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Questions on Relational Modeling, FD & Normalization

Complete Course on Database Management System

Vishvadeep Gothi • Lesson 15 • July 6, 2023

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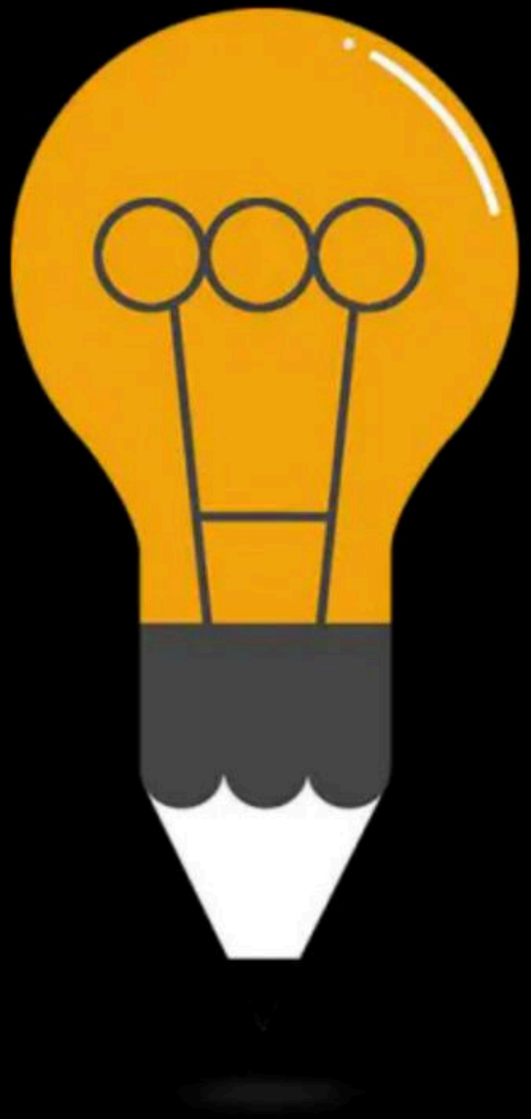

DBMS
Normalization

By: Vishvadeep Gothi

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Normalization

It is a process of grouping attributes into well structured relations, that contain minimum redundancy

It focuses on characteristics of specific entities

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Normalization

One relation should have one theme

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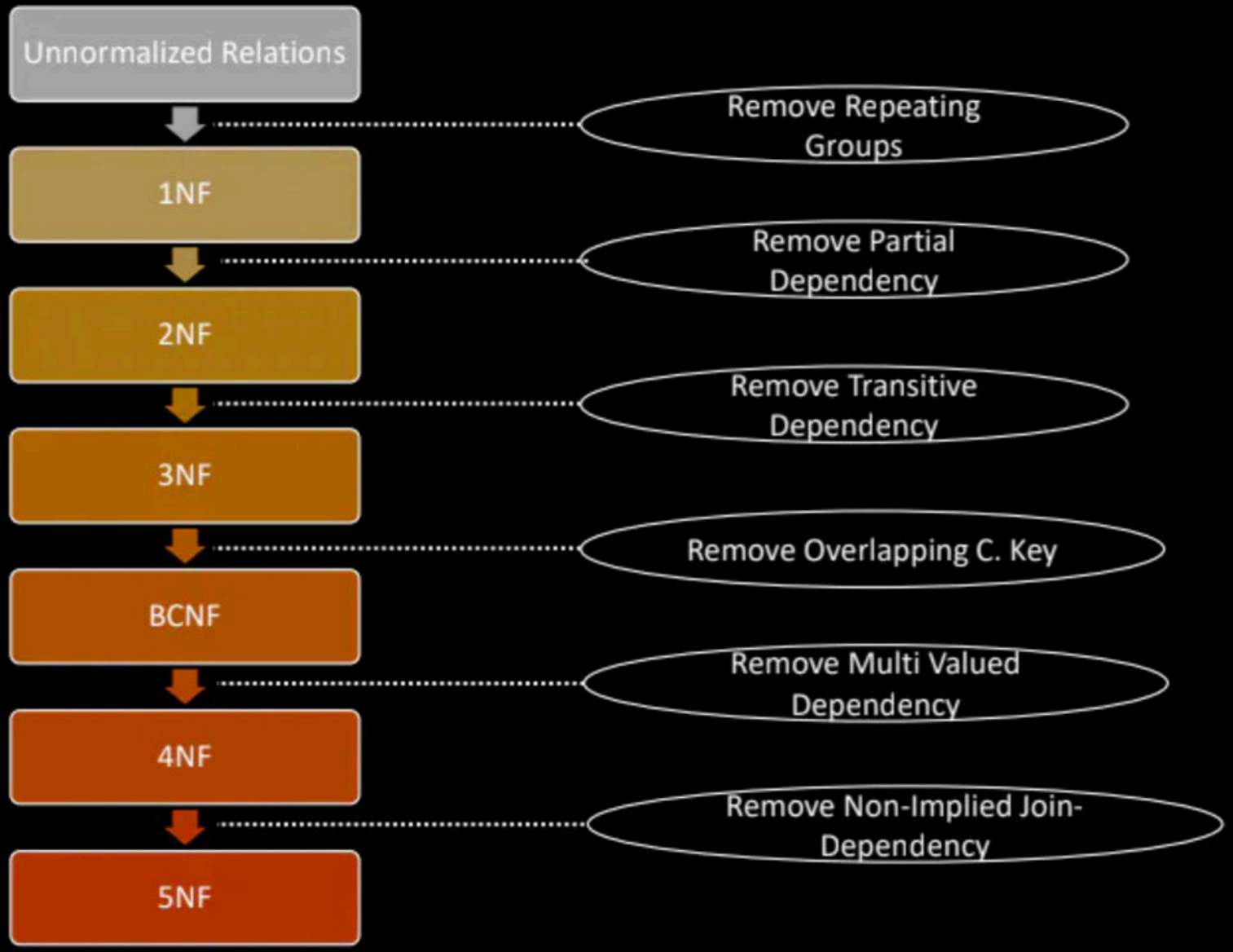
Normalization



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1NF

A relation R is said to be in 1NF if there is no any multivalued attribute in R

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2NF

A relation R is said to be in 2NF if there it is already in 1NF and there is no any non-prime attribute in R which is partially dependent on prime attribute of R

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2NF

Consider a relation R (A, B, C, D) with candidate key AB. Select the FD which will make the relation not in 2NF?

AB → C

AB → D

A → D

B → C

}

R(A, B, C)

A	B	C
A1	B1	C1
A2	B1	C1
A3	B2	C2
A4	B2	C2
A5	B2	C2
A1	B2	C2
A1	B3	C1

CKey = AB

AB → C

B → C

Partial dependency

B → C

Decompose based on 2NF

R1(A, B)

A	B
A1	B1
A2	B1
A3	B2
A4	B2
A5	B2
A1	B2
A1	B3

R2(B, C)

B	C
B1	C1
B2	C2
B3	C1

Question

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

FDs = {

AB → C,

D → E

}

C.key = ABD

Prime ⇒ A, B, D

non-prime ⇒ C, E

R1(A, B, D)

key :- ABD

R2(A, B, C)

{AB → C}

key = AB

R3 (D, E)

{D → E}

key :- D

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Question

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

FDs = {

A → C,

C → D,

B → E,

}

A → D

C.key ⇒ AB

R1 (A, B)

key = AB

R2 (B, E)

FD = {B → E}

key ⇒ B

R3 (A, C, D)

FD = {A → C

C → D}

key => A

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3NF

A relation R is said to be in 3NF if there it is already in 2NF and there is no any non-prime attribute in R which is transitively dependent on the key of R

key → non-prime 1

non-prime 1 → non-prime 2

Example:-

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

$FD = \{AB \rightarrow C,$
$C \rightarrow D\}$

C.key = AB

non-prime = C, D

Check for 2NF ⇒

No any partial dependency

⇓

In 2 NF

Check for 3NF ⇒

D is transitively dependent on key.

⇓

decompose R into 2 relations

$R(A, B, C)$

$AB \rightarrow C$

$R1(C, D)$

$C \rightarrow D$

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Question

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

FDs = {

A → BCF,

C → DE

}

C.key = A

already in 2NF because no partial dependency

decompose upto 3NF

DE are transitively dependent on key.

R(A, B, C, F)

A → BCF

R1(C, D, E)

C → DE

Ans.

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Question

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

FDs = {

AC → B,

C → D,

D → E

}

After 2 NF decomposition

① R (A, C, F)

Key => ACF

② R2 (A, C, B)

FD => AC → B

③ R31 (C, D)

C → D

④ R32 (D, E)

D → E

R3 (C, D, E)

FD => C → D

D → E

E is transitively dependent on key C

C.

Key = ACF

Question

Consider a relation R (A, B, C, D, E, F, G, H, I, J). The FDs are given as:

AC → B,

CD → GH,

A → J,

AD → EF,

F → I

}

$ACD^+ = \{A, C, D, B, G, H, J, E, F, I\}$

R1 (A, C, D)

R2 (A, C, B) FD = {AC → B}

R3 (C, D, G, H) FD = {CD → GH}

R4 (A, J) FD = {A → J}

R5 (A, D, E, F, I) FD = {AD → EF, F → I}

Decompose it till 3NF?

R51 (A, D, E, F)
AD → EF

R52 (F, I) F → I

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Question

Consider a relation R (A, B, C, D). The FDs are given as:

AB → CD

C → A

}

The maximum normal form satisfied by given relation?

(A) 1NF (B) 2NF (C) 3NF (D) Can not be determined

C.

Key ⇒ AB, BC

non-prime ⇒ ①

3 NF

Non-prime → non-prime

BCNF (Boyce Codd Normal Form)

A relation R is said to be in BCNF if there it is already in 3NF and for every functional dependency $\alpha \rightarrow \beta$, α should be super key in R

BCNF (Boyce Codd Normal Form)

R (A, B, C, D)

FDs = {

AB → CD,

D → B

}

c. keys ⇒ AB, AD

no any partial or transitive dependency. Hence already in 3NF.

Check for BCNF:-

AB → CD ✓ LHS AB is key

D → B ✗ LHS D is not key

Not in BCNF

Remove B from original table & keep it in another table with D.

R (A, C, D)

A → CD

R2 (D, B)

D → B

→ Upto 3NF decomposition ⇒ definitely { lossless & dependency preserving

→ BCNF decomposition → not necessarily

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Question

Consider a relation R with attributes A, B, C, D, E, X and Y; and following FDs:

AB → C,

AC → B,

AD → E,

B → D,

BC → A,

E → X

keys ⇒ { ADY, BCY, ACY }

Which of the following is the highest possible normal form satisfied by the relation R?

(A) 1NF (B) 2NF

(C) 3NF (D) BCNF

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Questions on Normalization

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Lossy vs Lossless Decomposition

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Question GATE-1995

Consider the relation scheme $R(A, B, C)$ with the following functional dependencies:

- $A, B \rightarrow C$,
- $C \rightarrow A$

A. Show that the scheme R is in $3NF$ but not in BCNF.
B. Determine the minimal keys of relation R.

C. keys = AB
BC

Question GATE-1997

For a database relation $R(a, b, c, d)$, where the domains a, b, c, d include only atomic values, only the following functional dependencies and those that can be inferred from them hold

- $a \rightarrow c$ → Partial
- $b \rightarrow d$ → partial

This relation is

A. in first normal form but not in second normal form
B. in second normal form but not in first normal form
C. in third normal form
D. none of the above

key → ab

Decompose :-

R1(a,b)
a, b, c

R2(a, c)
$a \rightarrow c$

R3(b, d)
$b \rightarrow d$

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Question GATE-1998

Which normal form is considered adequate for normal relational database design?

A. $2NF$ B. $5NF$ C. $4NF$ D. $3NF$

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Question

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

FDs = {

A –>BC,

BC –> D,

D –> EF,

EF –> A}

Decompose till 3NF?

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Question

Assume a relation R (M, N, O, P, Q) is already in 3NF. Which of the following 3FDs will support the relation?

a) MN –> O

b) MO –> Q

c) MN –> P

d) OP –> Q

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Question

Consider the following relation

deptSales(DeptNo, DeptName, Month, Year, Sales)

And consider the following set of FDs:

FD = {

DeptNo –> DeptName

DeptNo Month Year –> Sales

}

The relation could suffer from?

a) Insertion anomaly

b) Inconsistency

c) Delete anomaly

d) All of the above

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Lossy vs Lossless Decomposition

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Lossy Join Decomposition

The decomposition of relation R into R1, R2, R3 ….. Rn is lossy when the join of R1, R2, R3 ….. Rn does not produce the same relation as in R.

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12	Vishvadeep	CSE
56	Vishvadeep	AI

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Lossy Join Decomposition

Assuming decomposition of relation R into R1, R2, R3 ….. Rn. Then

$R = R1 \bowtie R2 \bowtie R3 .... \bowtie Rn$ Lossless

$R \subset R1 \bowtie R2 \bowtie R3 .... \bowtie Rn$ Lossy

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Question

Consider a relation R (X, Y, Z) and the records as showing in table below

R

X	Y	Z
1	5	4
2	5	2
1	8	6

The decomposition of R in to 2 relations R1(X, Y) and R2(B, C) is lossless or lossy?

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Question

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

FDs = {

A –> BC,

D –> CE,

}

Decomposition

R1 (A, B, D)

R2 (D, C, E)

Lossless or lossy?

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Question

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

FDs = {

A –> BC,

D –> CE,

}

Decomposition

R1 (A, B, C)

R2 (A, D, E)

Lossless or lossy?

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Question

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

FDs = {

A –> BC,

D –> CE,

}

Decomposition

R1 (A, B, C)

R2 (C, D, E)

Lossless or lossy?

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Question

R (A, B, C, D)

FDs = {

A –> BC,

BC –> A,

B –> CD

}

Decomposition

R1 (A, B, C)

R2 (B, C, D)

Lossless or lossy?

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Question

R (A, B, C, D)

FDs = {

A –> B,

B –> C,

C –> D

}

Decomposition

R1 (A, B)

R2 (B, D)

R3 (B, C)

Lossless or lossy?

Dependency Preserving Decomposition

A Decomposition D = { R1, R2, R3….Rn } of R is dependency preserving with respect to a set F of Functional dependency if

(F1 U F2 U … U Fn)+ = F+

Dependency Preserving Decomposition

Example 1:

R (A, B, C, D)

FDs = {

AB → C,

B → D

}

Decomposition:

R1 (A, B, C) FD = {AB → C}

R2 (B, D) FD = {B → D}

Dependency Preserving Decomposition

Example 1:

R (A, B, C, D)

FDs = {

AB –> C,

C –> D,

D –> A}

Decomposition

R1 (A, B, C) FD = {AB → C}

R2 (C, D) FD = {C → D}

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Question GATE-2001

Consider a schema $R(A, B, C, D)$ and functional dependencies $A \rightarrow B$ and $C \rightarrow D$. Then the decomposition of R into $R_1(A, B)$ and $R_2(C, D)$ is

A. dependency preserving and lossless join
B. lossless join but not dependency preserving
C. dependency preserving but not lossless join
D. not dependency preserving and not lossless join

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Happy Learning.!