COMPUTER SCIENCE

Database Management System

FD's & Normalization

Key Concepts & Finding Number of Candidate Keys Part-01

Lecture_02

Vijay Agarwal sir

TOPICS TO BE COVERED

01 Attribute Closure

02 Finding Candidate keys

RDBMS Concept

- Arity (Degree)
- Cardinality
- Schema
- Instances

FD Concept

Type of FD

1. Trivial FD
2. Non Trivial FD
3. Semi Non Trivial FD

Practice Question

t_1 & t_2 Any two Tuple

$X \to y$ exists

$\boxed{\text{If } t_1.X = t_2.X \text{ then } t_1.y = t_2.y \text{ must be Same}}$

11 - SHYAM

11 - SHYAM

56 - Vijay

56 - Vijay

Q.

P	Q	R
6	6	7
6	7	7
7	3	4
8	3	4

(a) 1
(b) 2
(c) 3
(d) 4

× $P \to Q$ ✓ $P \to R$ × $P \to QR$

× $Q \to P$ ✓ $Q \to R$ × $Q \to PR$

× $R \to P$ × $R \to Q$ × $R \to PQ$

✓ $PQ \to R$ × $QR \to P$ × $PR \to Q$

$P \to R$
$Q \to R$
$PQ \to R$

Q.

A	B	C
7	5	6
7	7	6
7	5	7
7	7	7
9	5	6

(a) 0
(b) 1
(c) 2
(d) 3

× $A \to B$ × $B \to A$ × $C \to A$ × $AB \to C$

× $A \to C$ × $B \to C$ × $C \to B$ × $BC \to A$

× $A \to BC$ × $B \to AC$ × $C \to AB$ × $AC \to B$

Note

Trivial FD's are always Valid.

Q.

A	B	C
2	2	4
2	3	4
3	2	4
3	3	4
3	2	4

Trivial

I. $AB \to A$ ✓

II. $AB \to B$ ✓

III. $AB \to AB$ ✓

Always valid.

(a) 0

(b) 1

(c) 2

(d) 3

$A \to C$

$B \to C$

$AB \to C$

✗ $A \to B$ ✗ $B \to A$ ✗ $C \to A$ ✓ $AB \to C$

✓ $A \to C$ ✓ $B \to C$ ✗ $C \to B$ ✗ $BC \to A$

✗ $A \to BC$ ✗ $B \to AC$ ✗ $C \to AB$ ✗ $AC \to B$

Q.

Given the following relation instance.

X	Y	Z
4	4	4
4	7	4
7	4	7
7	4	9
4	9	9

The number of non trivial FD's are satisfied by the instance ___

(a) 0
(b) 1
(c) 2
(d) 3

$YZ \to X$

$X \to Y$ $Y \to X$ $Z \to X$ $XY \to Z$

$X \to Z$ $Y \to Z$ $Z \to Y$ $YZ \to X$

$X \to YZ$ $Y \to XZ$ $Z \to XY$ $XZ \to Y$

Q. Given the following relation instance. [2000: 2 Marks]

X	Y	Z
1	4	2
1	5	3
1	6	3
3	2	2

Which of the following functional dependencies are satisfied by the instance?

(A) $XY \rightarrow Z$ and $Z \rightarrow Y$

(B) $YZ \rightarrow X$ and $Y \rightarrow Z$

(C) $YZ \rightarrow X$ and $X \rightarrow Z$

(D) $XZ \rightarrow Y$ and $Y \rightarrow X$

Note

Rule out the FD, Based on the table.

Note

Trivial FD's are always Valid

$AB \rightarrow A$, $AB \rightarrow B$. $AB \rightarrow AB$

Q. From the following instance of a relation scheme R (A, B, C), we can conclude that: [2002: 2 Marks]

$B \rightarrow C$

A	B	C
1	1	1
1	1	0
2	3	2
2	3	2

$A \rightarrow B,\ B \not\rightarrow C$

$\boxed{\text{Ans (C)}}$

(A) ~~A functionally determines B and B functionally determines C~~

(B) A functionally determines B and B does not functionally determines C

(C) B does not functionally determines C

(D) ~~A does not functionally determines B and B does not functionally determines C~~

Q.

Consider the relation X(P, Q, R, S, T, U) with the following set of functional dependencies

[2015: 1 Marks]

F = {

$\{P, R\} \rightarrow \{S, T\}$

$\{P, S, U\} \rightarrow \{Q, R\}$

}

In $X \rightarrow Y$

$\boxed{X \supseteq Y}$

$AB \rightarrow A$

$AB \rightarrow B$

$AB \rightarrow AB$

Which of the following is the trivial functional dependency in F^+ is closure of F?

(A) $\{P, R\} \rightarrow \{S, T\}$

$\boxed{\text{Ans (c)}}$

(B) $\{P, R\} \rightarrow \{R, T\}$

(C) $\{P, S\} \rightarrow \{S\}$

$X \supset Y$

(D) $\{P, S, U\} \rightarrow \{Q\}$

FD Concept

& Type of FD's.

Armstrong's Axioms/Inference Rules

Properties of FD's

- Axioms, or rules of inference, provide a simpler technique for reasoning about functional dependencies
- In the rules that follow, we use Greek letters (α, β, γ,...) for sets of attributes.
- We can use the following three rules to find logically implied functional dependencies.
- By applying these rules repeatedly, we can find all of F+, given F. This collection of rules called Armstrong's Axioms in honor of the person who first proposed it.
  - Reflexivity Rule: If α is a set of attributes and $\beta \subseteq \alpha$, then $\alpha \to \beta$ holds.
  - Augmentation rule: If $\alpha \to \beta$ holds and γ is a set of attributes, then $\gamma\alpha \to \gamma\beta$ holds.
  - Transitivity Rule: If $\alpha \to \beta$ holds and $\beta \to \gamma$, then $\alpha \to \gamma$ holds.

Additional Rules

- If $\alpha \rightarrow \beta$ holds and $\alpha \rightarrow \gamma$ holds, then $\alpha \rightarrow \beta\gamma$ holds (union)
- If $\alpha \rightarrow \beta\gamma$ holds, then $\alpha \rightarrow \beta$ holds and $\alpha \rightarrow \gamma$ holds (decomposition)
- If $\alpha \rightarrow \beta$ holds and $\gamma\beta \rightarrow \delta$ holds, then $\alpha\gamma \rightarrow \delta$ holds (Pseudo transitivity)

The above rules can be inferred from Armstrong's Axioms.

Armstrong's Axioms/Inference Rules

Inference rules that can be used to infer new dependencies from a given set of dependencies

- IR1 (reflexive rule) : If $X \supseteq Y$, then $X \rightarrow Y$.
- IR2 (augmentation rule)[2]: $\{X \rightarrow Y\} \models XZ \rightarrow YZ$.
- IR3 (transitive rule): $\{X \rightarrow Y, Y \rightarrow Z\} \models X \rightarrow Z$.
- IR4 (decomposition, or projective, rule): $\{X \rightarrow YZ] \models X \rightarrow Y$.
- IR5 (union, or additive, rule): $\{X \rightarrow Y, X \rightarrow Z] \models X \rightarrow YZ$.
- IR6 (pseudotransitive rule): $\{X \rightarrow Y, WY \rightarrow Z| \models WX \rightarrow Z$.

Attribute closure $[X]^+$

Let X be the attribute set of Relation R,

Set of all possible Attributes which are

Logically / functionally determined by Attribute 'X'

is called Attribute closure of X. $\boxed{[X]^+}$

Attribute closure $[X]^+$

$R(ABCDE)$ $[A \to B,\ B \to C,\ C \to D,\ D \to E]$

$[A]^+ = [ABCDE]$

$[B]^+ = [BCDE]$

$[C]^+ = [CDE]$

$[D]^+ = [DE]$

$[E]^+ = [E]$

$[BC]^+ = [BCDE]$

$[CE]^+ = [CED]$

$\Downarrow$

$[CDE]$

Example

Let us consider a relation with attributes A, B, C, D, E, and F. Suppose that this relation has the FD's $AB \rightarrow C$, $BC \rightarrow AD$, $D \rightarrow E$, and $CF \rightarrow B$.

What is the closure of $\{A, B\}$, that is, $\{A, B\}^+$?

$R(ABCDEF) \quad \{AB \rightarrow C,\ BC \rightarrow AD,\ D \rightarrow E,\ CF \rightarrow B\}$

$(AB)^+ = [ABCDE]$

$[ABCDE]$ Ans

$[A]^+ \Rightarrow$ Directly or Indirectly Determined by Attribute A.

$[A]^+ = [A \ldots\ldots\ldots\ldots]$

Q.

$F = \{Ssn \rightarrow Ename,$

$Pnumber \rightarrow (Pname, Plocation),$

$\{Ssn, Pnumber\} \rightarrow Hours\}$

Find

$\{Ssn\}^+$ = [Ssn Ename]

$\{Pnumber\}^+$ = [Pnumber Pname Plocation]

$\{Ssn, Pnumber\}^+$ = [Ssn Pnumber Hours Ename Pname Plocation]

Q.

R (ABCDEFG)

F : (AB → C, BC → AD, D → E, E → G, CE → B)

Find closure of ...

$(A)^+ = [A]$

$(B)^+ = [B]$

$(C)^+ = [C]$

$(D)^+ = [DEG]$

$(E)^+ = [EG]$

$(F)^+ = [F]$

$(G)^+ = [G]$

$(AB)^+ = [ABCDEG]$

$(AC)^+ = [AC]$

$(BC)^+ = [BCADEG]$

$(AD)^+ = [ADEG]$

$(AE)^+ = [AEG]$

$(AG)^+ = [AG]$

$(BD)^+ = [BDEG]$

$(BEG)^+ = [BEG]$

$(ABD)^+ = [ABDCEG]$

$(AEF)^+ = [AEFG]$

$(AFG)^+ = [AFG]$

$(BEF)^+ = [BEFG]$

$(CDG)^+ = [CDGEBA]$

$(DEF)^+ = [DEFG]$

Q. The following functional dependencies are given

$\{PQ \to RS, PU \to S, ST \to U, R \to V, U \to T, V \to P\}$

Which of the following option (s) is/are true ? **[MSQ]**

True (A) $\{RU\}^+ = \{PRSTUV\}$ $[RU]^+ = [RUVTPS] \Rightarrow [PRSTUV]$

~~(B)~~ $\{PU\}^+ = \{PRSTUV\}$ $[PU]^+ = [PUTS] \Rightarrow [PSTU]$

True (C) $\{QV\}^+ = \{PQRSV\}$ $[QV]^+ = [QVPRS] \Rightarrow [PQRSV]$

~~(D)~~ $(PQ)^+ = \{PQRSUV\}$ $[PQ]^+ = [PQRSV]$

$\boxed{(A) \& (C)}$

Pn DBMS Concepts :

(a) cc with Enjoying

(b) cc

(c) c

(d) Doubt

Q.

The following functional dependencies are given:

$AB \rightarrow CD$, $AF \rightarrow D$, $DE \rightarrow F$, $C \rightarrow G$, $F \rightarrow E$, $G \rightarrow A$.

MSQ

Which one of the following options is false? [2006: 2 Marks]

A (i) $\{CF\}^+ = \{ACDEFG\}$ True $[CF]^+ = [CFGEAD] \Rightarrow [ACDEFG]$

B (ii) $\{BG\}^+ = \{ABCDG\}$ True $[BG]^+ = [BGACD] \Rightarrow [ABCDG]$

C (iii) $\{AF\}^+ = \{ACDEFG\}$ False $[AF]^+ = [AFED] \Rightarrow [ADEF]$

D (iv) $(AB)^+ = \{ABCDFG\}$ False $[AB]^+ = [ABCDG]$

extra

$\boxed{\text{(iii) \& (iv)}}$

A	B	C
1	5	7
1	6	8

$A \to B$

$A \to BC$

Any Doubt ?

THANK YOU!