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COMPUTER SCIENCE & ENGINEERING

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EXPERIMENT- 04

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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.