Experiment – 1.4

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Aim: To analyze functional dependencies in the given relations, identify candidate keys, classify attributes as prime or non-prime, remove redundant dependencies, and determine the highest normal form of the relation schemas for efficient and reliable database design.

Q1 Question:

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

AB->C, C->D, D->A

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

Solution:

Candidate Keys:

- $AB^+ = \{A, B, C, D\} \rightarrow$ Key
- $BC^+ = \{B, C, D, A\} \rightarrow$ Key
- $BD^+ = \{B, D, A, C\} \rightarrow$ Key

So, candidate keys = {AB, BC, BD}

Prime Attributes: A, B, C, D
Non-Prime Attributes: ∅

Normal Form:

- AB → C is fine (AB is key).
- C → D, D → A violate BCNF (LHS not key).
- But RHS (A, D) are prime → valid in 3NF.

Highest Normal Form = 3NF

Q2 Question:

Relation R(ABCDE) having functional dependencies as:

A->D, B->A, BC->D, AC->BE

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

Solution:

Given: R(A, B, C, D, E) with FDs: A→D, B→A, BC→D, AC→BE

Candidate Keys:
AC^+ = {A,B,C,D,E} → Key
BC^+ = {A,B,C,D,E} → Key

So candidate keys = {AC, BC}

Prime Attributes: A, B, C
Non-Prime Attributes: D, E

Normal Form:
A→D: A not a superkey, D non-prime → violates 3NF
Hence relation not in 2NF/3NF
Highest Normal Form = 1NF

Q3 Question:

Consider a relation R having attributes as R(ABCDE), FD are given below:

B->A, A->C, BC->D, AC->BE

Identify the set of CK possible in relation R. List all the sets of P and N-P attributes.

Solution:

Given: R(A,B,C,D,E) with FDs: B→A, A→C, BC→D, AC→BE

Candidate Keys:
A^+ = {A,C,B,E,D} → Key
B^+ = {B,A,C,E,D} → Key

So candidate keys = {A, B}

Prime Attributes: A, B
Non-Prime Attributes: C, D, E

Normal Form:
Every FD has a superkey LHS (B, A, BC, AC are all superkeys) → satisfies BCNF.
Highest Normal Form = BCNF

Q4 Question:

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

A->BCD, BC->DE, B->D, D->A

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

Solution:

Given: R(A,B,C,D,E,F) with FDs: A→BCD, BC→DE, B→D, D→A

Candidate Keys:

A^+ = {A,B,C,D,E} → missing F → AF is key

B^+ (with F) → BF^+ = {A,B,C,D,E,F} → Key

D^+ (with F) → DF^+ = {A,B,C,D,E,F} → Key

So candidate keys = {AF, BF, DF}

Prime Attributes: A, B, D, F

Non-Prime Attributes: C, E

Explanation:

A^+ = {A,B,C,D,E} (misses F) ⇒ AF key. BF and DF similarly cover all attributes.

Normal Form:

A→C (A is part of key AF) gives a partial dependency determining non-prime C → violates 2NF.

Highest Normal Form = 1NF

Q5 Question:

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

X ->Y, WZ ->X, WZ ->Y, Y ->W, Y ->X, Y ->Z

The task here is to remove all the redundant FDs for efficient working OF DBMS

Solution:

Given: R(W, X, Y, Z) with FDs: X→Y, WZ→X, WZ→Y, Y→W, Y→X, Y→Z

Minimal Cover: {X→Y, WZ→X, Y→W, Y→Z}

Candidate Keys: X, Y, WZ

Prime Attributes: W, X, Y, Z

Non-Prime Attributes: Ø

Explanation:

Y^+={Y,W,X,Z}, X^+={X,Y,W,Z}, WZ^+={W,Z,X,Y} — each closure gives all attributes, so X, Y, WZ are keys. All attributes are prime.

Highest Normal Form: BCNF (every FD has a key as LHS).

Q6 Question:

Debix Pvt Ltd needs to maintain a database with dependent attributes ABCDEF. These attributes are functionally dependent on each other, for which the functional dependency set F is given as:

A -> BC, D -> E, BC -> D, A -> D

Consider a universal relation R1(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 attributes

Solution:

Given: R(A,B,C,D,E,F) with FDs: A→BC, D→E, BC→D, A→D

Candidate Key:

A^+ = {A,B,C,D,E} → missing F → AF is key

So candidate keys = {AF}

Prime Attributes: A, F

Non-Prime Attributes: B, C, D, E

Explanation:

A determines B,C,D,E but not F, so AF covers all attributes. Non-prime attributes (B,C,D,E) depend on A, which is only part of the key AF → partial dependency → violates 2NF.

Highest Normal Form = 1NF

Learning Outcomes

After completing these questions, students will be able to:

1. Apply closure method to find candidate keys.
2. Differentiate prime and non-prime attributes in a relation.
3. Detect and eliminate redundant functional dependencies.