Experiment 4

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Q1. 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 set of prime and non prime attributes.

Solution : To find the candidate keys, let us compute closures:

- (AB)+ = {A, B, C, D}
- (BC)+ = {A, B, C, D}
- (BD)+ = {A, B, C, D}

Hence, the possible candidate keys are AB, BC, and BD.

Since all attributes (A, B, C, D) are part of at least one candidate key, they are prime attributes. Thus, there are no non-prime attributes (Ø).

Normal Form Check

- **BCNF: Not satisfied.**
    - Rule: For each functional dependency X → Y, the left-hand side must be a superkey.
    - C → D: C alone is not a superkey → violates.
    - D → A: D alone is not a superkey → violates.
- **3NF: Satisfied.**
    - Rule: For every FD X → Y, either X is a superkey or Y is a prime attribute.
    - AB → C: AB is a key → valid.

- C → D: C is not a key, but D is prime → valid.
- D → A: D is not a key, but A is prime → valid.

Therefore, the relation is in 3NF but not in BCNF.

Q2. 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 set of prime and non prime attributes.

Solution: For relation R(A, B, C, D, E) with the given dependencies:

- A → D
- B → A
- BC → D
- AC → BE

Candidate Keys
Let's compute closures:

- (BC)+ = {A, B, C, D, E} → covers all attributes.
- (AC)+ = {A, B, C, D, E} → covers all attributes.

Thus, the candidate keys are {BC, AC}.
Here, attributes A, B, and C are part of at least one candidate key, so they are prime attributes.
Attributes D and E are not in any candidate key → they are non-prime attributes.
Normal Form Check

- **BCNF: Not satisfied.**
  - Rule: Every determinant should be a superkey.
  - A → D: A alone is not a key → violates.
  - B → A: B alone is not a key → violates.
- **3NF: Also not satisfied.**
  - Condition: Either the left side is a key or the right side contains only prime attributes.
  - A → D: A is not a key, and D is non-prime → violation.
- **2NF: Not satisfied** as well, since partial dependencies exist on candidate keys.

Hence, the relation is only in 1NF.

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

B->A, A->C, BC->D, AC->BE
Identify the set of candidate keys possible in relation R. List all the set of prime and non prime attributes.

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

- B → A
- A → C
- BC → D
- AC → BE

Closures:

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

Candidate Keys: { A, B }

Prime attributes: { A, B }
Non-prime attributes: { C, D, E }

BCNF: Yes

- B→A: B is a superkey → Ok
- A→C: A is a superkey → Ok

  So on.. all LHS are superkeys

Normal Form: BCNF

Q4.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 set of prime and non prime attributes.
Given: R(A,B,C,D,E,F) with FDs

- A → B C D
- BC → D E
- B → D

- D → A

Closures:

- (A)+ = {A, B, C, D, E}
- (B)+ = {A, B, C, D, E}
- (D)+ = {A, B, C, D, E}
- (F)+ = {F}
- (AF)+ = {A,B,C,D,E,F} → key
- (BF)+ = {A,B,C,D,E,F} → key
- (DF)+ = {A,B,C,D,E,F} → key

Candidate Keys: { AF, BF, DF }

Prime attributes: { A, B, D, F }
Non-prime attributes: { C, E }

BCNF: No

- A→BCD: A is not a superkey → violates.

3NF: No

- A→C (part of A→BCD): A not a superkey and C is non-prime → violates.

2NF: No

- AF is a key, but A→C (C non-prime) is a partial dependency on part of key AF → violates.

1NF: Yes — attributes assumed atomic.

Normal Form: 1NF

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

X ->Y

WZ ->X

WZ ->Y

Y ->W

Y ->X

Y ->Z

Identify the set of candidate keys possible in student database. List all the set ofprime and non prime attributes.

Given: attributes {W, X, Y, Z} with FDs

- X → Y
- WZ → X
- WZ → Y
- Y → W
- Y → X
- Y → Z

Closures:

- (Y)+ = {Y, W, X, Z} = all attributes → Y is a key.
- (X)+ = {X, Y, W, Z} = all attributes → X is a key.
- (WZ)+ = {W, Z, X, Y} = all attributes → WZ is a key.

Candidate Keys: { X, Y, WZ }
Prime attributes: { W, X, Y, Z }
Non-prime attributes: Ø

BCNF: Yes

- Every FD has LHS that is a superkey (X, Y, WZ) → satisfies BCNF.

Normal Form: BCNF

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 -> 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 attribute.

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

- A → B C
- D → E
- BC → D

- A → D

Closures:

- (A)+ = {A, B, C, D, E}
- (AF)+ = {A, B, C, D, E, F} → key
- (BC)+ = {B, C, D, E}
- (D)+ = {D, E}
- (F)+ = {F}

Candidate Keys: { AF }
Prime attributes: { A, F }
Non-prime attributes: { B, C, D, E }

BCNF: No

- A→BC / A→D: A not a superkey → violates.

3NF: No

- A→BC: A not a superkey and B,C are non-prime → violates.

2NF: No

- AF is a key, A→BC (BC non-prime) is a partial dependency on part of the key → violates.

1NF: Yes — attributes atomic.

Normal Form: 1NF