

COMPUTER SCIENCE

SUBJECT NAME: DBMS

CHAPTER NO.: 1

CHAPTER NAME: FUNCTIONAL DEPENDENCY & NORMAL FORMS

LECTURE NO.: 1

SYLLABUS

ER-model. Relational model: relational algebra, tuple calculus, SQL. Integrity constraints, normal forms. File organization, indexing (e.g., B and B+ trees). Transactions and concurrency control.

REFERENCE TEXTBOOKS:

- ① **Fundamentals of Database System**
Authors: Elmasri Ramez, Navathe Shamkant
- ② **Database System Concepts**
Authors: Abraham Silberschatz, Henry F. Korth
- ③ **Database Management Systems**
Authors: Raghu Ramakrishnan, Johannes Gehrke

RECORD: A collection of individual data items.

Dr. E. F Codd

DATABASE: An organized collection of records.

DBMS: A software that facilitates the end user to manage the underlying data base.

ARITY/DEGREE

NO. OF ATTRIBUTES = 3

CARDINALITY

NO. OF TUPLES = 4

Attribute		
A	B	C
a1	b1	c1
a2	b1	c1
a3	b2	c2
a1	b2	c1

→ RECORD/TUPLE

FUNCTIONAL DEPENDENCY

$A \rightarrow B$
DETERMINANT DEPENDENT

EACH VALUE OF 'A' SHOULD BE ASSOCIATED
WITH THE SAME VALUE 'B'

A	B	C
a1	b1	c1
a2	b1	c1
a3	b2	c2
a1	b2	c1

~~$A \rightarrow B$~~

~~$B \rightarrow C$~~

$A \rightarrow C$ ✓

~~$C \rightarrow A$~~

$AB \rightarrow C$ ✓

~~$BC \rightarrow A$~~

~~$AC \rightarrow B$~~

$A \rightarrow A$ ✓

$B \rightarrow B$ ✓

$C \rightarrow C$ ✓

$AB \rightarrow A$ ✓

$BC \rightarrow B$ ✓

FUNCTIONAL DEPENDENCY

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

$$XZ \rightarrow X \quad \checkmark$$

$$XY \rightarrow Z \quad \checkmark$$

$$Z \not\rightarrow Y$$

$$Y \rightarrow Z \quad \checkmark$$

$$XZ \not\rightarrow Y$$

FUNCTIONAL DEPENDENCY

(1) TRIVIAL FOR $X \rightarrow Y$ IF $X \supseteq Y$ Eg:- $AB \rightarrow A$, $AB \rightarrow B$, $AB \rightarrow AB$

(2) NON TRIVIAL FOR $X \rightarrow Y$ IF $X \cap Y = \emptyset$ Eg:- $AB \rightarrow CD$ $AB \cap CD = \emptyset$

(3) SEMI NONTRIVIAL FOR $X \rightarrow Y$ IF $X \cap Y \neq \emptyset$ AND $X \not\supseteq Y$

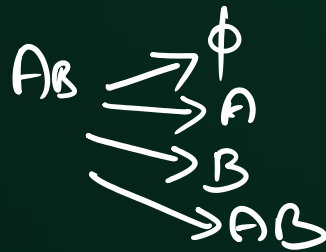
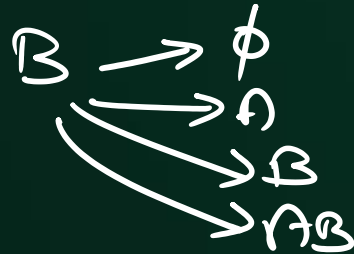
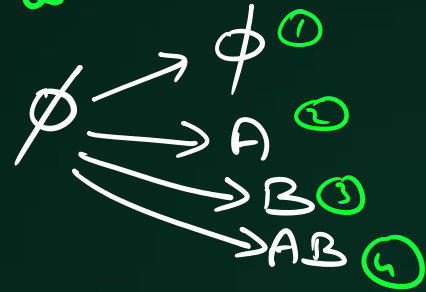
Eg:- $AB \rightarrow BC$

$$AB \cap BC = B \neq \emptyset$$

How many FDs are possible for a relation with "N" attributes?

$N=2$

A	B



$$2^N \times 2^N = \underline{\underline{2^{2N}}}$$

$$2^2 \times 2^2 = \underline{\underline{16}}$$

AMSTRONG'S AXIOMS:

$$\underline{XW} \rightarrow \underline{YW}$$

(1) REFLEXIVITY IF $X \supseteq Y$ THEN $X \rightarrow Y$

(2) AUGMENTATION IF $X \rightarrow Y$ THEN $XW \rightarrow Y$ AND/OR $XW \rightarrow YW$

(3) TRANSITIVITY IF $X \rightarrow Y$ AND $Y \rightarrow Z$ THEN $X \rightarrow Z$

(4) PSEUDOTRANSITIVITY IF $X \rightarrow Y$ AND $YW \rightarrow Z$ THEN $XW \rightarrow Z$

(5) UNION IF $X \rightarrow Y$ AND $X \rightarrow Z$ THEN $X \rightarrow YZ$

(6) DECOMPOSITION IF $X \rightarrow YZ$ THEN $X \rightarrow Y$ AND $X \rightarrow Z$

$$\begin{array}{c} \underline{X \rightarrow YZ} \\ X \rightarrow Y \\ X \rightarrow Z \end{array}$$

$$\begin{array}{c} \underline{X \rightarrow Y} \\ X \rightarrow Z \\ \hline X \rightarrow YZ \end{array}$$

CLOSURE OF ATTRIBUTE SET:

The set of all the attributes that are functionally determined by an attribute set S is called as Closure of Attribute Set S .

$R(ABCD)$

$FD = \{ A \rightarrow B$
 $B \rightarrow C$
 $C \rightarrow D \}$

$A^+ = ABCD$

$A \rightarrow \phi$

$A \rightarrow A$

$A \rightarrow B$

$A \rightarrow C$

$A \rightarrow D$

$A \rightarrow AB$

$A \rightarrow BC$

$A \rightarrow CD$

$A \rightarrow ABCD$

$B^+ = BCD$

$C^+ = CD$

$C \rightarrow \phi$

$C \rightarrow C$

$C \rightarrow D$

$C \rightarrow CD$

KEY:

Attributes or set of attributes that determines the tuples uniquely in a relation.

SUPER KEY:

Attributes or set of attributes that possesses Uniqueness property

$$\textcircled{1} (e_{id})^+ = e_{id}, e_{name}, salary$$

$$\begin{aligned} \textcircled{2} (e_{id}, e_{name})^+ \\ \textcircled{3} (e_{id}, e_{name}, salary)^+ \end{aligned}$$

SUPER KEY

CANDIDATE KEY:

Attributes or set of attributes that possesses two properties

- (1) Uniqueness
- (2) Irreducible

$$\begin{aligned} \textcircled{1} (e_{id})^+ & \text{UN + IR} \\ \textcircled{2} (e_{id}, e_{name})^+ & (e_{id})^+ = \text{————} \\ \textcircled{3} (e_{id}, e_{name}, salary)^+ & \end{aligned}$$

EMPLOYEE

<u>e_{id}</u>	e _{name}	Salary
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PRIMARY KEY:

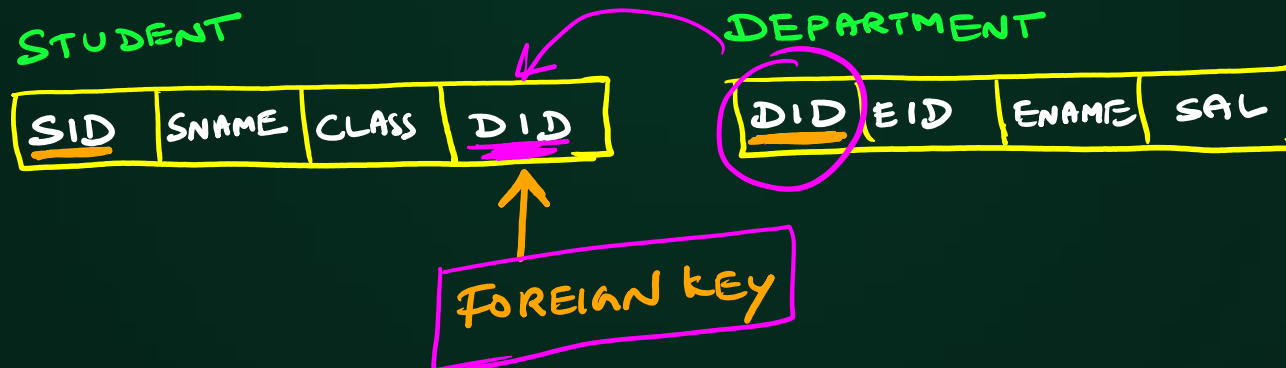
One of the Candidate Key selected by the designer of the database.

ALTERNATE KEY:

All Candidate Keys except the Primary Key

FOREIGN KEY:

Attributes or set of attributes in a relation that acts as Primary Key in another relation.



FINDING ALL CANDIDATE KEYS

$$R(ABCD)$$
$$F = \{AB \rightarrow \underline{C}D\}$$
$$C \rightarrow D$$
$$C \rightarrow \underbrace{A}$$

union

$AB \rightarrow C$
 $AB \rightarrow D$

ONLY LEFT

B

~~ONLY RIGHT~~

BOTH LEFT & RIGHT

A, C

$$(B)^+ = B$$

✓ ① $(BA)^+ = BACD$

$$\textcircled{2} \begin{pmatrix} B & C \\ I & T \end{pmatrix}^+ = BCDA$$

\downarrow \downarrow
 AB
 \downarrow
 ~~AB~~

~~TOTAL 2 Candidate keys~~

AB & BC

$R(ABCDE)$

$F = \{AB \rightarrow CD, C \rightarrow D\}$

① $(AB)^+ = ABCD$

ONLY ONE CK

ABE

LEFT ONLY

A B

RIGHT ONLY

D

BOTH LEFT & RIGHT

C

$(AB)^+ = ABCD$

$(ABE)^+ = ABCDE$

CK as well as SLK

$R(A B C \textcircled{D})$

$F = \{ AB \rightarrow C \\ C \rightarrow A \}$

① $(AB)^+ = ABC$

↓
② CB
 $\underbrace{\quad}_{AB}$
 $\underbrace{\quad}_{AB}$
 $AB \times$

Total cks

ABD & CBD

$R(ABCDEF)$

$F = \{ AB \rightarrow CDE$

$E \rightarrow F$

$C \rightarrow B$

$D \rightarrow A$

$F \rightarrow D \}$

$AB \rightarrow C$
 $AB \rightarrow D$
 $AB \rightarrow E$

① $(AB)^+ = ABCDEF$ ✓

② DB

③ AC

④ DC

⑤ FB

⑥ FC

⑦ EB

⑧ EC

Total 8 cks

$R(ABCDEFGG)$

$F = \{$
 $AB \rightarrow CD$
 $CD \rightarrow EF$
 $D \rightarrow A$
 $C \rightarrow B$
 $E \rightarrow F$
 $F \rightarrow D$
 $\}$

FIND ALL THE CANDIDATE KEYS?