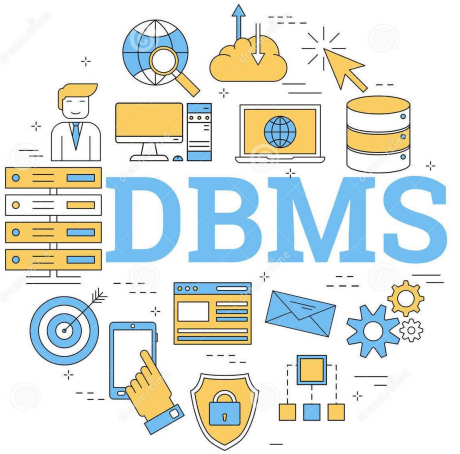
Unit III – Database Design

Dependencies and Normal forms - Functional Dependencies, **Armstrong's axioms for FD's,** closure of a set of FD's, minimal covers-Non- loss decomposition-First,Second,Third Normal Forms, Dependency Preservation-Boyce/Codd Normal Form-Multivalued Dependencies and Fourth Normal Form- Join Dependencies and Fifth Normal Form



Types of Functional Dependencies

Dependencies in DBMS is a relation between two or more attributes.

1.Trivial functional dependency

2.Non-Trivial functional dependency

3.Multivalued functional dependency

4.Transitive functional dependency

Trivial functional dependency

- In **Trivial Functional Dependency**, a dependent is always a subset of the determinant.

  If **X → Y** and **Y is the subset of X**, then it is called trivial functional dependency

Trivial functional dependency

- Example

roll_no	name	age
42	abc	17
43	pqr	18
44	xyz	18

{roll_no, name} → name is a trivial functional dependency, since the dependent **name** is a subset of determinant set **{roll_no, name}**

Similarly, **roll_no → roll_no** is also an example of trivial functional dependency.

Non Trivial functional dependency

- In **Non-trivial functional dependency**, the dependent is strictly not a subset of the determinant.

  If **X → Y** and **Y is not a subset of X**, then it is called Non-trivial functional dependency.

Non Trivial functional dependency

- Example

roll_no	name	age
42	abc	17
43	pqr	18
44	xyz	18

roll_no → name is a non-trivial functional dependency, since the dependent **name** is **not a subset of** determinant **roll_no**

Similarly, **{roll_no, name} → age** is also a non-trivial functional dependency,

since **age** is **not a subset of {roll_no, name}**

Multivalued functional dependency

- **Multivalued functional dependency**, entities of the dependent set are **not dependent on each other.**

- If **a → {b, c}** and there exists **no functional dependency** between **b and c**, then it is called a **multivalued functional dependency.**

Multivalued functional dependency

- Example

roll_no	name	age
42	abc	17
43	pqr	18
44	xyz	18
45	abc	19

roll_no → {name, age} is a multivalued functional dependency, since the dependents **name** & **age** are **not dependent** on each other(i.e. **name → age** or **age → name doesn't exist !**)

Transitive Functional dependency

- In transitive functional dependency, dependent is indirectly dependent on determinant.
- If **a → b** & **b → c**, then according to axiom of transitivity, **a → c**. This is a **transitive functional dependency**

Transitive functional dependency

Example

enrol_no	name	dept	building_no
42	abc	CO	4
43	pqr	EC	2
44	xyz	IT	1
45	abc	EC	2

enrol_no → dept and **dept → building_no**, Hence, according to the axiom of transitivity, **enrol_no → building_no** is a valid functional dependency. This is an indirect functional dependency, hence called Transitive functional dependency.

Armstrong's axioms for FD's

Primary

- ✓Axiom of reflexivity
- ✓Axiom of augmentation
- ✓Axiom of transitivity

Secondary

- ✓Union
- ✓Composition
- ✓Decomposition
- ✓Pseudo Transitivity

Axiom of reflexivity

- if Y is a subset of X, then X determines Y.
- If $X \supseteq Y$ then $X \rightarrow Y$
- $X \rightarrow X$

R.No	Name	Marks	Dept	Course
1	A	78	CS	C1
2	B	60	EE	C1
3	A	78	CE	C2
4	B	60	EE	C3
5	C	80	IT	C2

Axiom of Transitivity

- if X determines Y and Y determine Z, then X must also determine Z.

- **If X → Y and Y → Z**

  then X → Z

Ram is sibling of Sham
Sham is sibling of Mohan

Ram is sibling of Mohan

R.No	Name	Marks	Dept	Course
1	A	78	CS	C1
2	B	60	EE	C1
3	A	78	CE	C2
4	B	60	EE	C3
5	C	80	IT	C2

Name → Marks and Marks → Dept then

name → Marks

Axiom of Augmentation

- The augmentation is also called as a partial dependency.
- In augmentation, if X determines Y, then XZ determines YZ for any Z.
- If X → Y then XZ → YZ

R.No → Name then

R.No, Marks → Name, marks

R.No	Name	Marks	Dept	Course
1	A	78	CS	C1
2	B	60	EE	C1
3	A	78	CE	C2
4	B	60	EE	C3
5	C	80	IT	C2

Axiom of Union

- if X determines Y and X determines Z, then X must also determine Y and Z.

- If X → Y and X → Z then X → YZ

R.No → Name and R.No → Marks

R.No → Name, marks

R.No	Name	Marks	Dept	Course
1	A	78	CS	C1
2	B	60	EE	C1
3	A	78	CE	C2
4	B	60	EE	C3
5	C	80	IT	C2

Axiom of Decomposition / Splitting

- Decomposition rule is also known as project rule. It is the reverse of union rule.
- if X determines Y and Z, then X determines Y and X determines Z separately.
- If X → YZ Then X → Y then X → Z

Name, Marks→ Dept, Course then

Name, Marks→ Dept and

Name, Marks→ Dept, Course

R.No	Name	Marks	Dept	Course
1	A	78	CS	C1
2	B	60	EE	C1
3	A	78	CE	C2
4	B	60	EE	C3
5	C	80	IT	C2

Axiom of Pseudo Transitivity

- if X determines Y and YZ determines W, then XZ determines W.
- If X → Y and YZ → W then XZ → W

Roll No → Name, and

Name, Marks→ Dept

Then

Roll No, Marks→ Dept

R.No	Name	Marks	Dept	Course
1	A	78	CS	C1
2	B	60	EE	C1
3	A	78	CE	C2
4	B	60	EE	C3
5	C	80	IT	C2

Axiom of Composition

- If X → Y and A → B then XA → YB

Roll No → Name, and

Marks→ Dept

Then

Roll No, Marks→ Name, Dept

R.No	Name	Marks	Dept	Course
1	A	78	CS	C1
2	B	60	EE	C1
3	A	78	CE	C2
4	B	60	EE	C3
5	C	80	IT	C2


Thank You!