF relations

```
function DecomposeBCNF( R, F )
    begin
        Result := R;
            while there is a relation schema Ri in Result for which
                  the restriction of F+ to Ri contains a non-trivial
                  FD X → Y that violates the BCNF condition
            do
                Decompose Ri into Ri1 and Ri2 as on the previous slide;
                Replace Ri in Result by Ri1 and Ri2;
            end while
        return Result;
    end
```

Since FD2 violates BNCF:

- R1(E,F) with FD2 and E being the candidate key ⇒ FD2 does not violate BNCF.
- R2(A,B,C,D,E) with FD1 & FD2 and {A,B} & {A,D} being candidate keys ⇒ FD3 violates BNCF whilst FD1 does not.
  - R1X(D,B) with FD3 and D is candidate key ⇒ FD3 does not violate BNCF.
  - R2X(A,C,D,E) with FD1 and {A,D} is candidate key ⇒ FD1 does not violate BNCF.

Thus, R = {R1, R1X, R2X}.

4 Task 4

Consider the relation schema R(A, B, C, D, E) with the following FDs

- FD1: A,B,C → D,E
- FD2: B,C,D → A,E
- FD3: C → D

4.1 BCNF violation

- $\{A,B,C\}^+ = \{A,B,C,D,E\}$ ⇒ {A,B,C} is candidate key ⇒ FD1 does not violate BNCF.
- $\{B,C,D\}^+ = \{A,B,C,D,E\}$ ⇒ {A,B,C} is candidate key ⇒ FD2 does not violate BNCF.
- $\{C\}^+ = \{C,D\}$ ⇒ {C} is not candidate key ⇒ FD3 does violate BNCF.

4.2 Decomposition of R into a set of BCNF relations

Since FD3 violates BNCF:

- R1(C,D) with FD3, candidate key {C} $\Rightarrow$ FD3 does not violate BNCF.
- R2(A,B,C,E) with FD1 & FD2, candidate key {B,C} $\Rightarrow$
  - FD1 does not violate BNCF.
  - FD2 does not violate BNCF.