

# Database Management System – 34

## Database design – Closure and Equivalence set

Ajay James  
Asst. Prof in CSE  
Government Engineering College Thrissur

### Outline

- Closure
- Closure of attributes algorithm
- Cover
- Equivalence set

## Closure

- **Closure** of a **set F** of FDs is the **set  $F^+$**  of all FDs that can be **inferred from F**
- **Attribute Closure**
  - determine each set of attributes X that appears as a left-hand side of some FD in F
  - then determine the set of all attributes that are dependent on X

## Closure of X

- For each such set of attributes X
- Determine the set  $X^+$  of attributes that are functionally determined by X based on F
- $X^+$  is called the **closure of X under F**

## Algorithm to calculate $X^+$

- **Input:** A set  $F$  of FDs on a relation schema  $R$ , and a set of attributes  $X$ , which is a subset of  $R$ .

$X^+ := X$ ;

repeat

$oldX^+ := X^+$ ;

    for each functional dependency  $Y \rightarrow Z$  in  $F$  do

        if  $X^+ \supseteq Y$  then  $X^+ := X^+ \cup Z$ ;

until ( $X^+ = oldX^+$ );

$R(ABCDE) = \{AB \rightarrow C, B \rightarrow D, C \rightarrow E, D \rightarrow A\}$

$X^+ := X$ ;

repeat

$oldX^+ := X^+$ ;

    for each FD  $Y \rightarrow Z$  in  $F$  do

        if  $X^+ \supseteq Y$  then  $X^+ := X^+ \cup Z$ ;

until ( $X^+ = oldX^+$ );

- $AB^+$

- $X^+ := AB$

- $oldX^+ := AB$

1.  $AB \rightarrow C, AB \supseteq AB,$

$X^+ := ABC$

2.  $B \rightarrow D, ABC \supseteq B,$

$X^+ := ABCD$

3.  $C \rightarrow E, ABCD \supseteq C$

$X^+ := ABCDE$

4.  $D \rightarrow A, ABCDE \supseteq D$

$X^+ := ABCDE$

## Example

- CLASS ( Classid, Course#, Instr\_name, Credit\_hrs, Text, Publisher, Classroom, Capacity)
- FD1: Classid  $\rightarrow$  {Course#, Instr\_name, Credit\_hrs, Text, Publisher, Classroom, Capacity}
- FD2: Course#  $\rightarrow$  Credit\_hrs
- FD3: {Course#, Instr\_name}  $\rightarrow$  {Text, Classroom}
- FD4: Text  $\rightarrow$  Publisher
- FD5: Classroom  $\rightarrow$  Capacity

## Closure example

- { **Classid** }<sup>+</sup> = { Classid , Course#, Instr\_name, Credit\_hrs, Text, Publisher, Classroom, Capacity } = CLASS
- { **Course#** }<sup>+</sup> = { Course#, Credit\_hrs }
- { **Course#, Instr\_name** }<sup>+</sup> = { Course#, Instr\_name, Credit\_hrs, Text, Publisher, Classroom, Capacity }

## Equivalence of Sets of Functional Dependencies

- **COVER Definition**
- A set of functional dependencies  $F$  is said to **cover** another set of functional dependencies  $G$  if every FD in  $G$  is also in  $F^+$
- that is, if every dependency in  $G$  can be inferred from  $F$
- Alternatively, we say  $G$  is **covered** by  $F$

## Equivalence of Sets of Functional Dependencies

- **Definition**
- Two sets of functional dependencies  $G$  and  $F$  are equivalent if  $G^+ = F^+$ .
- Equivalence means that every FD in  $G$  can be inferred from  $F$ , and every FD in  $F$  can be inferred from  $G$
- $G$  is equivalent to  $F$  if both the conditions— $G$  covers  $F$  and  $F$  covers  $G$ —hold

$F = \{A \rightarrow C, AC \rightarrow D, E \rightarrow AD, E \rightarrow H\}$   
and  $G = \{A \rightarrow CD, E \rightarrow AH\}$

- **First Check G covers F or  $(F \subseteq G^+)$**
- **Check each FD in F:**
- **F1:  $A \rightarrow C$** 
  - find  $A^+$  in **G**
  - $A^+$  in  $G = \{ACD\}$  which includes C
- **F2:  $AC \rightarrow D$** 
  - get  $AC^+$  in **G**
  - $AC^+$  in  $G = \{ACD\}$  which contains D
- **F3:  $E \rightarrow AD, E \rightarrow H$** 
  - get  $E^+$  in **G**
  - $E^+$  in  $G = \{EACDH\}$  which contains AD and H.

$F = \{A \rightarrow C, AC \rightarrow D, E \rightarrow AD, E \rightarrow H\}$   
and  $G = \{A \rightarrow CD, E \rightarrow AH\}$

- **Second Check F covers G or  $(G \subseteq F^+)$**
- **Check each FD in G:**
- **G1:  $A \rightarrow CD$** 
  - find  $A^+$  in **F**
  - $A^+$  in  $F = \{ACD\}$  which includes CD
- **G2:  $E \rightarrow AH$** 
  - get  $E^+$  in **F**
  - $E^+$  in  $F = \{EACDH\}$  which contains AH
- **G covers F and F covers G , so, F and G are equivalent.**

## Summary

- Closure of X
- Cover
- Equivalent set

## Reference

- Elmasri R. and S. Navathe, Database Systems: Models, Languages, Design and Application Programming, Pearson Education 6<sup>th</sup> edition and 7<sup>th</sup> edition

Thank you

AJ-GEC THRISSUR