

COMPUTER SCIENCE



Database Management System

FD's & Normalization

Introduction of DBMS

Lecture_01



Vijay Agarwal sir

An orange diamond-shaped sign with a black border, mounted on a white pole. Below the sign is a construction barrier with two orange lights on top.

**TOPICS
TO BE
COVERED**

01

Introduction of RDBMS

02

Functional Dependency



DBMS

Lecture schedule

DBMS GATE Syllabus

8 - 10 marks



- Functional dependencies and Normalization.
- Transaction and Concurrency control.
- SQL
- Relational Algebra & TRC
- File Organization and Indexing
- ER model and Integrity constraints.

Functional Dependency (FD's)

- ❑ FD concepts
- ❑ FD types
- ❑ Armstrong's axioms/Inference rules
- ❑ Attribute closure
- ❑ Keys Concept
 - ❖ Super key
 - ❖ Candidate key
 - ❖ Primary key
 - ❖ Alternative / secondary key
- ❑ Finding multiple candidate keys
- ❑ Membership set

- ❑ Closure of FD set ✓
- ❑ Equality between 2 FD sets ✓
- ❑ Minimal cover (Canonical cover) ✓
- ❑ Lossy and Lossless Join Decomposition ✓
- ❑ Dependency preserving Decomposition ✓

Normalization

- Need of Normalization ? / Problem with Unnormalized Data

Normal Forms

✓❖ 1 NF

✓❖ 2 NF

✓❖ 3 NF

✓❖ BCNF

Multi Valued Dependencies → →

NF Decomposition

❖ 2NF Decomposition

❖ 3NF Decomposition

❖ BCNF Decomposition

Transaction & Concurrency Control

- ❑ Transaction concept
- ❑ ACID Properties
- ❑ Schedules (serial & non serial schedule)
- ❑ Serializable schedule
 - ❖ conflict Serializable
 - ❖ View serializable
- ❑ Testing method for conflict serializability
- ❑ Conflict equivalent schedule
- ❑ Problem due to concurrent execution
- ❑ Recoverable, cascadeless, strict recoverable schedule.

- ❑ Implementation of concurrency control
 - ❖ Lock based protocol.
- ❑ 2 Phase locking protocol (Basic 2PL, Strict 2PL, Rigorous 2PL, Conservative 2PL)
- ❑ Time stamp based protocol
 - ❖ Thomas Write rule
 - ❖ Deadlock Avoidance (Wait - die & Wound - wait)

Query Language

- Introduction of Relational Algebra (RA)

Operations

- ❖ Selection (σ)
- ❖ Projection (π)
- ❖ Union (\cup)
- ❖ Set Difference ($-$)
- ❖ Cross Product (\times)
- ❖ Rename (ρ)
- ❖ Intersection (\cap)
- ❖ Division ($/$)
- ❖ Join & its type.

- ❑ TRC (Tuple Relational Calculus) & DRC(Domain Relational Calculus)
- ❑ SQL & its clauses ✓
 - ❖ Aggregate operators
 - ❖ Set operators
 - ❖ Nested Query
 - ❖ Correlated nested query
- ❑ Null value concept ✓

File Organization & Indexing

- ❑ Spanned and unspanned organization
- ❑ Sparse & Dense Index
- ❑ Indexing type (Primary, Clustered, Secondary index)
- ❑ Multi level indexing
- ❑ B Tree
- ❑ Insertion & Deletion in B tree
- ❑ B⁺ Tree

ER Model & Integrity Constraints.

- ❑ Introduction of ER Model
- ❑ Attributes and its type
- ❑ Relationship set
- ❑ Participation constraints
- ❑ Cardinality Ratio
- ❑ Strong and weak entity set
- ❑ Specialization & Generalization

Foreign key concept and its constraint

Conversion of ER model to Relations (Tables).

Books:



Henry F. Korth → Transaction, ER model

Navathe → FD & Normalization

Raghu Ramakrishnan → Query Language

Jeffrey D. Ullman → File Org & Indexing

Monday to Friday 6PM onwards.

GATE Question

More than 95% Gate Question

CC : Crystal clear

C : Clear.

Doubt :

10th Pass &

(#) : Number

Bit Two way Communication

DBMS [Database management System]

Data: Raw facts

Information (meaning full Data)

Database [Collection of logical or Related Data or Collection of Similar Records]

DBMS [Set of Programs or Software Used to Access & Manipulate the Data in efficient manner.]

RDBMS

Relation — Table

- Row → Tuples @ Records
- Column → fields @ Attribute

Degree

Arity : Number (#) of Attribute
[4]

Cardinality : Number (#) of Tuples
[7]

Relational Schema : Table Abstraction/
Table Heading/
Name of Table

STUDENT (Roll No, Name,
Branch, CGPA)

STUDENT

| <u>Roll No</u> | <u>Name</u> | <u>Branch</u> | <u>CGPA</u> |
|----------------|-------------|---------------|-------------|
| 1 | A | CS | 9 |
| 2 | B | IT | 10 |
| 3 | C | CS | 9 |
| 4 | D | CS | 10 |
| 5 | E | IT | 9 |
| 6 | F | IT | 10 |
| 7 | G | CS | 9 |

Extension
↳ Table itself

Relational Instance : Set of Records

FD's

[Functional Dependency]

$X \rightarrow Y$

$R(X, Y)$

$X \rightarrow Y ?$

①

| X | Y |
|-----|-----|
| 1 | 6 |
| 2 | 8 |
| 3 | 9 |
| 4 | 2 |
| 5 | 5 |
| 6 | 7 |
| 7 | 8 |
| 1 | 6 |
| 4 | 5 |

②

| X | Y |
|-----|-----|
| 1 | 9 |
| 2 | 5 |
| 3 | 4 |
| 4 | 3 |
| 5 | 3 |
| 6 | 4 |
| 7 | 9 |
| 8 | 5 |

③

| X | Y |
|-----|-----|
| 1 | 5 |
| 2 | 5 |
| 3 | 5 |
| 4 | 5 |
| 5 | 4 |
| 6 | 4 |

④

| X | Y |
|-------|-------|
| x_1 | y_1 |
| x_2 | y_2 |
| x_3 | y_1 |
| x_2 | y_2 |
| x_3 | y_1 |
| x_4 | y_7 |

⑤

| X | Y |
|-------|-------|
| x_1 | y_1 |
| x_2 | y_1 |
| x_3 | y_2 |
| x_4 | y_2 |
| x_5 | y_3 |
| x_6 | y_3 |

⑥

| X | Y |
|-----|-----|
| 1 | 7 |
| 2 | 8 |
| 4 | 9 |
| 6 | 10 |
| 5 | 11 |
| 2 | 8 |
| 5 | 11 |
| 6 | 10 |

$X \rightarrow Y$

$X \rightarrow Y$

$X \rightarrow Y$

$X \rightarrow Y$

$X \rightarrow Y$

$X \rightarrow y$ FD

①

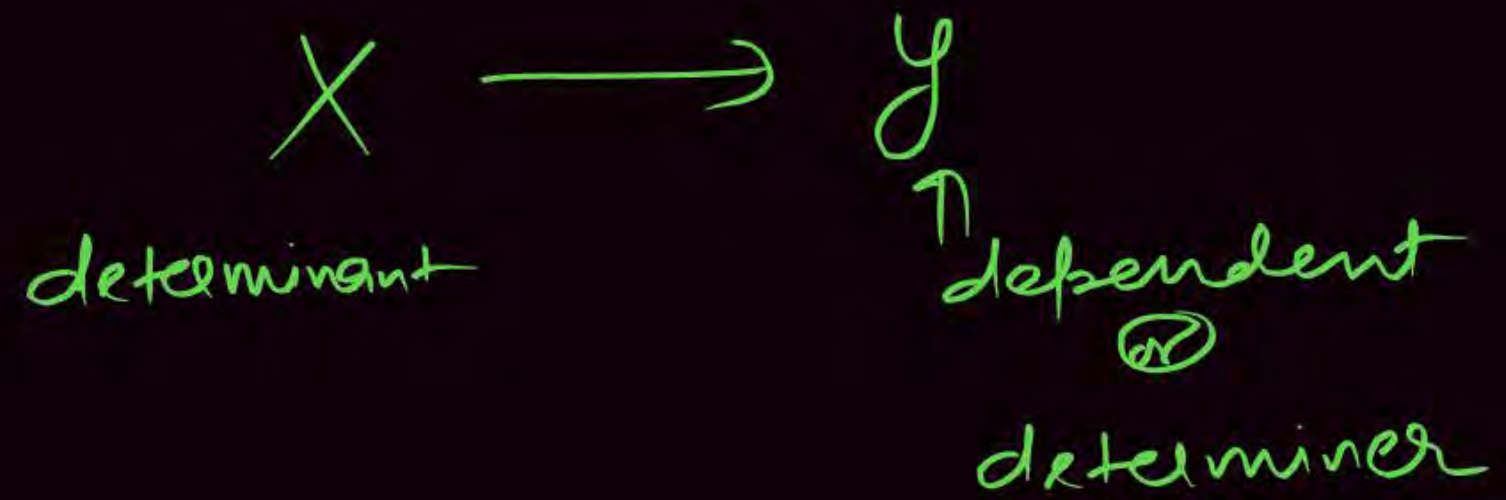
Consider a Relation schema R , with x & y be the attribute

Set of R , & t_1, t_2 Any Two Tuples Such that

$x \rightarrow y$
exist

Iff $t_1.x = t_2.x$ then $t_1.y = t_2.y$ Must be same.

Note In $x \rightarrow y$ Whenever X Value Repeat, ^{then} Corresponding y value
Must be same.



Type of FD's

Always valid

① Trivial FD

① Trivial FD

② Non Trivial FD

③ Semi Non Trivial FD

$X \rightarrow Y$ is Trivial FD

$$\text{Iff } X \supseteq Y$$

$$\underline{AB} \rightarrow \underline{A}$$

$$\underline{AB} \rightarrow \underline{B}$$

$$\underline{AB} \rightarrow \underline{AB}$$

$$\text{Sid Sname} \rightarrow \text{Sid}$$

$$\text{Sid Sname} \rightarrow \text{Sname}$$

$$\text{Sid Sname} \rightarrow \text{Sid Sname}$$

R.H.S (Right Hand side)

Attribute must be equal

⊆ Part of Left Hand side
(L.H.S) Attribute



Non Trivial FD

$X \rightarrow Y$ is Non Trivial

If $X \cap Y = \phi$ && $X \rightarrow Y$ must satisfy FD Definition

eg

A \rightarrow B

Sid \rightarrow Branch

Sid \rightarrow CGPA

Sid \rightarrow Sname

X

③ Semi Non Trivial / semi Trivial FD

$X \rightarrow Y$ is Semi Non Trivial

If $X \not\supseteq Y$ & $X \cap Y \neq \phi$

eg

AB \rightarrow BC

$X \supseteq Y$

$X \cap Y \neq \phi$

AB $\not\supseteq$ BC

$X \cap Y = \underline{B}$

11 - Priti

56 - Sameer

DBMS



Non Trivial FD's:

$X \rightarrow Z$
 $Y \rightarrow Z$
 $XY \rightarrow Z$

Ans

| X | Y | Z |
|---|---|---|
| 3 | 3 | 7 |
| 3 | 1 | 7 |
| 1 | 3 | 7 |
| 1 | 1 | 7 |
| 1 | 3 | 7 |

Find Non Trivial FD's satisfying by the instance ?

~~Trivial~~
 ~~$XYZ \rightarrow YZ$~~
 ~~XY~~
 ~~XZ~~

~~$X \rightarrow Y$~~
 $X \rightarrow Z$
 ~~$X \rightarrow YZ$~~

~~$Y \rightarrow X$~~
 $Y \rightarrow Z$
 ~~$Y \rightarrow XZ$~~

~~$Z \rightarrow X$~~
 ~~$Z \rightarrow Y$~~
 ~~$Z \rightarrow XY$~~

$XY \rightarrow Z$
 ~~$YZ \rightarrow X$~~
 ~~$XZ \rightarrow Y$~~



Consider the following relation:

| A | B | C | TUPLE# |
|----|----|----|--------|
| 10 | b1 | c1 | 1 |
| 10 | b2 | c2 | 2 |
| 11 | b4 | c1 | 3 |
| 12 | b3 | c4 | 4 |
| 13 | b1 | c1 | 5 |
| 14 | b3 | c4 | 6 |

II $B \rightarrow C$ ✓
Ans

Given the extension (state), which of the following dependencies

May hold in the above relation? If the dependency cannot hold, explain why by

Specifying the tuples that cause the violation.

~~I. $A \rightarrow B$~~ , II. $B \rightarrow C$, ~~III. $C \rightarrow B$~~ , ~~IV. $B \rightarrow A$~~ , ~~V. $C \rightarrow A$~~

Q.



| A | B | C |
|----------|---|----------|
| <u>1</u> | ① | <u>1</u> |
| <u>1</u> | ② | <u>1</u> |
| 2 | 1 | 2 |
| 2 | 1 | 3 |
| 1 | 3 | 3 |

Which Non Trivial FD are satisfying by the given Instance ?

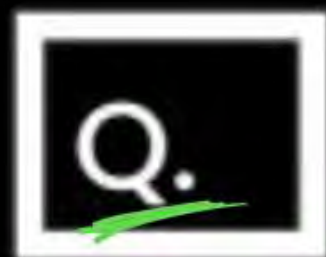
$BC \rightarrow A$ Ans

~~$A \rightarrow B$~~
 ~~$A \rightarrow C$~~
 ~~$A \rightarrow BC$~~

~~$B \rightarrow A$~~
 ~~$B \rightarrow C$~~
 ~~$B \rightarrow AC$~~

~~$C \rightarrow A$~~
 ~~$C \rightarrow B$~~
 ~~$C \rightarrow AB$~~

~~$AB \rightarrow C$~~
 $BC \rightarrow A$
 ~~$AC \rightarrow B$~~



2 marks
PSU

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





| A | B | C |
|---|---|---|
| 7 | 5 | 6 |
| 7 | 7 | 6 |
| 7 | 5 | 7 |
| 7 | 7 | 7 |
| 9 | 5 | 6 |



| A | B | C |
|---|---|---|
| 2 | 2 | 4 |
| 2 | 3 | 4 |
| 3 | 2 | 4 |
| 3 | 3 | 4 |
| 3 | 2 | 4 |



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 ____



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?

Ans (B)

~~A~~

$XY \rightarrow Z$ and $Z \rightarrow Y$

~~C~~

$YZ \rightarrow X$ and $X \rightarrow Z$

B

$YZ \rightarrow X$ and $Y \rightarrow Z$

~~D~~

$XZ \rightarrow Y$ and $Y \rightarrow X$

Any Doubt ?



**THANK
YOU!**

