**Lab3: Normalization**

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**Question 1:** **Consider the relational schema R (A, B, C, D, E, F) and the set of functional dependencies F = {FD1: A 🡪 BC; FD2: C 🡪 AD; FD3: DE 🡪 F}. Use the Armstrong rules to derive the functional dependencies.**

**(a) Derive FD: C 🡪 B**

**Solution:**

FD4: C 🡪 A (Decomposition of FD2)

FD5: C 🡪 BC (Transitivity of FD4 and FD1)

FD5: C 🡪 B (Decomposition of FD5)

**(b) Derive FD: AE 🡪 F**

**Solution:**

FD7: CE 🡪 ADE (Augmentation of FD2 with E)

FD8: CE 🡪 DE (Decomposition of FD7)

FD9: CE 🡪 F (Transitivity of FD8 and FD3)

FD10: AE 🡪 F (Pseudo-Transitivity of FD2 and FD4)

**Question 2: For the aforementioned relation schema with its functional dependencies, compute the attribute closure X+ for each of the following two sets of attributes.**

**(a) X = {A}**

**Solution:**

(A)+= {A, B, C}

**(b) X = {C, E}**

**Solution:**

(CE)+= {A, B, C, D, E, F}

**Question 3: Consider the relation schema R (A, B, C, D, E, F) with the following FD’s**

**FD1: AB 🡪 CDEF**

**FD2: E 🡪 F**

**FD3: D 🡪 B**

**(a) Determine the candidate keys for R.**

**Solution:** The attributes which are not in RHS, that attribute will always be a part of our candidate key. Finding the closure of those attributes.

(A)+=A

If the closure contains all attributes then it is the only key, else we need to find combinations of remaining attributes with attributes that are not present in RHS.

(AB)+ = ABCDEF (Candidate Key)

(AC)+ = AC

(AD)+ = ABCDEF (Candidate Key)

(AE)+ = AEF

(AF)+ = AF

Therefore, the Candidate Keys are {A, B} and {A, D}.

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

**Solution:** The FD’s that violate the BCNF condition are:

FD2: E 🡪 F and FD3: D 🡪 B

**(C) Decompose R into set of BCNF relations:**

**Solution:**

Decompose using FD2:

R1 (E, F) with FD2 and Candidate Key{E}

R2 (A, B, C, D, E) with new FD: AB 🡪 CDE which can be derived from FD1 using the decomposition rule and Candidate Key {A, B}.

Decompose R2 based on FD3:

R3 (B, D) with FD3 and Candidate Key {D}

R4 (A, C, D, E) with new FD: A 🡪 CDE and Candidate Key {A}

R3 and R4 are in BCNF. Hence, the result of the decomposition consists of R1, R3 and R4.

**Question 4: Consider the relation schema R (A, B, C, D, E) with the following FDs**

**FD1: ABC 🡪 DE**

**FD2: BCD 🡪 AE**

**FD3: C 🡪 D**

**(a) Show that R is not in BCNF.**

**Solution:** Super keys are {A, B, C}, {B, C, D}.

And Candidate Keys are {B, C}.

All the three Functional Dependencies violate BCNF, Hence R is not in BCNF.

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

**Solution:**

Decompose using FD3:

R1 (C, D) with FD3 and Candidate Key {C}.

R2 (A, B, C, E) with new FD: ABC 🡪 E which can be derived from FD1 using the decomposition rule and Candidate key {A, B, C}.

R1 and R2 are in BCNF.