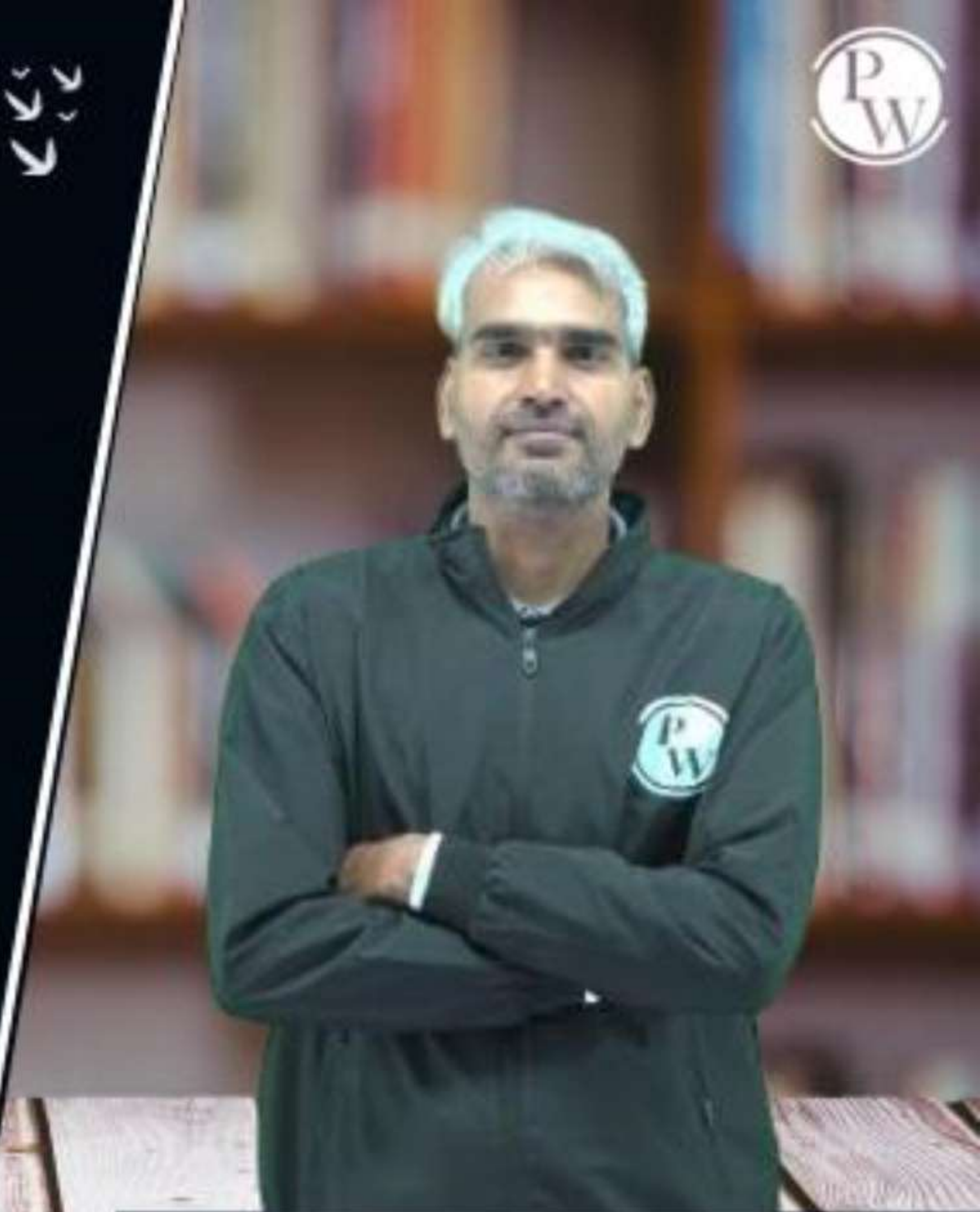
Computer Science & IT

Database Management System

Relational Model & Normal Forms

Lecture No. 05



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Recap of Previous Lecture

Topic Properties of functional dependency

Topic Different types of keys in RDBMS

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Topics to be Covered

- **Topic** Different types of keys in RDBMS
- **Topic** Candidate key
- **Topic** Super key
- **Topic** Closure of an attribute set

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Topic : Candidate key

A set of attributes from which no attribute can be removed without destroying its property of being a key

The minimal set of attributes that can uniquely identify each tuple of the relation is called Candidate Key

(or)

The minimal set of attributes that can determine all the attributes of the relation is called Candidate Key of that relation

Minimal Set :- A set from which no element can be deleted without destroying its property is called minimal set.

eg1: Consider the following relation

Student(Sid, Sname, fee)

Student

Sid	Sname	fee
S1	A	500
S2	A	400
S3	B	700
S4	C	500
S5	C	500
S6	D	600

Let FDs that exist in the relation are

$$\boxed{\begin{array}{l} Sid \rightarrow Sname \\ Sid \rightarrow fee \end{array}}$$

* Values of Sid will always be unique in the student table. ∴ Sid is a Key
* The values of (Sid, Sname) together will also be uniques in all the tuples.
  ∴ (Sid, Sname) is also a Key

* In eg: 1
  (Sid, Sname) together is a Key of the relation "Student", but it is not minimal because even if we remove the attribute 'Sname' from the set then 'Sid' alone can uniquely identify each tuple of the relation.
  ∴ {Sid, Sname} is a Key but it is not a Candidate Key.
* In eg: 1
  {Sid} is also a key and it is minimal as well,
  ∴ "Sid" is a C.K. of the relation Student.

In eg: 2

{Sid, Cid} is a key of the relation

① If we remove 'Sid' from the set then 'Cid' alone can not determine all the attributes of the relation.

Similarly, ② If we remove 'Cid' from the set, then 'Sid' alone can not uniquely identify each tuple of the relation.

i.e, if we remove anything from the set {Sid, Cid}, then it does not remain a key ∴ {Sid Cid} is a minimal key

Hence {Sid Cid} is a Candidate key of the relation.

eg 2: Consider the following relation

Enroll (Sid, Cid, I-id)

Instructor ID

Enroll

Sid	Cid	I-id
S_1	C_1	101
S_2	C_1	101
S_3	C_2	104
S_3	C_3	101
S_3	C_1	101

let following FD holds

$\boxed{Cid \rightarrow I\text{-}id}$

Together the values of (Sid, Cid) will always be unique in all the tuples.

∴ (Sid, Cid) is a key.

Topic : Candidate key

1. A key formed of a single attribute is always a Candidate key.
2. If a Candidate key is formed of a single attribute, then it is called a simple candidate key.
3. If a candidate key is formed of two or more attributes then it is called a Composite or Compound Candidate key.
4. A relation may have more than one candidate key.

Topic : Candidate key

(5) Attributes belonging to any of the candidate key of the relation are called prime attributes (key-attributes) of the relation, and attributes which does not belong to any of the candidate key are called non-prime attributes.

(6) Candidate key attributes may be allowed to take "NULL" values

Topic : Primary key

{ Primary key is also a Candidate key. }

- There may be multiple candidate keys in a relation. Out of those candidate keys one candidate key may be choosen as "Primary key".
- In a relation there can be $\underbrace{\text{at-most}}_{\{0 \text{ or } 1\}}$ one primary key
- Primary key attributes are not allowed to take NULL values.

Topic : Alternate key

Also known as "Secondary key"

- All candidate keys Except "primary key" are Called alternate keys.

* All alternate keys are candidate keys as well.
* Every primary key is also a candidate key

Topic : Super key

{May or may not be minimal}

A set of attributes that can determine all the attributes of a relation is called a Super key

{for super key, it need not be minimal}

* Every Candidate key is a Super key, but Every Super key need not be a Candidate key.

eg1: Consider the following relation
Student(Sid, Sname, fee)

Student

Sid	Sname	fee
S1	A	500
S2	A	400
S3	B	700
S4	C	500
S5	C	500
S6	D	600

Let FDs that exist in the relation are

$$\boxed{\begin{matrix} Sid \rightarrow Sname \\ Sid \rightarrow fee \end{matrix}}$$

* Values of Sid will always be unique in the student table. ∴ Sid is a Key
* The values of (Sid, Sname) together will also be uniques in all the tuples. ∴ (Sid, Sname) is also a Key

• In eg 1:
"Sid" is the Only Candidate key of the relation

Q: Find all the Superkeys of the relation.

'Sid' is a C.K, ∴ all the values in the relation w.r.t. 'Sid' are unique.
If we take any Super-set of 'Sid', then values w.r.t. that set of attributes will also be unique.

⇒ ∴ Superkeys of the relation Student are,
{Sid},
{Sid, Sname}
{Sid, fee}
{Sid, Sname, fee}

Every set is a Superset of itself.

Total '4' Super keys

Hence, Every Super-set of 'Sid' is a Super Key.

Topic : Super key

Note :- At least one subset of set of attributes of a super key is a Candidate key.

Note :

Super key attribute set = All attributes of any one Candidate key + 0 or more attributes out of remaining attributes of the relation.

Q: Consider the following relational schema $R(A_1, A_2, A_3, \ldots, A_n)$
Find the total number of super keys in relation R.

(i) When attribute 'A_1' is the only Candidate key of relation R

Super key = Attribute "A_1" must be present (and) 0 or more attributes out of remaining '$n-1$' attributes

$\therefore$ # Super keys = $1 * \left\{ {}^{n-1}C_0 + {}^{n-1}C_1 + {}^{n-1}C_2 + \cdots + {}^{(n-1)}C_{(n-1)} \right\}$

Only one way to select 'A_1'

$= 1 * 2^{n-1}$

$= 2^{n-1}$ Ans

$$\boxed{{}^nC_0 + {}^nC_1 + {}^nC_2 + \cdots + {}^nC_n = 2^n}$$

Q: Consider the following relational schema $R(A_1, A_2, A_3, \ldots, A_n)$

Find the total number of super keys in relation R.

(i) When attribute 'A_1' is the only Candidate key of relation R

Super key = Attribute A_1 must be present (and) No Constraint on remaining $(n-1)$ attributes

$$\therefore \# \text{ Super keys} = \underset{A_1}{1} * \underbrace{\underset{A_2}{2} * \underset{A_3}{2} * \underset{A_4}{2} * \cdots * \underset{A_n}{2}}_{(n-1) \text{ time } 2} = 2^{n-1} \quad \underline{\underline{\text{Ans}}}$$

Only one way to Choose 'A_1'

for every other attribute We have two choices, either take it or leave it

Q: Consider the following relational schema $R(A_1, A_2, A_3, \ldots, A_n)$

Find the total number of super keys in relation R.

(ii) When $(A_1 A_2)$ together is the only candidate key of relation R.

Super key = Both A_1 & A_2 must be present (and) no constraint on remaining $(n-2)$ attributes

$$\begin{array}{ccccccc} A_1 & A_2 & A_3 & A_4 & \ldots & A_n \\ \downarrow & \downarrow & \downarrow & \downarrow & & \downarrow \end{array}$$

$$\# \text{ Super keys} = \underbrace{1 * 1}_{\text{Select both } A_1 \& A_2} \quad \underbrace{2 * 2 * \ldots * 2}_{(n-2) \text{ times '2'}} = 2^{n-2}$$

Ans

Q: Consider the following relational schema $R(A_1, A_2, A_3, \ldots, A_n)$
Find the total number of super keys in relation R.

(iii) When 'A_1' and 'A_2' are the only two candidate keys of relation R.

$$A_1 \quad A_2 \quad A_3 \quad A_4 \; \ldots \; A_n$$

In a super key of R:

A1 is taken, A2 is not taken:
$$\checkmark \; \times \; ? \; ? \; \ldots \; ?$$
$$1 * 1 * \underbrace{2 * 2 * \ldots * 2}_{(n-2) \text{ times}} = 2^{n-2}$$

(or)

A1 is not taken & A2 is taken:
$$\times \; \checkmark \; ? \; ? \; \ldots \; ?$$
$$1 * 1 * \underbrace{2 * 2 * \ldots * 2}_{(n-2) \text{ times}} = 2^{n-2}$$

(or)

Both A1 & A2 are taken:
$$\checkmark \; \checkmark \; ? \; ? \; \ldots \; ?$$
$$1 * 1 * \underbrace{2 * 2 * \ldots * 2}_{(n-2) \text{ times}} = 2^{n-2}$$

Total No. of Superkeys $= 2^{n-2} + 2^{n-2} + 2^{n-2} = 3 \cdot 2^{n-2}$

Ans

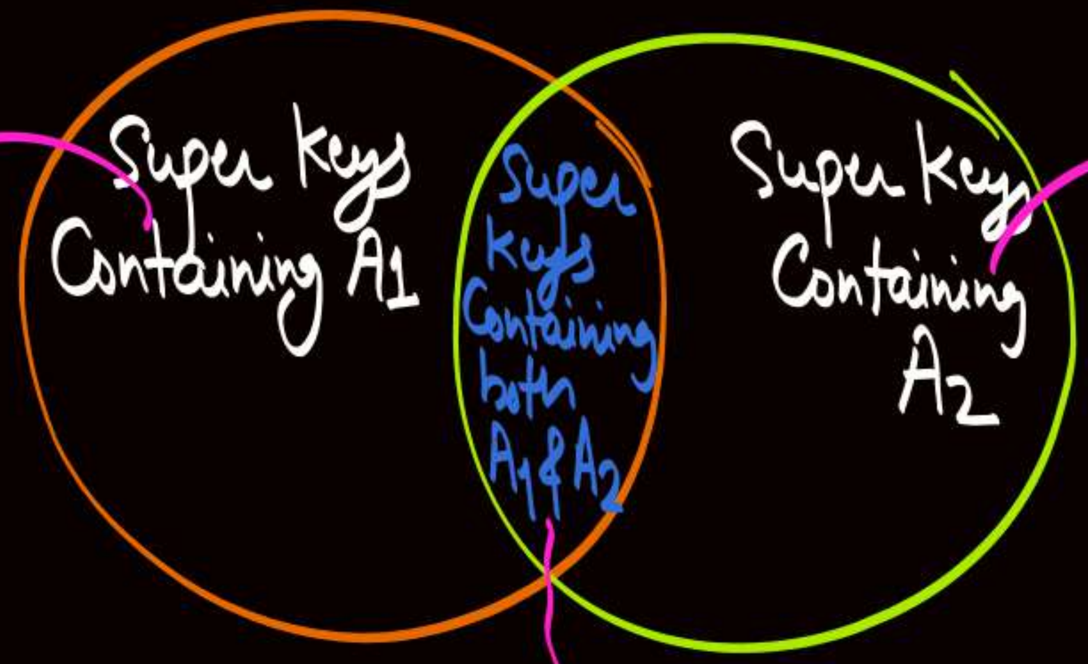
Q: Consider the following relational schema $R(A_1, A_2, A_3, \ldots, A_n)$

Find the total number of super keys in relation R.

(iii) when 'A_1' and 'A_2' are the only two candidate keys of relation R.

Soluⁿ:

2^{n-1}



2^{n-1}

2^{n-2}

$\therefore$ Total No. of Super Keys $= 2^{n-1} + 2^{n-1} - 2^{n-2}$

$= \boxed{3 \cdot 2^{n-2}}$ Ans

Q: Consider the following relational schema $R(A_1, A_2, A_3, \ldots, A_n)$

Find the total number of super keys in relation R.

(iv) When $(A_1 A_2)$ & $(A_2 A_3)$ are the only two candidate keys of relation R.

Q: Consider the following relational schema $R(A_1, A_2, A_3, \ldots, A_n)$

Find the total number of super keys in relation R.

(V) When $(A_1 A_2)$ & $(A_3 A_4)$ are the only two candidate keys of relation R.

Q: Consider the following relational schema $R(A_1, A_2, A_3, \ldots, A_n)$

Find the total number of super keys in relation R.

(Vi) When (A_1), (A_2) & (A_3) are the only three candidate keys of relation R.

2 mins Summary

- **Topic** Different types of keys in RDBMS
- **Topic** Candidate key
- **Topic** Super key
- **Topic** Closure of an attribute set

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THANK - YOU

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