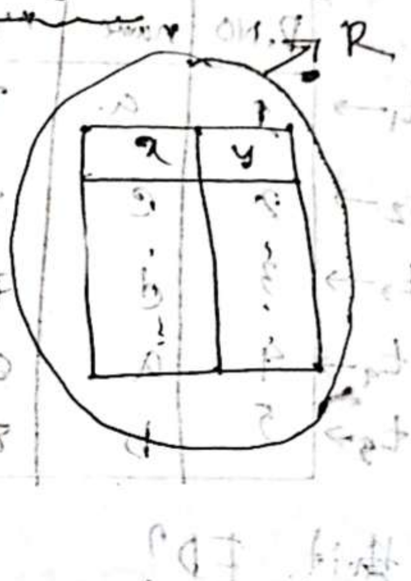
DBMS

Functional Dependency , keys

FD : $x \xrightarrow{\text{(determinent)}} y \rightarrow$ (dependent)



$\boxed{\text{tapples = rows}}$

** x এর মান যদি একই হয় y এর মান ও same হতে হবে।

** If the tapple of x is same then y will also same values.

case 1

	x	y
$t_1 \rightarrow$	1	1
$t_2 \rightarrow$	2	1
$t_3 \rightarrow$	3	2
$t_4 \rightarrow$	4	5
$t_5 \rightarrow$	2	3

case 2

	x	y
$t_1 \rightarrow$	1	1
$t_2 \rightarrow$	2	1
$t_3 \rightarrow$	3	2
$t_4 \rightarrow$	2	1

■ FD : $x \rightarrow y$

if $t_1.x = t_2.x$ then must be $t_1.y = t_2.y$ (case 2)

■ FD : $x \rightarrow y$

if $t_1.x \neq t_2.x$ then you don't need to check the condition of y. y would be same or not same. (case 2)

But

■ FD : $x \rightarrow y$

if $t_1.x = t_2.x$ and $t_1.y \neq t_2.y$ then it is not the case of Functional dependency. case (1)

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Example:

	R.NO	name	marks	Dept	course
$t_1 \rightarrow$	1	a	70	CSE	C_1
$t_2 \rightarrow$	2	c	80	EEE	C_2
$t_3 \rightarrow$	3	d	70	CSE	C_1
$t_4 \rightarrow$	4	a	68	ME	C_3
$t_5 \rightarrow$	5	b	81	EEE	C_2

is it FD?

$\boxed{\underbrace{\text{R.no}}_{x} \rightarrow \underbrace{\text{name}}_{y}}$ ✓

~~$t_1.x \neq t_2.x$~~

It is FD, 1 is true

$\boxed{\overset{x}{\text{Name}} \rightarrow \overset{y}{\text{R.no}}}$ ✗

* $t_1.x = t_4.x$ but $t_1.y \neq t_4.y$ so: it is not FD

$\boxed{\overset{x}{\text{Dept}} \rightarrow \overset{y}{\text{course}}}$ ✓

$t_1.x = t_3.x$ and

$t_1.y = t_3.y$

Again $t_2.x = t_5.x$

$t_2.y = t_5.y$ (it is FD)

1 $\boxed{}$ $t_1.x \neq t_2.x$ then no need to check y and it is a FD.

2 $\boxed{}$ $t_1.x = t_2.x$ then must be $t_1.y = t_2.y$. then it will FD otherwise it is not FD.

3 $\boxed{}$ Every time we just check the repeted value to determine FD. That's make our calculat[ion] easier.

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$\underbrace{\text{R.no, Name}}_{x} \longrightarrow \underbrace{\text{Marks}}_{y}$ ✓

R.no.	name	mark
1	a	60
2	b	70
3	d	80
4	e	90
1	a	61

$\underset{x}{\boxed{\text{R.no, name}}} \longrightarrow \underset{y}{\boxed{\text{marks}}}$

In this case not FD.

~~কোনো একটা condition এ FD এর কোনো~~
কোনো একটা case না মিললেই সেটা FD হবে না।
অন্যগুলো check করা লাগবে না।

[***] methods/properties.

Reflecxivity: If y is a subset of x then $x \rightarrow y$ (trivial)

Augmentation: If $x \rightarrow y$ then $xz \rightarrow yz$

**** Transitive:** If $x \rightarrow y$ and $y \rightarrow z$ then $x \rightarrow z$

Union: If $x \rightarrow y$ and $x \rightarrow z$ then $x \rightarrow yz$

Composition: If $x \rightarrow y$ and $z \rightarrow w$ the $xz \rightarrow yw$

Decomposition: If $x \rightarrow yz$ then $x \rightarrow y$ and $x \rightarrow z$

Pseudutransitive: If $x \rightarrow y$ and $wy \rightarrow z$ the $wx \rightarrow z$

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Trivial FD: (~~Reflexivity~~)

if $x \to y$ and y is subset of x is called trivial FD and y is an attribute.

$\boxed{\text{This case always true.}}$ Valid

L.H.S	R.H.S
id, name $\to$	id
id, address $\to$	address

L.H.S $\cap$ R.H.S $\neq \phi$.

Non ~~trivial~~ trivial:

if $x \to y$ and y is not the subset of x is ~~also~~ called non-trivial FD.

L.H.S	Right
id $\to$	name
id $\to$	semester

L.H.S $\cap$ R.H.S $= \phi$

Trivial FD: (No need to check the table it always valid)

$x \to y$ if $y \subseteq x$	id, name $\to$ name
$x \to x$ if $x \subseteq x$	id $\to$ id

* very less use case

Non trivial FD: $x \to y$ and $x \cap y = \phi$ and $y \not\subseteq x$. ~~but it is semitrivial.~~

id $\to$ name

x, y are totally different

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if $\underbrace{id, name}_{x} \rightarrow \underbrace{name, Marks}_{y}$

x and y are different but here is an attribute common in L.H.S and R.H.S. This time it's call Semi trivial.

~~Armstrong's Axioms / In~~

Armstrong's Axioms / Inferece rules:

1. Reflexivity : $x \rightarrow x$, $x \rightarrow y$ and $y \subseteq x$ (trivial)

2. Transivity : if ($x \rightarrow y$ and $y \rightarrow z$) then $x \rightarrow z$

   Name $\rightarrow$ Dept

   Dept $\rightarrow$ Faculty

   Then name $\rightarrow$ Faculty.

3. Agmentention : if $x \rightarrow y$ then $xA \rightarrow yA$
   id, city $\rightarrow$ name, city

4. Union : if $\underbrace{x \rightarrow y}_{id \rightarrow name}$ and $\underbrace{x \rightarrow z}_{id \rightarrow city}$ then $\underbrace{x \rightarrow yz}_{id \rightarrow name, city}$

5. Decomposition/splitting: if $\underbrace{x \rightarrow yz}_{id \rightarrow name, city}$ then $\underbrace{x \rightarrow y}_{id \rightarrow name}$ and $\underbrace{x \rightarrow z}_{id \rightarrow city}$

we can't split L.H.S.

But $xy \rightarrow z$ then $x \rightarrow z$ and $y \rightarrow z$ that's not possible.

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Psedo transitive: If ($x \to y$ and $yz \to A$) then $xz \to A$.

Exp: id → name, name, city → marks then id, city → marks.

Composition: if $x \to y$ and $a \to b$ then $xa \to yb$

Attribute closure / closure set

** If you find all the closure set of attributes then it is easy to find candidate / super etc keys.

** If you find the candidate keys then you can easily do 2nd, 3rd, BCNF normalization

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table → $R(\underbrace{A, B, C, D, E}_{\text{attributes}})$

FD ($A \to B$, $B \to C$, $C \to D$, $D \to E$)

$A \to B$ and $B \to C$

So $A \to C$ (transitivity)

Also, $A \to A$ (Reflexivity)

$A \to C$
~~$A \to B$~~
$A \to D$
$A \to E$ } (transitivity)

$A \to ABCDE$ } (union)

$B \to C$
$B \to D$
$B \to E$ } transitivity

$B \to BCDE$ (union)

$C \to D$
$C \to E$ (transitivity)
$C \to CDE$ (union)

$D \to E$
$D \to DE$

$E \to E$

Closure: (X = set of attributes)

$X^+ \to$ Contains set of attributes determined by X

$A^+ = \{A, B, C, D, E\} \to SK$ ✓

$AD^+ = \{A, D, B, C, E\} \to SK$ ✓

$B^+ = \{B, C, D, E\}$ ×

$CD^+ = \{C, D, E\}$ ×

** super key: set of attributes whose closure contains all the attributes of given relation on table.

** Here A^+ is a super key, so AB^+, AC^+, AD^+, AE^+, ABC^+, $ABCD^+$ etc are also super key according to Augmentation rules.

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So how many super key are there?

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

A → SK

B, C, D, E → super key বাদে বাকি যতগুলো attribute আছে তাদেরকে 2^n এ আকারে লিখলে যা হয় তাই হলো মোট super keys এর সংখ্যা। $2^4 = 16$

Candidate key:

Minimal super key, meaning no attribute can be removed without losing the ability to uniquely identify tuples

*A super key whose proper subset not to be a super key.

Exam: $A^+ = \{A, B, C, D, E\} \rightarrow SK$

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

Here proper subset of AD is {{A}, {D}} and {A}, is also a super key. So AD cannot be a candidate key.

So only {A} A^+ is a candidate key.

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

$FD(A \rightarrow B, D \rightarrow E)$

closure set:

$A^+ = \{A, B\}$ ×

$BC^+ = \{B, C\}$ (Reflexivity) ×

$ABCDE^+ = \{A, B, C, D, E\}$ (Super key)

$ABDE^+ = \{A, B, D, E\}$ ×

$ACDE^+ \rightarrow \{A, C, D, E, B\}$ SK

$ACD^+ \rightarrow \{A, C, D, B, E\}$ SK

$AD^+ \rightarrow \{A, D, B, E\}$ ×

$CD^+ \rightarrow \{C, D, E\}$

$AC^+ \rightarrow \{A, C, B\}$

candidate key:

$ABCDE^+$ এর proper subset এ ACDE, ACD etc চলে আসে যারা super keys. So $ABCDE^+$ candidate key হবে না। As same ACDE.

But ACD^+ এর proper subset:

A	AD
C	CD
D	AC

যার কোনোটিই SK নয়

So ACD^+ is a candidate key.

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how many candidate keys are there?

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

FD → {A → B, D → E}

1. $A\cancel{B}CDE^+ = \{A, B, C, D, E\}$ SK
2. $ACD\cancel{E}^+ = \{A, B, C, D, E\}$ SK

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

$AC^+ = \{\}$
$CD^+ = \{$
$AD^+ = \{$
$A^+ = \{$ }
$C^+ = \{$
$D^+ = \{$

none of SK

সবচেয়ে candidate key বের করব:

① R( ) Table এর অ্যাট্রিবিউট নিয়ে একটা closure set বের করব যেটা অবশ্যই SK হবে।

② FD অনুযায়ী যে সব attributes বাদ দিব যাদেরকে অন্য attributes দিয়ে determine করা যায়। বামে থাকে

③ সবশেষে এমন একটি closure ~~...~~ আসবে যার কোনো attribute আর বাদ দেওয়া যায় না।

④ এখন check করব অবশিষ্ট closure এর proper subject এর কোনো SK ~~...~~ নাকি, না হলে এটাই candidate key হবে।

So, candidate key is ACD^+ and there are no more ck.

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Prime Attributes: (part of candidate Keys) FD (A → B, D → E)

candidate key is $[ACD]^+$

So prime attributes {A, C, D}

*Now check ~~of~~ Are prime attri. available on the R.H.S of the FD? If ans. is NO. then there is no more candidate keys in the Relation.

$\boxed{\text{So only candidate key is ACD.}}$

Exmp: 2 R(A, B, C, D)

$FD \rightarrow \{ \underbrace{A \rightarrow B}_{i}, \underbrace{B \rightarrow C}_{ii}, \underbrace{C \rightarrow A}_{iii} \}$

step 1: $ABCD^+ = \{A, B, C, D\} \rightarrow SK$

step 2:

(i) $ACD^+ = \{A, C, D, B\} \rightarrow SK$

(ii) $AD^+ = \{A, D, B, C\} \rightarrow SK$

proper subset of AD $\left\{ \begin{array}{l} A^+ = \{A, B, C\} \\ D^+ = \{D\} \end{array} \right\}$ not SK

Now we need to find any other ck is exist or not.

So candidate key is AD^+.

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Prime Attributes are {A, D}, [Check this: A এখন দেখবো এ Attri এর কোনো FD এর R.H.S. আছে কি না] Yes, C → A

A R.H.S এ আছে. So we can write AD as CD because C can determine A.

A D
↓
C D → SK

SK ⇒ $C^+ = \{C, A, B\}$ } Now check is it a ck?

~~SK~~ → $D^+ = \{D\}$

proper subset এ কোনো SK নেই.

So we can say CD is also a CK.

So the final prime Attributes are {A, D, C}.

আবার, CT করে দেখবো,

Yes D → C, C is on the R.H.S. So we can ~~write~~ write,

AD → CK
↓
SK → CD → ck

SK → BD → Now check if it a ck?

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$B^+ = \{B, C, A\}$ } none of SK
$D^+ = \{D\}$

So. BD is a CK

So, the Prime attn. $= \{A, D, C, B\}$

again CT করবো। Yes $A \to B$ B is on the R.H.S. So we can write,

$AD \to CK$
$\downarrow$
$SK \to CD \to CK$
$\downarrow$
$SK \to BD \to CK$
$\downarrow$
$SK \to AD \to CK$ } we already check this.

So, All the CK are $= \{AD, CD, BD\}$

and prime attributes $= \{A, B, C, D\}$

There is no non-prime attributes.

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Example:

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

$FD = \{AB \to C, C \to DE, E \to F, D \to A, C \to B\}$

$ABCDEF^+ = \{A, B, C, D, E, F\} \to SK$

$ABDEF^+ = \{A, B, C, D, E, F\} \to SK$

$ABF^+ = \{A, B, F, C, D, E\} \to SK$

$AB^+ = \{A, B, C, D, E, F\} \to SK$

$A^+ = \{A\}$
$B^+ = \{B\}$ none of SK

So AB is a CK.

Prime Attributes $\{\underline{A}, B\}$

$AB \to CK$
↓
$SK \to DB$

$D^+ = \{D, A\}$

$B^+ = \{B\}$

So DB is a CK

prime attri $\{A, \underline{B}, D\}$

$AB \to AC \to SK$
↓
DD

$A^+ = \{A\}$ SK

$C^* = \{C, D, E, A, F, B\}$
SK

So, AC not a CK.

But C is a CK.

$P.A = \{A, B, \underline{D}, C\}$

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$AB - \overset{\times}{AC}$

$\downarrow$

DB

$\downarrow\downarrow$

not CK $\rightarrow$ CB $\rightarrow$ SK

$C^+ = \{ \quad \}$ SK

$B^+ = \{ \quad \}$

$CK = \{AB, BD, C\}$

$PA = \{A, B, C, D\}$

non-$PA = \{E, F\}$

Canonical Cover

A canonical cover (or minimal cover) of a set of FD is simplified version of that set where

1. Redundent dependenetes are removed
2. " attributes within dependencies are remov
3. Each dependency is a single attribute dependenc on the right side.

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F' if F' don't have

(i) extraneous attribute/redundant att

(ii) Redundent FD.

To make this.

Step (i) Spliting rule/Decomposition

so that in every R.H.S has single attribute

step (2) ** You can't split L.H.S **

Example: $A \to BC$ so $A \to B$ and $A \to C$

Step: (ii) Remove redundent attribute.

Example:

$F_1 = \{AB \to C,\ \underline{A \to C}\}$

Here we can define C by A alone

So no need to define C by AB.

eg same $\{AB \to C,\ \underline{A \to B}\}$ | we can remove B from AB

$F_2 = \{AB \to C,\ \underline{B \to C}\}$

no need to AB.

(we can remove A from AB)

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(iii) Remove ~~$~~ redundent/duplicate FD.

Example:

F :- $\{AB \to C,\ C \to AB,\ B \to C,\ ABC \to AC,\ A \to C,\ AC \to B\}$

Step 1: :- $\{A\cancel{B} \to C,\ C \to A,\ C \to B,\ B \to C,\ \cancel{A}BC \to A,\ A\cancel{BC} \to C,\ A \to C,\ A\cancel{C} \to B\}$

we can find B indirectly by $A \to B$

step 2: :- $\{\cancel{B \to C},\ C \to A,\ \cancel{C \to B},\ B \to C,\ \cancel{A \to C},\ A \to B\}$

step 3: :- $\{C \to A,\ B \to C\}$, $A \to B$

** Canonical Cover এর answer কখনো same নাও হতে পারে। Person to person ~~veri~~ vary করবে। **

$C^+ = C, B$ we cannot get A here so we cannot remove $C \to A$

$C^+ = C, A, B$

$B^+ =$

$A^+ = A, B, C$

$A^+ = A, C$

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Semester Q. Solve

Topic Functional Dependency: (20-21 final exam) {19-20 Q.1(b) / 18-19 Q.2(d)}

Q: 2(a) / Let R = (A, B, C, D). If AB and BD can uniquely identify a tuple in a relation r(R) separately then how many super keys, CK and PK are there?

Answer: candidate key:
We are given that AB and BD can each uniquely identify a tuple in R without any redundancy.

Since AB and BD uniquely identify tuples and contain the minimal attributes with uniqueness, so they are the candidate key of that relation.

So the number of candidate keys are two. these are = {AB, BD}.

Super key: Super keys are sets of attributes that can uniquely identify a tuples.

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They include ck and any superset of those ck.

We already found that candidate keys are AB and BD.

So ~~the~~ according to Augmentation rules we can say all the combination of attributes with cks are also super keys.

Any combination with AB : (ABC, ABD, ABCD)

Any " " BD : (BDA, BDC, BDAC)

So the superkeys are,

{AB, BD, ABC, ABD, ~~ABCD~~ BDC, ABCD}

number of super keys are 6.

Primary key: A primary is a key that can uniquely identify any tuples in a Relation. In a relation there will be only one PK.

So PK is = {AB or BD} num. of PK is 1.

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6 (a)

~~Assumptions~~

~~The~~ Given that,

employee(emp-id, emp-name, emp-phone, dept-name, dept-phone, dept-mgr id, skill-id, skill-name skill-date, skill-level)

Assumptions:

1. emp-id uniquely identifies each employee.
2. dept-name identifies dept-mgr id which is unique to each department.
3. skill-id uniquely identifies each skill-name.
4. combination of emp-id and skill-id can uniquely identifies ~~all of~~ emp-name, ~~emp-phone~~ skill-level, skill-date, skill-name.
5. dept-mgr id uniquely identifies dept-name, dept-phone.

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So the Functional Dependencies are.

FD 1 : emp-id → emp-name, emp-phone, dept-name

FD 2 : dept-name → ~~dept-pho~~ dept-mgrid, dept-phone

FD 3 : dept-mgrid → dept-name, dept-phone

FD 4 : skill-id → skill-name

FD 5 : (emp-id, skill-id) → emp-name, ~~emp-phone, dept-name~~, skill-name, skill-date, skill-level.

These are all the dependencies.

6 (a) (i) ~~Functional Dependency set~~:

~~Bas~~ Assumption:

(1) An employee can have multiple skills, but each skill is unique to an employee.

(2) A skill can be possessed by multiple employee

(3) A department has a unique manager.

Functional dependency Set:

1. Employee Information: (1) emp-id → emp-name, emp-phone, dept-na

~~(2) emp-id → dept-name~~ .

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2. Department Information:

dept-name → dept-phone, dept-mgr id

3. Skill information:

skill-id → skill-name

4. Employee-skill relationship:

(emp-id, skill-id) → skill-date, skill-level.

(ii) To normalize the database into BCNF we can decompose it into the following relations.

1. Employee (emp-id, emp-name, emp-phone, dept-name)

primary key: emp-id.

2. Department (dept-name, dept-phone, dept-mgrid)

Primary key: dept-name

3. Skill (skill-id, skill-name)

Primary key: skill-id

4. Employee skill (empid, skill-id, skill date, skill-level)

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Primary key: (emp-id, skill-id)

This decomposition ensure that each relation is in BCNF. ~~The~~ first three relations are already in BCNF as they are atomic and have simple primary key. The 4th relation, (Employee_skill) is also in BCNF because the primary key (emp-id, skill_id) uniquely determines all other attributes.

This normalized design remove all of the redundancy and ensure data integrity.

id → name, desig, email.

name, desig → email, salary

name → email

~~email~~ → id

~~To compute canonical cover we should follow these steps.~~

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(B) Given the functional dependency (FDs),

1. id → name, designation, email
2. name, designation → salary, email
3. name → email
4. email → id

* Now consider id as 'A', name as 'B', designation as 'C', email as 'D', salary as 'E' to easier the calculation.

So, 1. A → B, C, D
2. B, C → E, D
3. B → D
4. D → A

Step 1: Decomposition

Decompose all the FDs so that every FDs has a single value on the R.H.S.

1. A → B
2. A → C
3. A → D
4. (B, C) → E
5. BC → D
6. B → D
7. D → A

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Step 2: Remove Etraneous Attributes from

FD 4: $BC \to E$

if we remove C ~~then can we~~

B alone can't determine E.

again if we remove B

C alone can't determine E

So $BC \to E$ remain as is.

FD 5: $BC \to D$

if we remove C

B can determine D

So, we can remove C and the FD remains $B \to D$

After the step 2 we get the FDs are,

1. $A \to B$
2. $A \to C$
3. $A \to D$
4. $BC \to E$
5. $B \to D$
6. $D \to A$

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Step 3: Remove Redundant FDs

FD 3: if we remove A→D,

we can still get A→D from

~~A→C~~, ~~B→D~~ D→A and A→C, A→B

So A→D is a redundant FD.

So The final FDs are,

1. A → B = id → name
2. A → C = id → designation
3. BC → E = (name, designation) → salary
4. B → D = name → email
5. D → A = email → ~~name~~ id

These are the final canonical cover.

F :- (id → name, id → designation, (name, designation) → salary, name → email, email → id)

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7(a)

Given that,

Relation schema $R = \{A, B, C, D, E\}$

FD: $A \rightarrow BC$, $CD \rightarrow E$, $B \rightarrow D$, $E \rightarrow A$

Now, the closure set of following are

$A^+ = \{ABCDE\}$

$(AB)^+ = \{A, B, C, D, E\}$

$(BC)^+ = \{B, C, D, E, A\}$

$(ABC)^+ = \{A, B, C, D, E\}$.

All of those are super keys. ~~and the minimal of them is A, so A~~

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(19-20)

6 (b)

(i) AB → C :

AB → C that means A, B determines C and ~~every time~~ if row with the same value of A and B then have the same value for C.

In rows 1 and 3 we have identical ~~values for C but different~~ values for A=1 and B=2 but different ~~for~~ values for C (in row 1: C=3 and in row 3, C=4)

Result: As same value of AB doesn't match with C in rows 1 and 3, so AB → C doesn't holds in relation.

(ii) B → D :

That means B determines D and if rows of B are same value then D should be same values.

In rows 1 and 3 we see B=2 and D=4 and in row 2 B=4 and D=4

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Result: For every values of B the values of D remain same. So B→D holds in relation.

(iv) DE→A:

If the same value of D and E have the same value for A exist then it will be hold in relation.

In rows 1 and 2 identical values of D = 4 and E = 2 and both have A = 1.

Result: DE→A holds because rows with identical values of D and E have a consistent value for A.

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6(c)

~~Given that Function~~

Given Relation and Functional dependency:

$R(A,B,CD)$

FDs : 1. $AB \rightarrow CD$

2. $BC \rightarrow D$

Step 1. Decompose R.H.S:

FDs:

1. $AB \rightarrow C$
2. $AB \rightarrow D$
3. $BC \rightarrow D$

Step 2 Remove Redundant Attributes:

1. For $AB \rightarrow C$:

(i) Removing A: $B^+ = \{B\}$ doesn't include C, so A is not redundant

(ii) Removing B: $A^+ = \{A\}$ doesn't include C, so B isn't redundant.

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2. For $AB \to D$:

(i) Removing A : $B^+ = \{B\}$ doesn't include D, so A is not redund.

(ii) Removing B : $A^+ = \{A\}$ doesn't include D, so B is not redun

3. For $BC \to D$:

(i) Removing B : $C^+ = \{C\}$ ~~doesn't~~ include D, so B is not redundant

(ii) Removing C : $B^+ = \{B\}$ " " D, so C " " "

So, all the dependencies ~~are not re~~ has no redundant attributes.

Step 3: Remove Redundant FDs

Since $BC \to D$ is not implied by $AB \to C$ and $AB \to D$ so it is not redundant.

Final Minimal cover for $R(A, B, C, D)$ is:

1. $AB \to C$
2. $AB \to D$
3. $BC \to D$.

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18-19

4(a) Is it important to have a FD in each Table? Why ~~and~~ or why not?

Ans: No, it is not strictly necessary to have a functional dependency (FD) in each table. However, FDs are important for defining the relationships between attributes and ensuring data integrity. They help with normalization, reducing redundancy and eliminating update anomalies.

In case where no FDs exist, the table may lack meaningful structure and could lead to data anomalies.

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(b) (i)

Given the dependencies are,

1. $A \to BC$ Relation, $R(A, B, C, D, F)$

2. $B \to E$

3. $CD \to EF$

closure set:

$ABCDF^+ = \{A, B, C, D, F, E\} \to$ super key (SK)

$ADF^+ = \{A, D, F, B, C, E\} \to sk$ [BC can determine by A]

Now the subset of ADF.

$A^+ = \{A, B, C, E\} \to$ not a sk

$D^+ = \{D\} \to$ not a sk

$F^+ = \{F\} \to$ not a sk

$AD^+ = \{A, D, B, C, E, F\} \to$ sk

~~$AF^+ = \{A, F, B, C, E\} \to$ not a sk~~

~~$DF^+ = \{$~~

~~As AD is a super key, so the AD~~

As AD is a super key and the minimal of all super keys, so it is the candidate key.

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(11) Prove that AD → F Holds in R.

To prove that AD → F holds, we can use the closure of AD to see if it includes F

closure of AD^+:

$(AD)^+ = \{A, D\}$

Using A → BC, we get $AD^+ = \{A, D, B, C\}$

Using B → E we get $AD^+ = \{A, D, B, C, E\}$

Using CD → EF we get $AD^+ = \{A, D, B, C, E, F\}$

Since AD^+ includes F, the dependency AD → F holds in R.

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6(d) List all the non-trivial FDs :

A	B	C	D
a1	b1	c1	d1
a1	b2	c1	d2
a2	b2	c2	d2
a2	b2	c2	d3
a3	b3	c2	d4

Non-trivial FDs:

Non-trivial FDs are those where dependent doesn't the part of of ~~dep~~ determinant.

Example: $A \rightarrow B$, $CD \rightarrow E$ etc.

But $A \rightarrow A$, $CD \rightarrow D$ are trivial FDs.

The non-trivial FDs are given below:

~~FD1 : A → C~~

~~a1 maps c1 and a2 maps c2 both times.~~

~~FD2 : A → B~~

~~a1 maps b1 and b2~~

~~FD2 : B → D~~

~~b1 maps~~

~~FD2: AB → C~~

~~a2 and b2 maps c2 both times.~~

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FD 1: $A \to C$

FD 2: $AB \to C$

FD 3: $AD \to C$

FD 7: $D \to B$

FD 4: $CD \to A$

FD 8: $AD \to B$

FD 5: $ABD \to C$

FD 9: $BC \to A$

FD 10: $CD \to B$

FD 6: $BCD \to A$

FD 11: $ACD \to B$

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