KEYS IN DBMS

KEYS

- SUPER KEYS (KEYS)
- CANDIDATE KEYS
- PRIMARY KEYS
- FOREIGN KEYS

Keys in DBMS

STUDENT [Table | Relation]

Attributes / Fields.

Name	Marks	Dept	Course
Ram	78	CSE	C_1
Sham	65	ECE	C_2
Ram	78	CSE	C_2
sham	65	ECE	C_3
Kumar	80	EEE	C_2

rows / records / tuples.

Keys : [Super key] Attribute or a set of attributes that uniquely identify each record of a relation.

{Dept, course} → Key / SK ✓

{Name, Marks} → key ✗

{Name, Marks, Dept, course} → Key / SK ✓

* Consider the below relation for Student

Roll No	Name	Marks	Dept	Course.
CS101	Ram	78	CSE	C1
EC201	Sham	65	ECE	C2
CS102	Ram	78	CSE	C2
EC202	sham	65	ECE	C3
EE301	Kumar	80	EEE	C2

{Roll No} → key / SK ✓

{Roll No, Name} → key / SK ✓

{Roll No, Marks} → key / SK ✓

{Roll No, Dept} → key / SK ✓

{Roll No, course} → key / SK ✓

Candidate key : Super key whose proper subset is not a super key.

Consider R(A, B, C, D)

A	B	C	D
1	1	3	1
2	1	5	1
3	1	5	1
4	2	5	1
5	2	3	1
6	2	3	2

SK ⇒ {A}, {AB}, {AC}, {A,D}
{A,B,C}, {A,C,D}
{A,B,D}, {A,B,C,D}

no proper subset : satisfied only for {A}.

⇒ {A} is the Candidate key.

~~All the other superkeys~~

Primary key :- A candidate key with no null values is set as the primary key.

Alternate keys :- All the other candidate keys are considered as alternate keys or secondary keys.

* Every relation can have more than one super keys / candidate keys

* There can be only one primary key for a relation.

Consider the relation

R(A, B, C)

A	B	C
1	3	5
2	3	6
3	4	5
4	4	6

Identify the super keys, candidate keys and primary key.

SK $\Rightarrow$ $\{A\}$, $\{A,B\}$, $\{A,C\}$, $\{A,B,C\}$

$\{B,C\}$

CK $\Rightarrow$ $\{A\}$ $\{B,C\}$

PK $\Rightarrow$ Any One of $\{A\}$ or $\{B,C\}$ can be a primary key.

ATTRIBUTE CLOSURE

ATTRIBUTE CLOSURE

- Attribute closure of an attribute set can be defined as set of attributes which can be functionally determined from it.
- Attribute closure of an attribute X is denoted by X^+
- **Algorithm**
- Let's see the algorithm to compute X^+
- **Step 1** – $X^+ = X$
- **Step 2** – repeat until X^+ does not change
  - For each FD Y->Z in F
    - If $Y \subseteq X^+$ then $X^+ = X^+ \cup Z$

ATTRIBUTE CLOSURE

- Consider a relation R(A,B,C,D,E,F,G) and FDs: E->A, E->D, A->C, A->D, AE->F, AG->K.

Find the closure of E or E^+

Solution:

E+ = E

=EA {for E->A add A}

=EAD {for E->D add D}

=EADC {for A->C add C}

=EADC {for A->D D already added}

=EADCF {for AE->F add F}

=EADCF {for AG->K don't add k AG $\not\subset$ D+)

Attribute Closure / closure set

$R(A, B, C, D, E)$

FD $\{A \rightarrow B,\ B \rightarrow C,\ C \rightarrow D,\ D \rightarrow E\}$

$A \rightarrow B$	$B \rightarrow C$	$C \rightarrow C$	$D \rightarrow E$	$E \rightarrow E$
$A \rightarrow C$	$B \rightarrow D$	$C \rightarrow D$		
$A \rightarrow A$	$B \rightarrow E$	$C \rightarrow E$		
$A \rightarrow D$	$B \rightarrow B$	$C \rightarrow CDE$		
$A \rightarrow E$	$B \rightarrow BCDE$			

$A \rightarrow A, BCDE$

$A^+ = \{A, B, C, D, E\} \longrightarrow$ ✓ SK

$AD^+ = \{A, D, B, C, E\} \longrightarrow$ ✓ SK

$B^+ = \{B, C, D, E\} \longrightarrow$ X SK

$CD^+ = \{C, D, E\} \longrightarrow$ X SK

CANONICAL / MINIMAL COVER

- If a functional dependency set F is given, F’ is a canonical cover of given FD set if **it does not have:**

    i) Extraneous Attributes / Redundant Attributes

    ii) Redundant Functional Dependancies

- Steps to Determine Minimal Cover:
- **Step 1:** Apply Split Rule such that every FD has only single attribute on the RHS of the FD.
- **Step 2:** Remove Extraneous Attribute
- **Step 3:** Remove Redundant Functional Dependencies

MINIMAL COVER EXAMPLE

- Given F {AB -> C, C -> AB, B -> C, ABC -> AC, A -> C, AC -> B} for R(A,B,C), find the minimal cover.

Solution:

Step 1: Apply Split rule:

FD will become {AB->C, C->A, C->B, B->C, ABC->A, ABC->C, A->C, AC->B}

In the above FD set ABC->A, ABC->C are trivial FDs and hence can be discarded.

The revised FD set will be {AB->C, C->A, C->B, B->C, A->C, AC->B}

Step 2: Remove Extraneous / Redundant Attributes:

{AB->C, C->A, C->B, B->C, A->C, AC->B}

In the above FD set, it can be seen that AB->C and B->C => B alone can determine C.

Like wise A->C and AC ->B => A alone can determine B.

⇒{**A**B->C, C->A, C->B, B->C, A->C, **A**C->B} => {B->C, C->A, C->B, B->C, A->C, A->B}

⇒ {C->A, C->B, B->C, A->C, A->B}. This is the FD set at the end of step 2.

MINIMAL COVER EXAMPLE

Step 3: Remove Redundant Functional Dependencies:

{C->A, C->B, B->C, A->C, A->B}. This is the FD set at the end of step 2.

Consider C->A, To check if this is redundant, take attribute closure for C without considering FD C->A.

Perform C+ over {C->B, B->C, A->C, A->B}

C+ = CB => Closure not attained => Cannot discard => C-> A cannot be removed

Now {C->A, C->B, B->C, A->C, A->B}

Perform C+ over {C->A, B->C, A->C, A->B}

C+ = CAB => Closure attained => C-> B can be discarded.

The revised FD set will be {C->A, B->C, A->C, A->B}

Now check for {C->A, B->C, A->C, A->B}

Perform B+ over {C->A, A->C, A->B}

B+ = B => Closure not attained => Cannot discard => B->C cannot be removed

MINIMAL COVER EXAMPLE

Now check for {C->A, B->C, A->C, A->B}

Perform A+ over {C->A, B->C, A->B}

A+ = ABC => Closure attained => Can discard => A->C can be removed

Now the FD set will be {C->A, B->C, A->B}. Check for A->B

Perform A+ over {C->A, B->C}

A+ = A => Closure not attained => Cannot discard => A->B cannot be removed

The final refined FD set **F' = {C->A, B->C, A->B}.** This is the minimal cover set.

DETERMINING THE CANDIDATE KEYS OF A RELATION

- **Problem 1:** Given R (A, B, C, D, E) and FD: {A -> B, D ->E}, Find all the candidate keys and primary attributes.
- **Solution:**

ABCDE+ = {A,B,C,D,E} => SK

Because A -> B and D - > E, B and E can be eliminated.

ACD+ = {A, C, D, B, E} => SK

To determine if ACD is a Candidate key (CK), the proper subset should not be a super key.

A+, C+, D+ AC+, CD+ and AD+ are not SKs. => **ACD can now be considered as a candidate key.**

Prime attributes (A, C, D) – Attributes that are part of Candidate key.

Next Step: Check if any other candidate key exists.

In the first iteration the Primary attributes were {A, C, D}

Check whether any primary attribute is present in the RHS of the FDs.

There are none => **{A, C, D} is the only Candidate Key and the Primary attributes are A,C,D.**

DETERMINING THE CANDIDATE KEYS OF A RELATION

- **Problem 2:** Given R (A, B, C, D) and FD: {A -> B, B->C, C->A}, Find all the candidate keys and primary attributes.
- **Solution:**

ABCD+ = {A,B,C,D} => SK

Because A -> B, B->C , B and C can be eliminated.

AD+ = {A,D,B,C} => SK

To determine if AD is a Candidate key (CK), the proper subset should not be a super key.

A+ and D+ are not SKs. => **AD can now be considered as a candidate key.**

Prime attributes (A, D) – Attributes that are part of Candidate key.

Next Step: Check if any other candidate key exists.

In the first iteration the Primary attributes were {A, D}

Check whether any primary attribute is present in the RHS of the FDs.

A is available on the RHS of given FD C->A.

DETERMINING THE CANDIDATE KEYS OF A RELATION

So replace A in {A,D} with C and check if {C,D} can also be a SK.

CD+ = {C,D,A,B} => SK

Now check if CD can be a Candidate key

C+ and D+ are not SKs. => **CD can now be considered as a candidate key.**

=> **Prime attributes (A, D, C)**

Next Step: Check if any other candidate key exists.

Check whether any primary attribute is present in the RHS of the FDs.

C is available on the RHS of given FD B->C.

So replace C in {C,D} with B and check if {B,D} can also be a SK.

BD+ = {B,D,C,A} => SK

B+ and D+ are not SKs. => **BD can now be considered as a candidate key.**

⇒**Prime attributes (A, D, C, B)**

⇒**Candidate Keys are AD, CD and BD**