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**COMPUTER SCIENCE & ENGINEERING**

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**EXPERIMENT- 04**

**Student Name:** YASHWANTH KANABOINA **UID:** 23BCS10501

**Branch:** BE-CSE

**Section/Group:** Krg\_1A

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**Q1. Consider a relation R having attributes as R(ABCD), functional dependencies are given below:**

**$AB \rightarrow C, C \rightarrow D, D \rightarrow A$**

**Identify the set of candidate keys possible in relation R. List all the set of prime and non-prime attributes.**

**Sol-** Since attribute **B** never appears on the RHS of any dependency, it must be part of every candidate key.

**Closures:**

- $(AB)^+ = ABCD$
- $(CB)^+ = CBDA$
- $(DB)^+ = DBAC$

**Keys:**

- Candidate Keys = {AB, CB, DB}
- PA = {A, B, C}
- NPA = {D, E}

**Normalization check:**

- In **BCNF**, the dependencies  $C \rightarrow D$  and  $D \rightarrow A$  is a problem because C and D are not a superkeys. Hence BCNF is violated.
- In **3NF**, all attributes are prime, so it is satisfied.
- In **2NF**, there are no partial dependencies (since there is no non-prime attribute), so it satisfies.
- In **1NF**, the relation is already in 1NF as there are no multivalued dependencies.

**Q2. Relation R(ABCDE) having functional dependencies as:**

**$A \rightarrow D, B \rightarrow A, BC \rightarrow D, AC \rightarrow BE$**

**Identify the set of candidate keys possible in relation R. List all the set of prime and non-prime attributes.**

**Sol-** Since attribute **C** never appears on the RHS of any dependency, it must be part of every candidate key.

**Closures:**

- $(AC)^+ = ACBED$
- $(BC)^+ = ACDBE$

**Keys:**

- Candidate Keys = {AC, BC}
- PA = {A, B, C}
- NPA = {D, E}

**Normalization check:**

- In BCNF, dependencies like  $A \rightarrow D$  and  $B \rightarrow A$  are problems because A and B are not superkeys. Hence BCNF is violated.
- In 3NF, dependency  $B \rightarrow A$  also violates the condition since B is not a superkey.
- In 2NF,  $A \rightarrow D$  creates a partial dependency (A is part of AC), so it is violated.
- In 1NF, the relation is already in 1NF as there are no multivalued dependencies.

**Q3. Consider a relation R having attributes as R(ABCDE), functional dependencies are given below:**

$$B \rightarrow A, A \rightarrow C, BC \rightarrow D, AC \rightarrow BE$$

**Identify the set of candidate keys possible in relation R. List all the set of prime and non-prime attributes.**

**Sol-** All attributes appear on RHS, so we determine candidate keys using closure.

**Closures:**

- $(A)^+ = ACBED$
- $(B)^+ = BACDE$

**Keys:**

- Candidate Keys = {A, B}
- PA = {A, B}
- NPA = {C, D, E}

**Normalization check:**

- In BCNF, all LHS of dependencies are superkeys. Hence BCNF is satisfied.
- In 3NF, since BCNF is satisfied, 3NF is also satisfied.
- In 2NF, no partial dependencies exist, so 2NF is satisfied.
- In 1NF, the relation is already in 1NF as there are no multivalued dependencies.

**Q4. Consider a relation R having attributes as R(ABCDEF), functional dependencies are given below:**

$A \rightarrow BCD, BC \rightarrow DE, B \rightarrow D, D \rightarrow A$

**Identify the set of candidate keys possible in relation R. List all the set of prime and non-prime attributes.**

**Sol-** Since attribute F never appears on the RHS of any dependency, it must be part of every candidate key.

**Closures:**

- $(AF)^+ = ABCDEF$
- $(BF)^+ = BFEDAC$
- $(DF)^+ = DFABCE$

**Keys:**

- Candidate Keys = {AF, BF, DF}
- PA = {A, B, D, F}
- NPA = {C, E}

**Normalization check:**

- In BCNF, dependencies like  $A \rightarrow BCD$ ,  $B \rightarrow D$ , and  $D \rightarrow A$  are a problem because A, B, D are not superkeys. Hence BCNF is violated.
- In 3NF,  $A \rightarrow BCD$  violates 3NF because RHS has non-prime attributes.
- In 2NF, there are no partial dependencies, so 2NF is satisfied.
- In 1NF, the relation is already in 1NF as there are no multivalued dependencies.

**Q5: Designing a student database involves certain dependencies which are listed below:**

$X \rightarrow Y, WZ \rightarrow X, WZ \rightarrow Y, Y \rightarrow W, Y \rightarrow X, Y \rightarrow Z$

**The task here is to remove all the redundant FDs for efficient working of the student database management system.**

**Sol-** Firstly, we will check each FD to see if it can be derived from others.

- $X \rightarrow Y$  is redundant because  $Y \rightarrow X$  exists.
- $WZ \rightarrow Y$  is redundant because  $WZ \rightarrow X$  and  $X \rightarrow Y$  together give  $WZ \rightarrow Y$ .
- $Y \rightarrow W, Y \rightarrow X, Y \rightarrow Z$  are essential.

**Reduced FD:**

- $WZ \rightarrow X$
- $Y \rightarrow W$



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- $Y \rightarrow X$
- $Y \rightarrow Z$

## Closures:

- $(WZ)^+ = WXZY$
- $(Y)^+ = YWXZ$

## Keys:

- Candidate Keys =  $\{WZ, Y\}$
- $PA = \{W, X, Y, Z\}$
- $NPA = \emptyset$

## Normalization check:

- **BCNF:** All functional dependencies have a candidate key in the RHS, so BCNF is satisfied.
- **3NF:** All functional dependencies either have a candidate key in the RHS or their dependent attributes are prime, so 3NF is satisfied.
- **2NF:** There are no partial dependencies, so 2NF is satisfied.
- **1NF:** All attributes are atomic or don't have multi-values, so the relation satisfies 1NF.

**Q6: Debix Pvt Ltd needs to maintain database having dependent attributes ABCDEF. These attributes are functionally dependent on each other for which functionally dependency set F given as:**

$$\{A \rightarrow BC, D \rightarrow E, BC \rightarrow D, A \rightarrow D\}$$

**Consider a universal relation  $R_1(A, B, C, D, E, F)$  with functional dependency set F, also all attributes are simple and take atomic values only. Find the highest normal form along with the candidate keys with prime and non-prime attribute.**

**Sol-** Since attribute **F** never appears on the RHS of any dependency, it must be part of every candidate key.

## Closure:

- $(AF)^+ = ABCDEF$

## Keys:

- Candidate Keys =  $\{AF\}$
- $PA = \{A, B, C, D, E, F\}$
- $NPA = \emptyset$

## Normalization check:

- **BCNF:** Some functional dependencies have determinants that are not candidate keys ( $A \rightarrow BC, D \rightarrow E, BC \rightarrow D, A \rightarrow D$ ), so BCNF is violated.
- **3NF:** Some functional dependencies have non-prime attributes on RHS ( $BC \rightarrow D, D \rightarrow E$ ), so 3NF is



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violated.

- **2NF:** Partial dependency exists ( $A \rightarrow BC$  is a partial dependency on candidate key  $AF$ ), so 2NF is violated.
- **1NF:** All attributes are atomic or don't have multi-values, so 1NF is satisfied.