DBMS ASSIGNMENT

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LAB 5

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→ TOPIC: Working With Functional Dependencies, Database Design & Normalization:-

Q1) For each of the following FDs on r(A, B, C, D, E)

a) Find a Candidate key

b) Find Attribute Closure of AB

1(i) $AB \rightarrow C \mid D \rightarrow E \mid B \rightarrow E$

1(i)(a) Candidate Key:-

$\{A\}^+ = A$, $\{C\}^+ = \{C\}$, $\{E\}^+ = \{E\}$

$\{B\}^+ = \{B, E\}$, $\{D\}^+ = \{D, E\}$,

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

↳ here we're missing 'D'

So, $\{A,B,D\}^+ = \underline{\{A,B,C,D,E\}}$

↓

Contains all attributes.

Thus $\{A,B,D\}$ → Candidate key

1(i)(b)

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

$\because \{A\}^+ = \underline{\{A\}}, \{B\}^+ = \underline{\{B,C\}}$

& $\{AB\}^+ = \underline{\{C\}}$

1(ii)(a)] $(A \to CD,\ B \to DE)$

Ans 1(ii)(a)] Candidate key:

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

$\{B\}^+ = \{B, D, E\}$

1(ii)(b)] $\{AB\}^+ = \{A, B, C, D, E\} \longrightarrow$ CANDIDATE KEY

$\Downarrow$

Contains all attributes

1(iii)(b)] $(C \to D,\ AB \to C)$

(a)] $\{A\}^+ = \{A\}$, $\{B\}^+ = \{B\}$, $\{C\}^+ = \{C, D\}$, $\{D\}^+ = \{D\}$,

$\{F\}^+ = \{F\}$

(b)] $\{A, B\}^+ = \{A, B, C, D\}$

→ we're missing 'E' here

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

↓

CANDIDATE KEY

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2) Normalization: For below FDs, decompose into BCNF!

(i) $AB \rightarrow C$, $D \rightarrow E$, $B \rightarrow E$

* Finding Candidate & Superkeys :-

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

$\{A, B, D\}^+ = \{A, B, C, D, E\}$ → Candidate Key

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

$\{A, B, C, D\}^+ = \{A, B, C, D, E\}$ → SKey

$\{A, B, D, E\}^+ = \{A, B, C, D, E\}$ → SKey

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

$\{A, B, C, D, E\}^+ = \{A, B, C, D, E\}$ → SKey

* Prime Attributes = {A, B, D}

NPA = {C, E}

* Checking in order from 1NF to BCNF :-

- Relation is in 1NF as there are no multivalued attributes. Each attribute exists as one value per row.

- Not in 2NF, :

(i) $\{A, B\} \rightarrow C$

(ii) $\{B\} \rightarrow E$

∴ should actually the full subset: {A, B, D}

∴ these partial dependencies exist. It is not in 2NF form.

- Not in 3NF,

  As none of the 3 conds are satisfied :-

  (i) All the dependencies not trivial

  (ii) The RHS is NPA

  (iii) LHS is not a superkey.

  All the depencies fail here.

- Not in BNF as well, ; more of the FDs are superkeys in their LHS.

* Converting to 3NF using Synthesis algorithm :-

  R_A (BE), with FD: $B \to E$

  R_B (DEE), with FD: $D \to F$

  R_C (ABC), with FD: $AB \to C$

  ∴ we don't have the key, adding R_D as well.

$R_D(ABD)$, no FD

* Converting to BCNF from 3NF :-

The decomposed relations: R_A, R_B, R_C & R_D are already in BCNF as all LHS are superkeys.

2(2) : $(A \to CD,\ B \to DE)$

Not in 3NF as 3NF's conditions are not satisfied.
Thus it can't be in BCNF as well.

Ohh and also note, here

Candidate keys :-

$\{A,B\}^+ : \{A,B,C,D,E\}$

Super keys :-

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

* Prime Attributes: A, B

* NPA: C, D, E

So by Synthesis Algorithm, we convert to 3NF

$R_A(ACD)$; F.D: $A \to CD$

$R_B(BDE)$; F.D: $B \to DE$

$\longrightarrow$ $R_E(AB)$; F.D: none. Adding AB as it its the candidate key & is not present in ACD & BDE

∴ all LHS of FDs w.r.t R_A, R_B & R_C are superkeys. R_A, R_B & R_C are in BCNF as well.

2(3) : $(AB \to C, C \to D)$

Candidate key:

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

Superkeys:-

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

* Prime A : $\{A, B, E\}$
* NPA : $\{C, D\}$

Not in 3NF. Converting with Synthesis Algorithm :-

$R_A(CD)$; FD : $C \rightarrow D$

$R_B(ABC)$; $AB \rightarrow C$

* $R_3(ABE)$ { Adding Candidate Key } } in 3NF form

Again : all LHS are superkeys, this 3NF qualifies as BCNF as well.

3) schema: $r(A, B, C, D, E)$

(a) Canonical Cover

(b) Convert into 3NF

(i) $A \to CD,\ B \to DE,\ C \to D$

(a) Splitting f.Ds, new f.D set :-

$$\{A \to C,\ A \to D,\ B \to D,\ B \to E,\ C \to D\}$$

* $A \to C$ → necessary ∵ $A^+_{w/o} = AD$, $A^+_{with} = ADC$

∵ the closures are diff. We can't exclude $A \to C$. It is important!

(ii) ey),

* $B \to D$, $B \to E$ & $C \to D$ are necessary

* $A \to D$: not important ∵ $A^+_{w/o} = ACD$, $A^+_{w} = ACD$

They are same. Thus redundant.

Thus canonical cover :-

$$\{ A \to C,\ B \to DE,\ C \to D \}$$

(b) Candidate keys : $\{A, B\}$

* Prime A : A, B
* NPA : C, D, E

Not in 3NF By Synthesis algorithm,

$R_A(AC)$; F.D : $A \to C$

$R_B(BDE)$; $B \to D$; $B \to E$

$R_C(CD)$; F.D : $C \to D$

* $R_D(AB)$; F.D : None (∵ Candidate Key)

} 3NF

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(ii) $\{A \to B,\ B \to C,\ A \to C,\ D \to E,\ B \to F,\ AD \to E\}$

(A) CANONICAL COVER:- Split $AD \to E$ → $A \to E$, $D \to E$

* $A \to B$ is necessary : $A^+_{w/o} = \{A, F, C\}$

and $A^+_w = \{A, B, C, E\}$ are diff.

* IIIly $B \to C$, $B \to E$ & $D \to C$ are necessary.

* $A \to C$ is not important as $A^+_w == A^+_{w/o}$.

Thus Canonical Cover $= \{A \to B;\ B \to CE;\ D \to C\}$

(B) Not in 3NF form. Converting by Synthesis Algorithm:-

$R_1(AB)$; FD: $A \to B$

$R_2(BCE)$; F.D: $B \to C$; $B \to E$

$R_3(DE)$; F.D: $D \to E$

* $R_4(AD)$; F.D: None (Candidate key)

4) Real life Example: Consider a DB

A) student (ID, name, courseID, year, semester, grade)

B) instructor (ID, name, deptname, deptbudget)

List out FDs you expect to see & convert to BCNF.

(A) Here the FDs I'd like to see!-

* ID - derives name : name is dependent on ID

FD 1: ID → name

* Now grade is also a dependent factor but here it depends on a bunch of attributes

FD 2: (ID, courseID, semester, year) → grade

✦ With this in place, converting to BCNF is easy. Just ensure that $\forall X \to Y$, X is a superkey

Thus we can decompose into, (By Synthesis)

* student (ID, name) for F.D 1

* CoursesForStudent (ID, couseID, semester, year, grade) for F.D 2

In both cases, LHS is a superkey. Thus it is in BCNF.

(B) Here like in student,

F.D 1: ID → name

And it makes : to link deptname & budget together & avoid redundancy in data

Thus, F.D 2: deptname → deptbudget

So now, by Synthesis Algorithm,

* instructor (ID, name), F.D 1

* department (deptname, deptbudget), F.D 2

* instDept (ID, deptname) {Candidate key}

* Now ; all LHS of each f depency X->Y in the above relation are superkeys

We can safely verify that is in BCNF form.

THE END

THANK YOU, MA'AM !

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