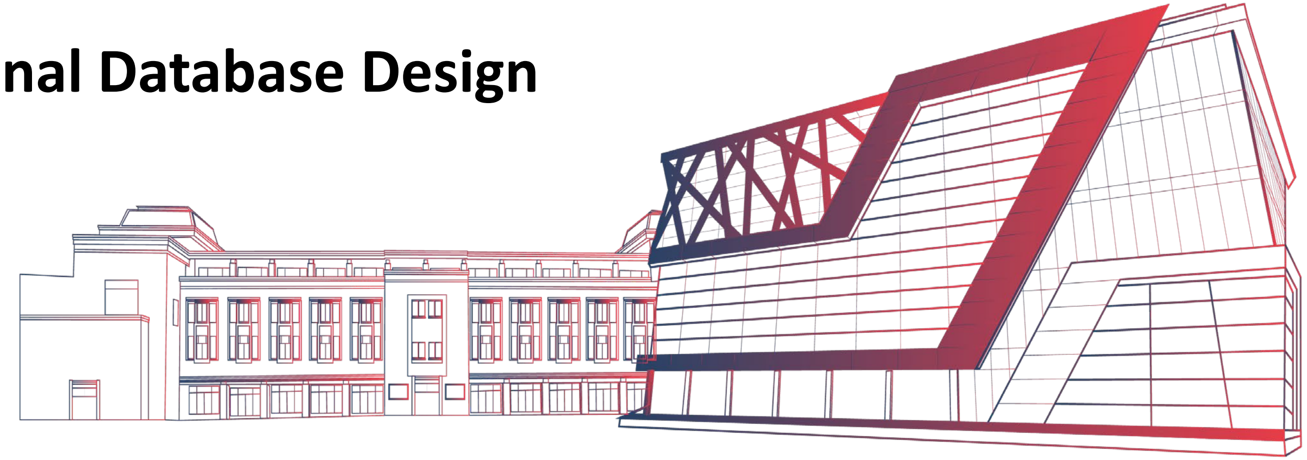
UNIT III

Relational Database Design



Lecture 15

Equivalence of FD Sets

FD Membership Test

- Let F be the FD set with FD $X \rightarrow Y$

- FD $X \rightarrow Y$ is implied in F iff

X^+ determines Y in FD set F

i.e. FD $X \rightarrow Y$ is implied in F iff $X^+ = \{.....Y.....\}$

FD Membership Test Example

- **Relation R (A, B, C, D)**

  Is AB → D a member of F = { AB → C, BC → D}?

  AB+ = ABCD ∴ AB → D is a member of F.

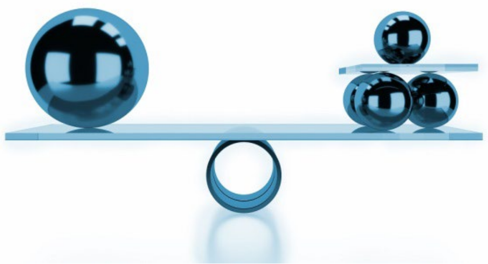
- **Relation R (A, B, C, D)**

  Is C → AB a member of F = { AB → C, C → D, D → A}?

  C+ = { C, D, A} ∴ C → A is implied but C → B is not implied

  ∴ C → AB is not a member of F

Equivalence of FD Sets



- Two sets of FDs F and G are **equivalent** if:

  - every FD in F is implied in G, *and*

  - every FD in G is implied in F

- **Definition:**

  a) F **covers** G ($F \supseteq G$) if every FD in G is implied in F.

  b) Similarly, G **covers** F ($G \supseteq F$) if every FD in F in implied in G.

- **F and G are equivalent if F covers G and G covers F**

Equivalence of FD Sets Example

- **Consider the following two sets of FDs**

  F= {A → C, AC → D, E → AD, E → H}

  G = {A → CD, E → AH}

  Check whether or not they are equivalent.

- **Solution**

  Proof that G is covered by F:

  {A} + = {A, C, D} (with respect to F), which covers A →CD in G

  {E} + = {E, A, D, H, C} (with respect to F), which covers E →AH in G

  Proof that F is covered by G:

  {A} + = {A, C, D} (with respect to G), which covers A → C in F

  {A, C} + = {A, C, D} (with respect to G), which covers AC →D in F

  {E} + = {E, A, H, C, D} (with respect to G), which covers E → AD and E → H in F

Equivalence of FD Sets Drill

1. A relation R (A , C , D , E , H) is having two functional dependencies sets F and G as shown-

$$F = \{ A \rightarrow C, AC \rightarrow D, E \rightarrow AD, E \rightarrow H \}$$

$$G = \{ A \rightarrow CD, E \rightarrow H \}$$

Check if F and G are equivalent?

2. Are these two FD sets equivalent or not?

$$FD1 = \{AB \rightarrow C, D \rightarrow E, E \rightarrow C\}$$

$$FD2 = \{ AB \rightarrow C, D \rightarrow E, AB \rightarrow E, E \rightarrow C\}$$

Solution Equivalence of FD Sets Drill

1. **Determining whether F covers G-**

$(A)^+ = \{ A , C , D \}$ // using set F

$(E)^+ = \{ A , C , D , E , H \}$ // using set F

Thus, we conclude F covers G i.e. $F \supseteq G$

Determining whether G covers F-

$(A)^+ = \{ A , C , D \}$ // using set G

$(AC)^+ = \{ A , C , D \}$ // using set G

$(E)^+ = \{ E , H \}$ // using set G

Thus, we conclude G does not cover F

$\therefore F \neq G$

Solution Equivalence of FD Sets Drill

2. FD2 covers FD 1

   FD1 does not cover FD 2 as AB → E is not implied in FD 1.

Thus, FD1 ≠ FD2

Practice Drill

Ques: Relation R has eight attributes ABCDEFGH. Fields of R contain only atomic values.

$$F = \{ CH \rightarrow G,\ A \rightarrow BC,\ B \rightarrow CFH,\ E \rightarrow A,\ F \rightarrow EG\}$$

is a set of functional dependencies (FDs)

How many candidate keys does the relation R have?

Solution

A+ = ABCEFGH which is all attributes except D.

B+ = ABCEFGH which is all attributes except D.

E+ = ABCEFGH which is all attributes except D.

F+ = ABCEFGH which is all attributes except D.

So, there are total 4 candidate keys AD, BD, ED and FD

Practice Drill

Consider a relation with schema R(A,B,C,D)

FDs are {AB → C, C → D, D → A}.

a. What are some of the nontrivial FDs that can be inferred from the given FDs?

b. What are all candidate keys of R?

Solution

a) Some of the non-trivial FDs:

C → ACD D → AD AB → ABCD

AC → ACD BC → ABCD BD → ABCD

CD → ACD ABC → ABCD ABD → ABCD

BCD → ABCD

b) Attribute Closure:

A → A B → B C → ACD D -→ AD

AB → ABCD AC → ACD AD → AD BC → ABCD

BD → ABCD CD → ACD ABC → ABCD

ABD → ABCD ACD → ACD BCD → ABCD

Thus, candidate keys are: AB, BC, and BD

Thanks!!