Experiment 1.4

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THEORY

1. **Problem Title:** Functional Dependency And Keys.
2. **Problem Description:** In relational databases, keys are defined using functional dependencies (FDs). A super key is any set of one or more attributes that can uniquely identify a tuple in a relation; formally, if a set of attributes X functionally determines all attributes of the relation (X → R), then X is a super key. Among super keys, the candidate keys are those that are minimal, meaning no proper subset of them can still uniquely determine all attributes of the relation. From the set of candidate keys, one is chosen as the primary key, which serves as the main identifier for tuples in the relation. When a key is made up of two or more attributes, it is called a composite key, and this occurs when the combination of attributes together functionally determines all other attributes of the relation, but no single attribute in that set can do so individually. Thus, super keys guarantee uniqueness, candidate keys are the minimal super keys, the primary key is the selected candidate key, and composite keys are keys formed by combining multiple attributes.
3. **Questions:**
   a. 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.
   Ans)

   Given: R(A,B,C, D); ***FD:*** AB->C, C->D, D->A.

   AB+ = ABCD
   BC+ = CBDA
   DB+ = DBAC

   Ckeys = {AB,BC,DB} PA={A,B,C,D} NPA={}
   Normalisation: 3NF because (X is a super key or candidate key OR Y is a prime attribute) (If all attributes comes out to be prime – R is in 3NF).

   b. 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.
   Ans)

   Given: R(A,B,C, D, E); ***FD:*** A->D, B->A, BC->D, AC->BE.

CA+ = DCABE
CB+ = CBADE

Ckeys = {CA,CB} PA={A,C,D} NPA={B}
Normalisation: 1NF because (X is a subset of candidate key AND Y is non-prime attribute) – then R is not in 2NF.

c. 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.
Ans)

Given: R(A,B,C, D, E); ***FD:*** B->A, A->C, BC->D, AC->BE.

A+ = DCABE
B+ = CBADE

Ckeys = {A,B} PA={A,B} NPA={C,D,E}
Normalisation: BCNF or 3.5NF because (All the FD in X is super key or candidate key).

d. 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.
Ans)

Given: R(A,B,C, D, E, F); ***FD:*** A->BCD, BC->DE, B->D, D->A

FB+ = BDACEF
FD+ = DABCEF

Ckeys = {FB,FD} PA={A,D,F,B} NPA={C,E}
Normalisation: 1NF because (X is a subset of candidate key AND Y is non-prime attribute) – then R is not in 2NF.

e. 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 the student database management system.

Ans)
Given: R(W, X, Y, Z); ***FD:*** X ->Y, WZ ->X, WZ ->Y, Y ->W,Y ->X, Y ->Z.
Redundant: WZ ->X, WZ ->Y
Since X -> Y so we can write WZ ->Y.

FD': X ->Y, WZ ->Y, Y ->W, Y ->X, Y ->Z.

X+ = YWXZ
Y+ = WXZY
WZ+ = WZYX

Ckeys = {X,Y,WZ} PA={X,Y,WZ} NPA={ }
Normalisation: BCNF because (All the FD in X is super key or candidate key).

f. 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.

Ans)

Given: R(A,B,C,D,E,F); ***FD:*** A -> BC, D -> E, BC -> D, A -> D**.**

AF+ = AFDBCE

Ckeys = {AF} PA={A,F} NPA={B,C,D,E }

Normalisation: 1NF because (X is a subset of candidate key AND Y is non-prime attribute) – then R is not in 2NF.