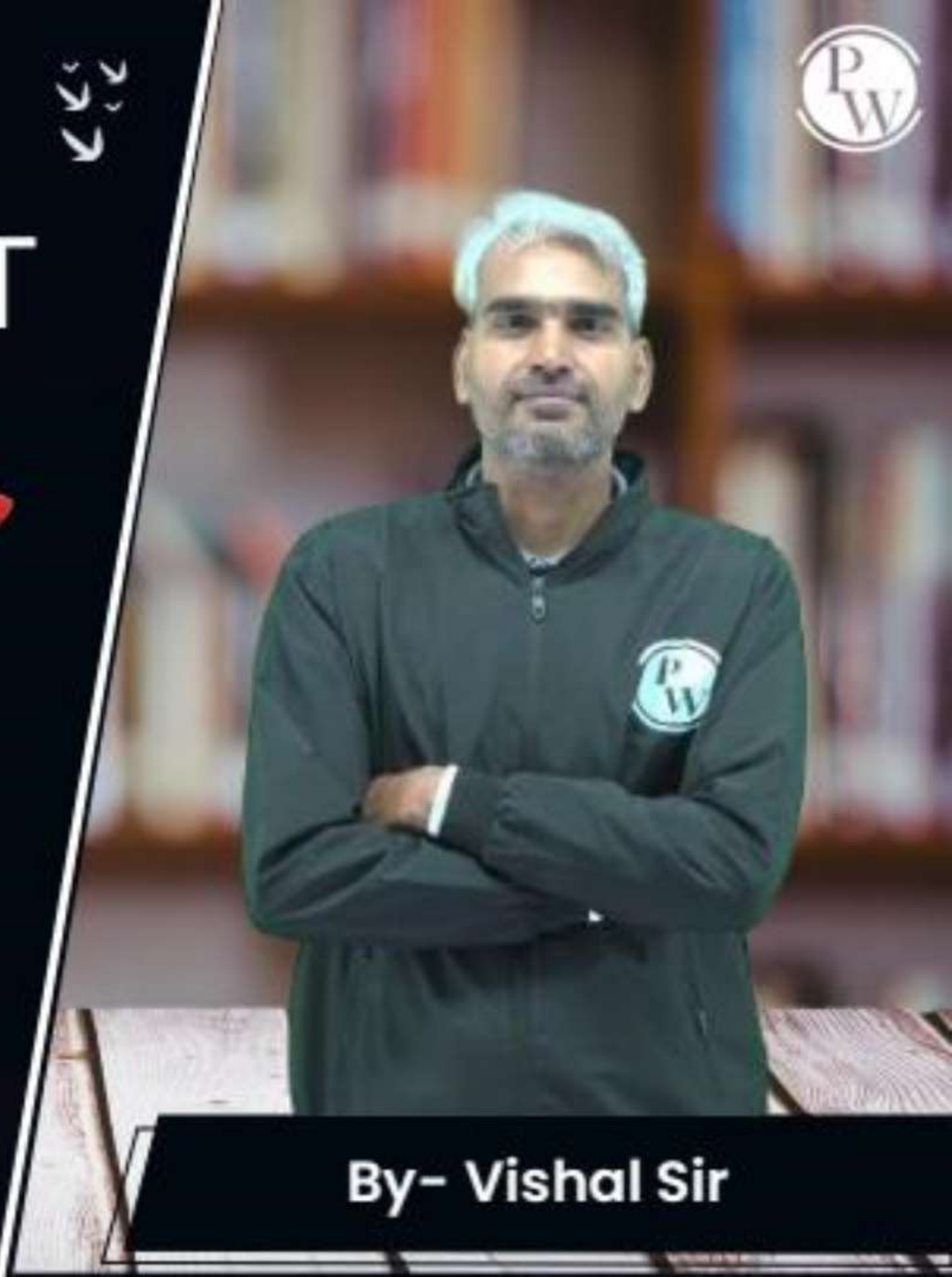
Computer Science & IT

Database Management System

Relational Model & Normal Forms

Lecture No. 13



By- Vishal Sir

Recap of Previous Lecture

Topic Normal forms { 1NF, 2NF, 3NF, BCNF, 4NF }

Topic First normal form (1NF) { No multi-valued Attributes / By default normal form of relation is 1NF }

Topic Redundancy in relation because of FD

- If $X \longrightarrow Y$ is a non-trivial FD & X is a S.K., then no redundancy w.r.t. $X \longrightarrow Y$
- If $X \longrightarrow Y$ is a non trivial FD & X is not a S.K, then redundancy is possible w.r.t. $X \longrightarrow Y$.

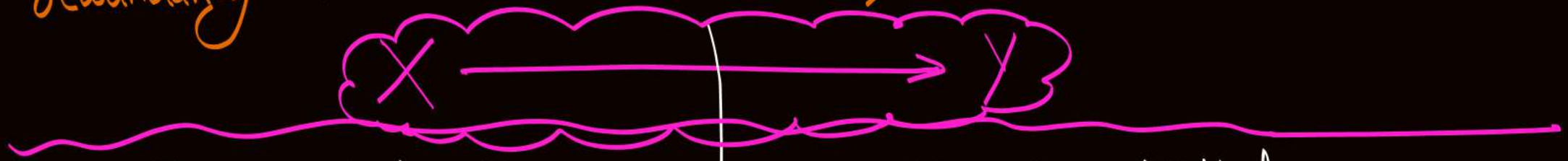
Slide

Topics to be Covered

- Topic: Redundancy in relation because of FD
- Topic: Second normal form (2NF)
- Topic: Third normal form (3NF)
- Topic: Boyce codd normal form (BCNF)
- Topic: Decomposition of relation

Slide

Possible non-trivial FDs "$X \longrightarrow Y$" that may cause redundancy in the relation are,



Case ① Proper subset of a C.K. → Non-prime Attribute

Case ② (Proper subset of a C.K + Non-prime Attribute) → Non-prime Attribute

Case ③ Non-prime Attribute → Non-prime Attribute

Non-prime Attribute → Proper Subset of a C.K

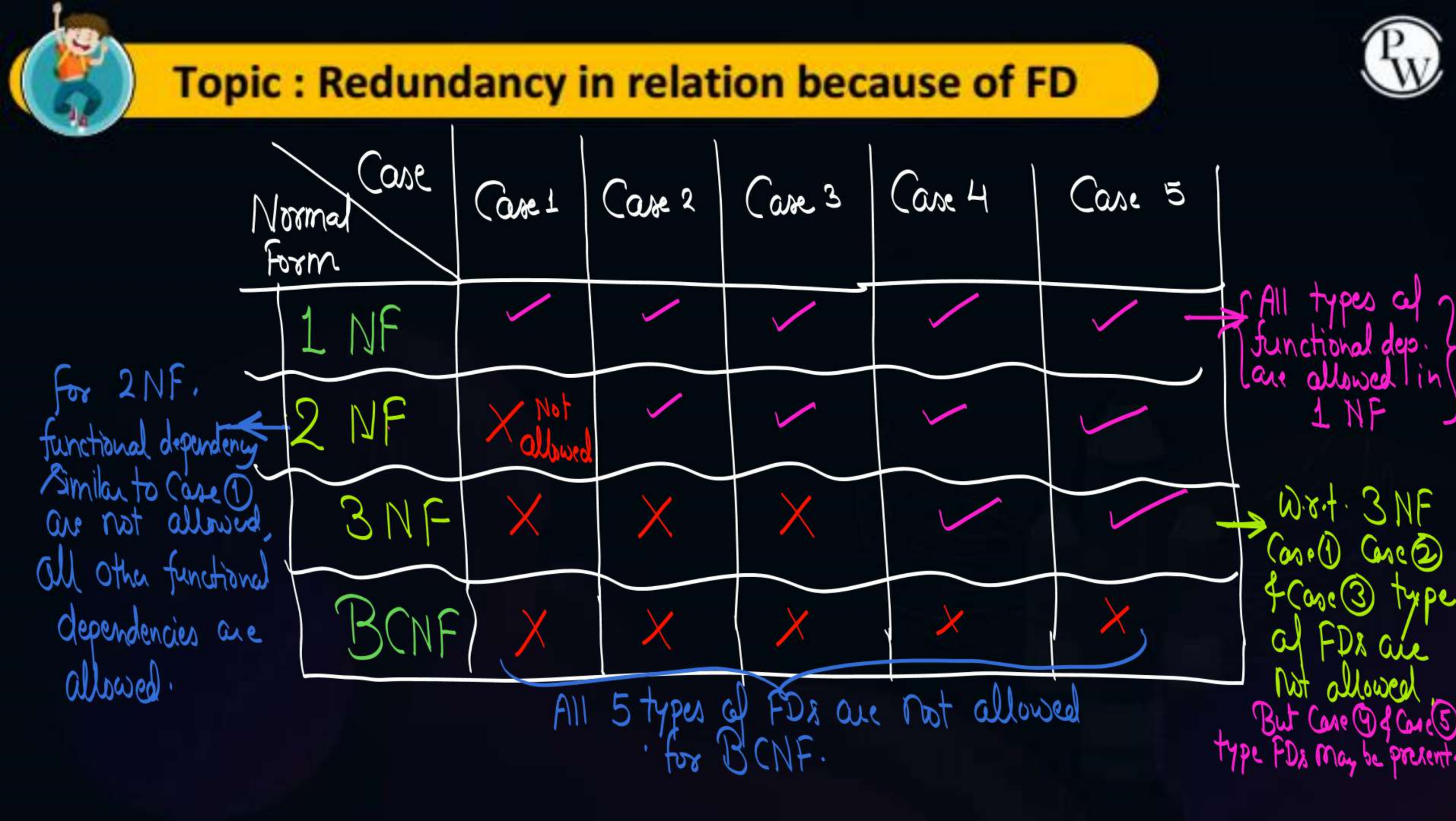
(Not possible if $X \longrightarrow$ Prime Attribute, then that prime Attribute can be replaced by X, and X will also become part of C.K i.e. Prime Attribute)

Proper Subset of a Candidate Key → Proper Subset of same C.K {Not possible}

Case ④ Proper Subset of one C.K → Proper Subset of another C.K

Case ⑤ (Proper Subset of one C.K + Non-prime Attribute) → Proper Subset of some other C.K

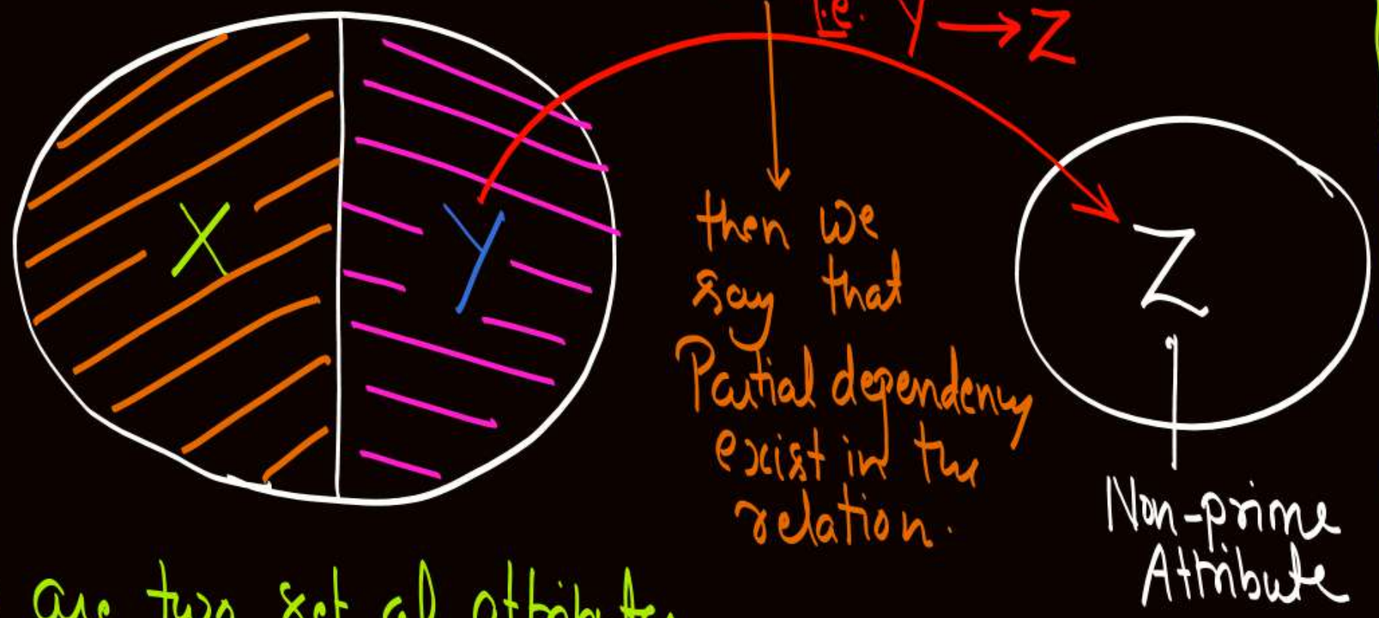
Topic : Redundancy in relation because of FD



Topic : Second normal form (2NF)

- A relation R is in 2NF only if,
  - (i) Relation is in 1NF.
  - (ii) Relation must not contain any partial dependency

Partial Functional Dependency :-



X & Y are two set of attributes & (XY) together is Candidate key of the relation

{ X & Y becomes some Proper subsets of C.K }

Let "XY" is Candidate key & Z is non-Prime attribute

Note:

1. if 'Z' is fully dependent on "XY" { i.e. No Proper subset of XY can determine Z }, then XY → Z is a Full functional dependency
2. If a Proper subset of Candidate key "XY" can determine 'Z', then XY → Z is called a Partial functional dependency.

Topic : Third normal form (3NF)

A relation R is in 3NF only if,
Every non-trivial functional dependency $X \longrightarrow Y$ is with

(i) X as a Super key

(or)

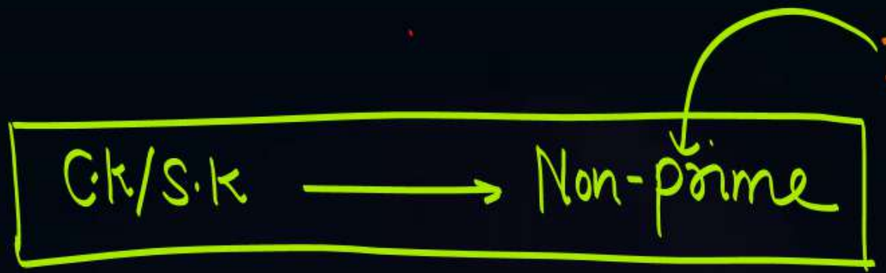
(ii) Y as a prime attribute

in $X \to Y$ if 'X' is a Super key. then there will be no redundancy wrt. $X \to Y$, hence $X \to Y$ will be in BCNF, and hence in 3NF as well.

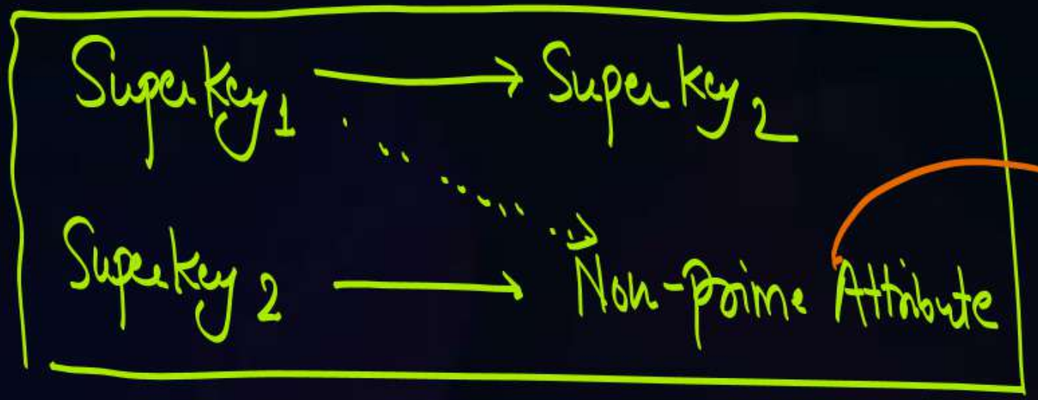
i.e; Case(1), Case(2) & Case(3) are not allowed.

Topic : Third normal form (3NF)

- A relation R is in 3NF only if.
  Relation R does not contain any transitive dependency.

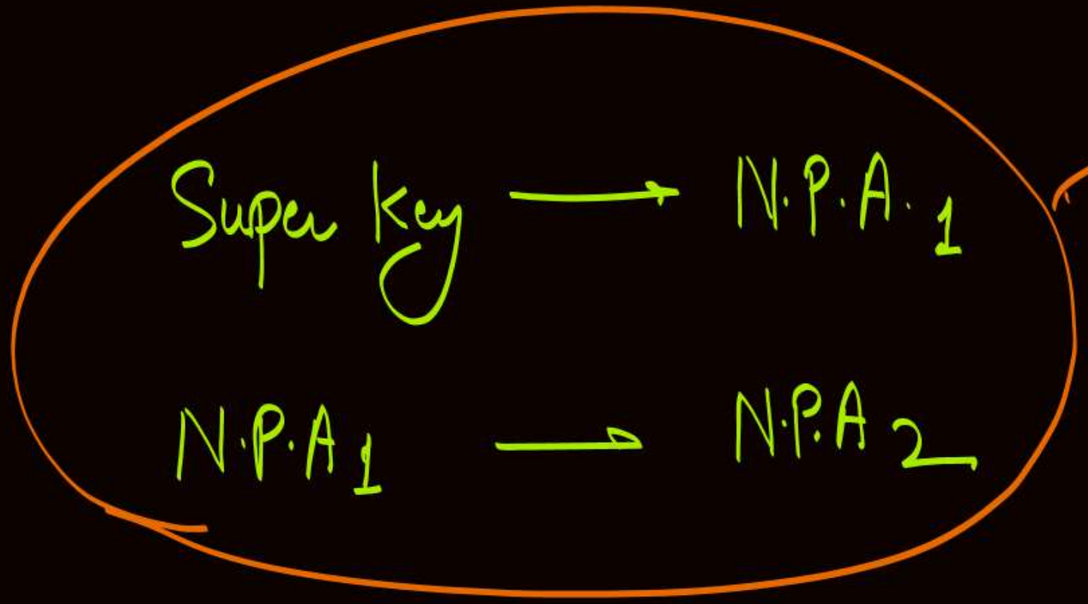


In this case non-prime attribute is directly dependent on C.k/S.k. ∴ No transitive dependency



In this case also non-prime attribute is directly dependent on S.k$_2$

→ A functional dependency is called transitive dependency if "non-prime" attribute is transitively dependent on Superkey/C.k. {i.e. Not directly dependent on S.k or C.k.}

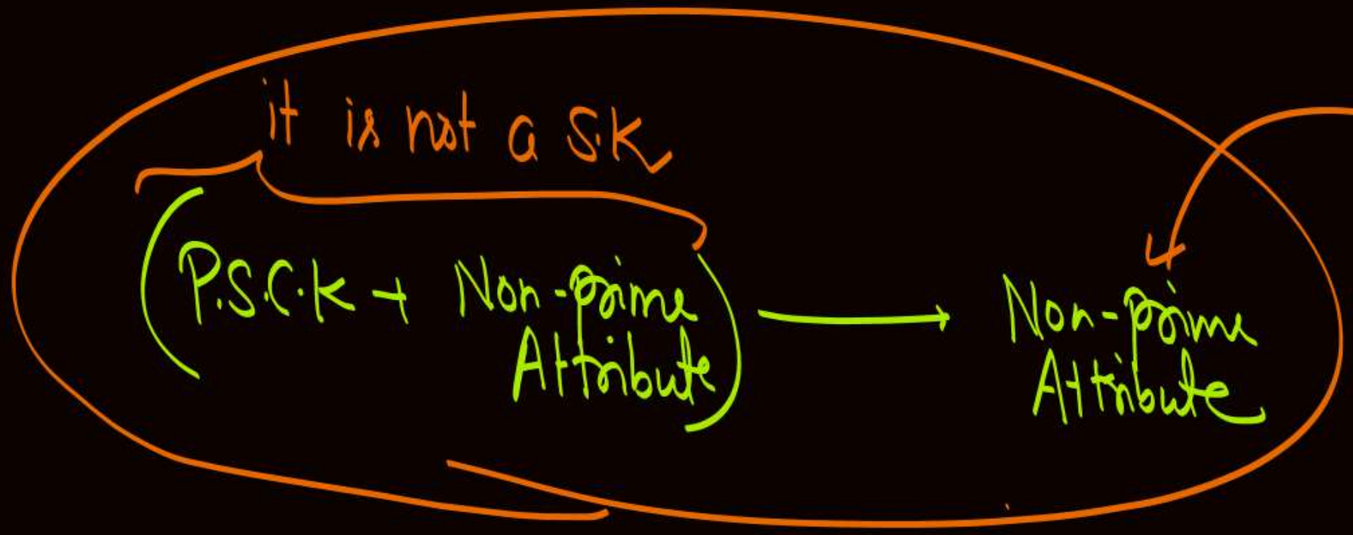


NPA_1 is directly dependent on super key {∵ Super key → NPA_1 is allowed in 3NF}

But NPA_2 is not directly dependent on S.K.

∴ { $NPA_1 \longrightarrow NPA_2$ is not allowed in 3NF }

i.e. Case ③ type of FDs are not allowed



This non-prime attribute is not directly dependent on a Super key

i.e; Case ② type of FDs are not allowed

Topic : Boyce codd normal form (BCNF)

A relation R is in BCNF only if Every non-trivial functional dependency $X \longrightarrow Y$ must be with "X" as a Super key of relation R

for a relation to be in BCNF there must be no redundancy because of functional dependency

∴ All 5 types of FDs are not allowed in BCNF

#e.g. Given R(ABCDEF) and

F={AB→CD, D→A, C→E, B→F }

Find the normal form of the relation.

AB → CD {BCNF}
D → A {3NF}
C → E {2NF}
B → F {1NF}

Normal form of the relation will be the least of the normal forms of all the FDs

↳ Hence Normal form of Relation is 1NF

AB is a CK

Prime Attribute = {A, B}

AB → D

D → A

↑ Prime Attribute

∴ Replace A by D

DB is a C.K.

Prime Attribute = {A, B, D}

Non-prime Attribute = {C, E, F}

C.K = (AB) & (DB)

① $AB \longrightarrow CD$

S.K $\longrightarrow$ ∴ Allowed upto BCNF

② $D \longrightarrow A$

Proper Subset of one C.K $\longrightarrow$ Proper Subset of another C.K — Case ④ — Allowed upto 3NF But not allowed in BCNF

③ $C \longrightarrow E$

N.P.A $\longrightarrow$ N.P.A — Case ③ — Allowed upto 2 NF not allowed in 3NF

④ $B \longrightarrow F$

P.S.C.K $\longrightarrow$ N.P.A — Case ① $\longrightarrow$ Allowed in 1 NF not allowed in 2 NF

Decomposition of Relation into Sub-relations

#e.g. Given R(ABCDE) and F={AB→C, C→D, B→E}

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

∴ AB is a C.K.

Find the normal form of the relation, and if relation is not already in BCNF then decompose the relation up to BCNF.

P.A = {A, B}

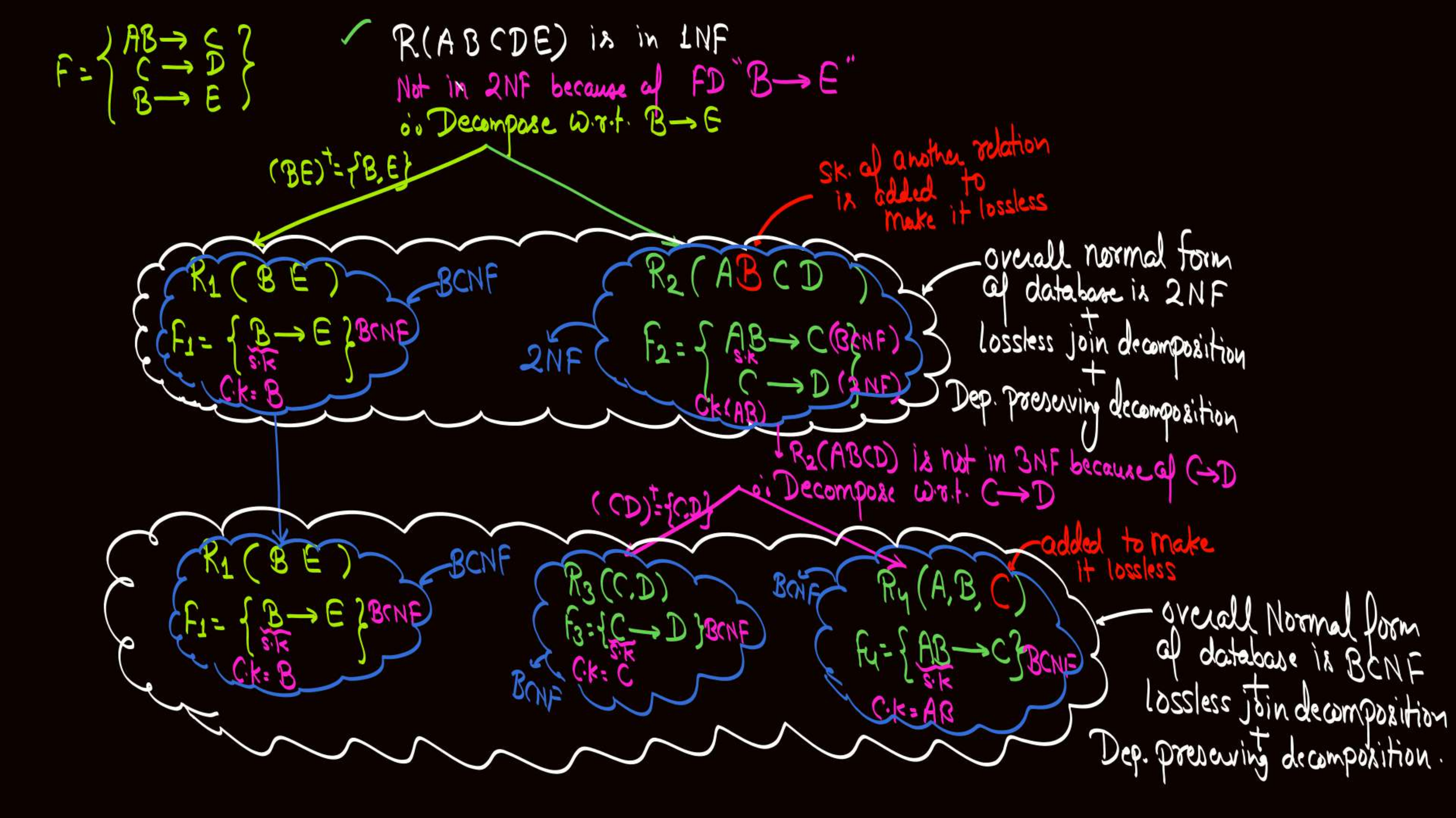
N.P.A = {C, D, E}

AB → C {BCNF}
S.K

Case (3) C → D {2NF}
N.P.A N.P.A

Case (1) B → E {1NF}
P.S.C.K N.P.A

Normal Form of Relation is 1NF


F = { AB → C, C → D, B → E }
R(ABCDE) is in 1NF
Not in 2NF because of FD "B → E"
i.e. Decompose w.r.t. B → E
(BE)+ = {B, E}
Sk. of another relation is added to make it lossless
R1 (B E)
F1 = { B → E } BCNF
s.k
C.k: B
BCNF
2NF
R2 (A B C D)
F2 = { AB → C (BCNF), C → D (3NF) }
s.k
Ck (AB)
overall normal form of database is 2NF + lossless join decomposition + Dep. preserving decomposition
R2(ABCD) is not in 3NF because of C → D
i.e. Decompose w.r.t. C → D
(CD)+ = {C, D}
R1 (B E)
F1 = { B → E } BCNF
s.k
C.k: B
BCNF
R3 (C, D)
F3 = { C → D } BCNF
s.k
C.k: C
BCNF
BCNF
R4 (A, B, C)
F4 = { AB → C } BCNF
s.k
C.k: AB
added to make it lossless
overall Normal form of database is BCNF + lossless join decomposition + Dep. preserving decomposition.

H.W.

#e.g. Given R(ABCDEF) and F={A→BCDEF, BC→ADEF, D→E , E→F}

Find the normal form of the relation, and if relation is not already in BCNF then decompose the relation up to BCNF.

H.W.

#e.g. Given R(ABCD) and F={AB→C, BC→D}

Find the normal form of the relation, and if relation is not already in BCNF then decompose the relation up to BCNF.

H.W.

#e.g. Given R(ABCDEFGHIJ) and F={AB→C, A→DE, B→F, F→GH, D→IJ}

Find the normal form of the relation, and if relation is not already in BCNF then decompose the relation up to BCNF.

H.W.

#e.g. Given R(ABDLPT) and F={B→PT, T→L, A→D}

Find the normal form of the relation, and if relation is not already in BCNF then decompose the relation up to BCNF.

H.W.

#e.g. Given R(ABCDE) and F:{A→BC, CD→E, B→D, E→A}

Find the normal form of the relation, and if relation is not already in BCNF then decompose the relation up to BCNF.

HW.

#e.g. Given R(ABCD) and F={AB→CD, D→A }

Find the normal form of the relation, and if relation is not already in BCNF then decompose the relation up to BCNF.

2 mins Summary

- Topic: Redundancy in relation because of FD
- Topic: Second normal form (2NF)
- Topic: Third normal form (3NF)
- Topic: Boyce codd normal form (BCNF)
- Topic: Decomposition of relation

Slide

THANK - YOU

Slide