UNIVERSITY INSTITUTE OF ENGINEERING

Advanced Database Management System

Experiment 2.1

23CSP-333

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Consider the following questions and answer accordingly.

1. 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.

2. 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.

3. 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.

4. 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.

5. Consider a relation schema R(W, X, Y, Z) with the following functional dependencies:
   1. $X \rightarrow Y$
   2. $WZ \rightarrow X$
   3. $WZ \rightarrow Y$
   4. $Y \rightarrow W$
   5. $Y \rightarrow X$
   6. $Y \rightarrow Z$

   Tasks:
   1. Identify all the candidate keys of R.
   2. List the prime and non-prime attributes.
   3. Determine the highest normal form of the relation R with proper justification.

6. Consider a relation schema R(A, B, C, D, E, F) with the following functional dependencies:
   $A \rightarrow BC,\ D \rightarrow E,\ BC \rightarrow D,\ A \rightarrow D$

   Tasks:
   1. Find all the candidate keys of R.
   2. List the prime and non-prime attributes.
   3. Determine the highest normal form of relation R with proper justification.

Answers of the above given questions are as follows:

1. **Given: R(A B C D) with FDs: AB → C, C → D, D → A.**
   Candidate keys: AB, BC, BD.
   (Checks: AB^+ = ABCD; BC^+ = B,C→AD → ABCD; BD^+ = B,D→A → AB→C → ABCD. All are minimal.)
   Prime attributes: A, B, C, D (every attribute appears in some candidate key).
   Non-prime attributes: none.
   Highest normal form: 3NF (all FDs either have a superkey on the left — e.g. AB→C — or have a prime attribute on the right; violates BCNF because C→D (and D→A) have non-superkey determinants).

2. **Given: R(A B C D E) with FDs:**
   A → D, B → A, BC → D, AC → BE.
   Candidate keys: AC, BC.
   (Checks: AC^+ = {A,C} → BE (by AC→BE) and A→D ⇒ {A,B,C,D,E}.
   `BC^+ = {B,C} → A (by B→A) → D (by A→D) and AC→BE gives E ⇒ all attributes.)
   Prime attributes: A, B, C.
   Non-prime attributes: D, E.
   Highest normal form: 1NF.
   Reason: A → D is a partial dependency (A is a proper subset of the candidate key AC and D is non-prime), so the relation violates 2NF (hence also not in 3NF/BCNF).

3. **Given: R(A B C D E) with FDs:**
   B → A, A → C, BC → D, AC → BE.
   Candidate keys: A, B.
   (Checks: A^+ = A → C; AC → BE ⇒ B,E; BC → D ⇒ D so A^+ = ABCDE.
   B^+ = B → A; A → C ⇒ C; AC → BE ⇒ E; BC → D ⇒ D so B^+ = ABCDE.)
   Prime attributes: A, B.
   Non-prime attributes: C, D, E.
   Highest normal form: BCNF (every FD has a superkey as determinant: A and B are keys, and BC, AC are supersets of keys).

4. **Given: R(A B C D E F) with FDs:**
   A → B C D, BC → D E, B → D, D → A.
   Candidate keys: AF, BF, DF.
   (Reason: A^+ = {A,B,C,D,E} so AF^+ = all attributes; similarly B^+ and D^+ each give {A,B,C,D,E}, so adding F yields the whole relation. F must be included because no FD produces F.)
   Prime attributes: A, B, D, F.
   Non-prime attributes: C, E.
   Highest normal form: 1NF.

(Why: e.g. $A \rightarrow C$ is a partial dependency — A is a proper subset of the candidate key AF and determines non-prime C — so 2NF is violated; hence relation is not in 2NF/3NF/BCNF.)

5. **Given: R(W X Y Z) with FDs:**
   $X \rightarrow Y$, $WZ \rightarrow X$, $WZ \rightarrow Y$, $Y \rightarrow W$, $Y \rightarrow X$, $Y \rightarrow Z$.
   Candidate keys: X, Y, WZ.
   (Checks: $X^+ = X \rightarrow Y \rightarrow \{W,Z\}$ so $X^+ = \{W,X,Y,Z\}$.
   $Y^+ = Y \rightarrow W,X,Z$ so $Y^+ = \{W,X,Y,Z\}$.
   $(WZ)^+ = WZ \rightarrow Y \rightarrow$ then $Y \rightarrow W,X,Z$ so $(WZ)^+ = \{W,X,Y,Z\}$. All are minimal.)
   Prime attributes: W, X, Y, Z (every attribute appears in some candidate key).
   Non-prime attributes: none.
   Highest normal form: BCNF — every FD's left side is a superkey (X, Y, and WZ are all keys).

6. **Given: R(A B C D E F) with FDs:**
   $A \rightarrow BC$, $D \rightarrow E$, $BC \rightarrow D$, $A \rightarrow D$.
   Candidate key(s): AF.
   (Reason: $A^+ = \{A \rightarrow BC \rightarrow D \rightarrow E\} = \{A,B,C,D,E\}$, so adding F gives $AF^+ = \{A,B,C,D,E,F\}$. F is not produced by any FD, so every key must include F; A is required to reach the other attributes, so AF is the minimal key.)
   Prime attributes: A, F.
   Non-prime attributes: B, C, D, E.
   Highest normal form: 1NF.
   (Why: $A \rightarrow BC$ is a partial dependency because A is a proper subset of the candidate key AF and determines non-prime attributes B and C, so the relation violates 2NF — hence it is only in 1NF.)