CS & IT ENGINEERING

Database Management System

DBMS

Lecture No. 4

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Recap of Previous Lecture

Topic Normalization

Topics to be Covered

- **Topic** Integrity Constraints & ER Model (2 Marks)
- **Topic** Normalization (2-4 Marks)
- **Topic** Queries (Relational Algebra, SQL, Tuple Relational Calculus) (4 Marks)
- **Topic** File Organization & Indexing(2-4 Marks)
- **Topic** Transactions & Concurrency Control (2- 4 Marks)

Topics to be Covered

Topic Normal Forms- 1NF, 2NF, 3NF, BCNF, 4NF

Topic Finding Highest NF of a Relation

Topic Decomposition into Highest NF

60-70%

Topic: Normal Forms

Normal Forms:

- Used to identify degree of redundancy.

Topic: Normal Forms

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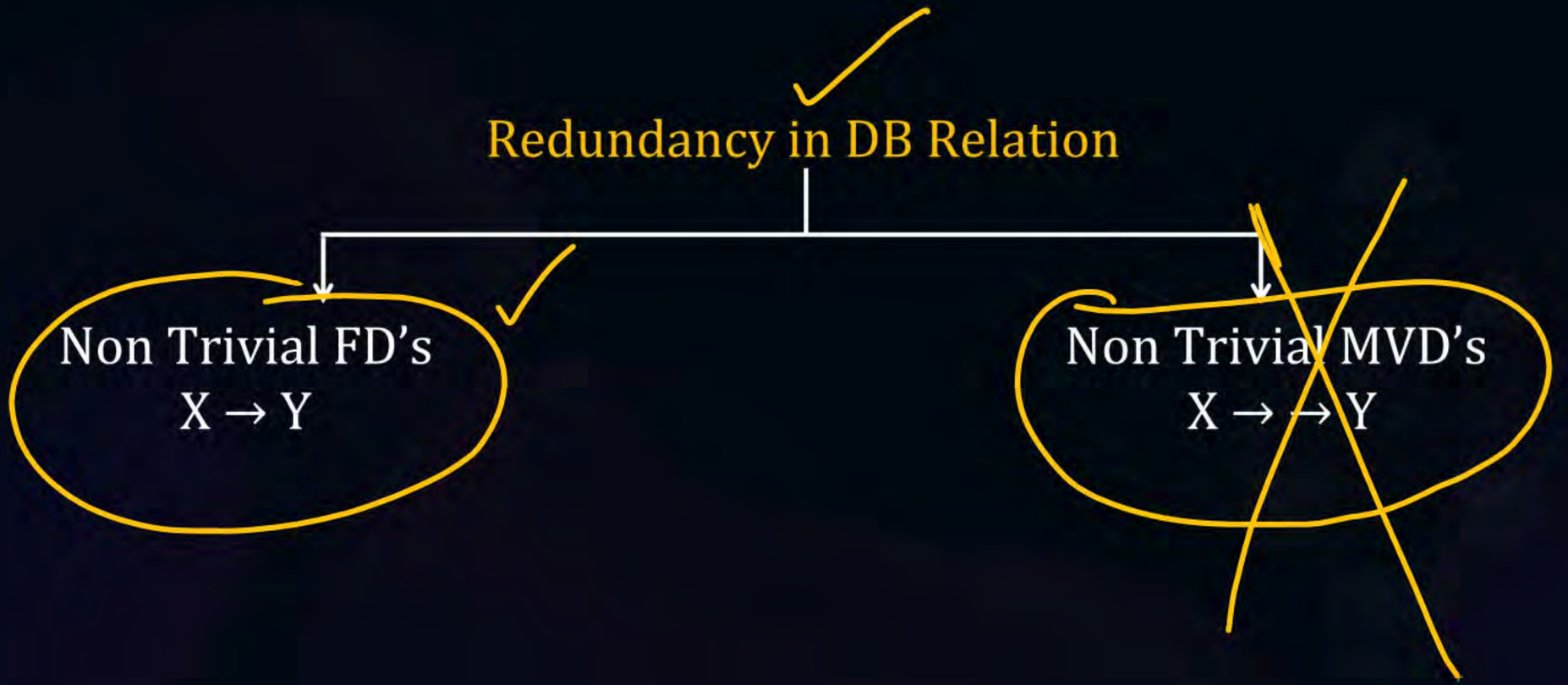
- Used to identify degree of redundancy.



Topic: Normal Forms

Different Normal Forms are (Redundancy ↓ as we go down) :

(i) 1 NF

(ii) 2 NF

(iii) 3 NF

(iv) BCNF

~~(v) 4 NF~~

Topic: Normal Forms

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(iv) BCNF
(v) 4 NF

Done over FD set ($X \rightarrow Y$)

Topic: Normal Forms

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(ii) 2 NF
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} Done over FD set ($X \rightarrow Y$)

(iv) BCNF → 0% redundancy over FD's, ~~may not on MVD's~~

(v) 4 NF

Topic: Normal Forms

Different Normal Forms are (Redundancy ↓ as we go down) :

(i) 1 NF
(ii) 2 NF
(iii) 3 NF
} Done over FD set (X → Y)

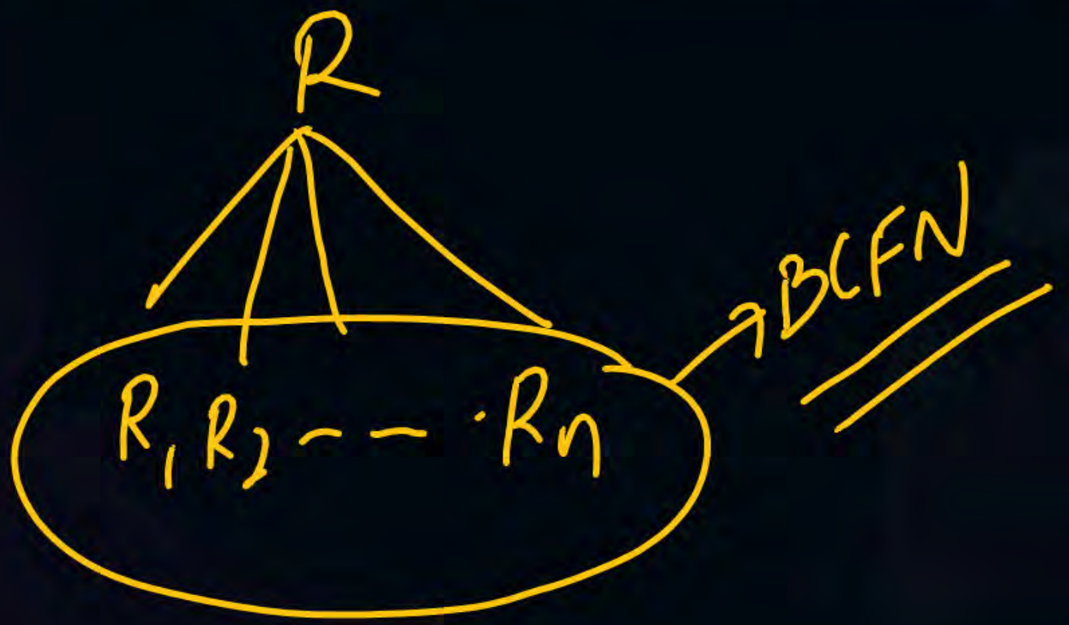
(iv) BCNF → 0% redundancy over FD's, may not on MVD's

(v) ~~4 NF~~ → Done over MVD set → 0% redundancy on FD's & MVD's (X →→ Y)

Topic: Normal Forms

Very frequent questions in GATE from 1NF, 2NF, 3NF and BCNF.

- To remove redundancies in FD's, decompose till it follows BCNF.



Topic: Normal Forms

Very frequent questions in GATE from 1NF, 2NF, 3NF and BCNF.

- To remove redundancies in FD's, decompose till it follows BCNF. ✓
- To remove redundancies in MVD's decompose till it follows 4NF. ✗

Topic: Normal Forms

Very frequent questions in GATE from 1NF, 2NF, 3NF and BCNF.

- To remove redundancies in FD's, decompose till it follows BCNF.
- To remove redundancies in MVD's decompose till it follows 4NF.

Topic: Normal Forms

Very frequent questions in GATE from 1NF, 2NF, 3NF and BCNF.

- To remove redundancies in FD's, decompose till it follows BCNF.
- To remove redundancies in MVD's decompose till it follows 4NF.
- 1NF is default RDBMS condition.

Inspiring Stories : Dr. Diwan Singh

Background: **Punjabi doctor-poet in Port Blair.**

Struggles: **Led the Indian Independence League in the islands.**

Achievements: **Opposed tyranny even under Japanese occupation; tortured to death in 1944.**

Impact: **A museum and records honor him; islanders remember his fearless voice.**

Topic: Normal Forms

(i) First Normal Form (1NF):

- Relation R is in 1NF iff no multivalued attributes are present.
- Every attribute of R must be atomic/single valued.
- Default NF of RDBMS relations, i.e., relation is by default 1NF by RDBMS guidelines.

Topic: Properties of Decomposition

Ex1 : Let a Relation R be the following & FD is Sid → Sname

Sid	Sname	Cid
S1	A	C1 / C2
S2	B	C2 / C3
S3	B	C3

Cid is multivalued attribute.

∴ R is not in 1NF hence, not a RDBMS.

Topic: Properties of Decomposition

Ex1 : Let a Relation R be the following & FD is Sid → Sname

Sol: For Sid → Sname, CK is Sid Cid.

∴ We can write data like below because of unique rows.

Sid	Sname	Cid
S1	A	C1 / C2
S2	B	C2 / C3
S3	B	C3

=>

Sid	Sname	Cid
S1	A	C1
S1	A	C2
S2	B	C2
S2	B	C3
S3	B	C3

Topic: Properties of Decomposition

Ex2 : For a Relation R, with FD Sid → Sname & the table as below.

Sid	Sname	Cid	Phno	email
S1	A	C1 / C2	P1 / P2 / P3	e1 / e2 / e3 / e4
S2	B	C2 / C3	P3 / P4	e4 / e5

2 3 4

2 2

Topic: Properties of Decomposition

Ex2 : For a Relation R, with FD Sid → Sname & the table as below.

Sid	Sname	Cid	Phno	email
S1	A	C1 / C2	P1 / P2 / P3	e1 / e2 / e3 / e4
S2	B	C2 / C3	P3 / P4	e4 / e5

Sol : To convert 1NF, the CK is Sid Cid Phno email

S1 – 24 tuples
(2 × 3 × 4)

S2 – 8 tuples
(2 × 2 × 2)

Sid	Sname	Cid	Phno	email
S1	A	C1	P1	e1
S1	A	C2	P1	e1
⋮	⋮	⋮	⋮	⋮
S1	A	C2	P3	e4
S2	B	C2	P3	e4
⋮	⋮	⋮	⋮	⋮
S2	B	C3	P4	e5

Topic: Properties of Decomposition

Now the relation is DBMS and is in 1NF

$\Rightarrow$ Now there are 24 tuples with (S1, A……) row and 8 tuples of (S2, B…) which causes very high redundancy

Topic: Properties of Decomposition

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⇒ 1NF – default NF of RDBMS

Topic: Properties of Decomposition

Now the relation is DBMS and is in 1NF

⇒ Now there are 24 tuples with (S1, A……) row and 8 tuples of (S2, B…) which causes very high redundancy

⇒ 1NF – default NF of RDBMS

⇒ 2NF, 3NF, BCNF, 4NF – used to reduce/ eliminate redundancy

Topic: Properties of Decomposition

Some points to remember about Redundancy:

⇒ X → Y FD of Relation R forms redundancy iff

- X → Y is Non- trivial FD

and

- X is not Super Key of R

X → Y

↓

Not SK

Topic: Properties of Decomposition

Some points to remember about Redundancy:

⇒ $X \rightarrow Y$ FD of Relation R forms redundancy iff

- $X \rightarrow Y$ is Non- trivial FD

and

- X is not Super Key of R

⇒ $X \rightarrow Y$ FD of Relation R doesnt form redundancy iff

- $X \rightarrow Y$ is a trivial FD ($X \supseteq Y$)

or

- X is Super Key of R

$X \rightarrow Y$

↓

SK

Topic: Properties of Decomposition

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S1 – 24 tuples
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S2 – 8 tuples
(2 × 2 × 2)

Sid	Sname	Cid	Phno	email
S1	A	C1	P1	e1
S1	A	C2	P1	e1
⋮	⋮	⋮	⋮	⋮
S1	A	C2	P3	e4
S2	B	C2	P3	e4
⋮	⋮	⋮	⋮	⋮
S2	B	C3	P4	e5

Topic: Properties of Decomposition

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Sid	Sname	Cid	Phno	email
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S1	A	C2	P1	e1
⋮	⋮	⋮	⋮	⋮
S1	A	C2	P3	e4
S2	B	C2	P3	e4
⋮	⋮	⋮	⋮	⋮
S2	B	C3	P4	e5

Explanation : After converting to 1NF, Sid → Sname forms redundancy becoz Sid is not a superkey

Topic: Properties of Decomposition

Ex : R (eid, ename, DOB, rating, salary) and FD are {eid → ename DOB rating, rating → salary}

Topic: Properties of Decomposition

NO Redun

Ex : R (eid, ename, DOB, rating, salary) and FD are {eid → ename DOB rating, rating → salary}

Sol : eid is CK.

eid → ename DOB rating

↓

SK ∴ No redundancy occurs

Topic: Properties of Decomposition

Ex : R (eid, ename, DOB, rating, salary) and FD are {eid → ename DOB rating, rating → salary}

Sol : eid is CK.

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SK ∴ No redundancy occurs

rating → salary

↓

Not SK ∴ Forms redundancy

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Ex : R (eid, ename, DOB, rating, salary) and FD are {eid → ename DOB rating, rating → salary}

Sol : eid is CK.

eid → ename DOB rating

↓

SK ∴ No redundancy occurs

rating → salary

↓

Not SK ∴ Forms redundancy

eid	ename	DOB	rating	Salary
e1			8	50k
e2			8	50k
e3			8	50k
e4			10	70k

Redundancy in a FD $X \rightarrow Y$ occurs if X is not SK

Topic: Properties of Decomposition

Ex : R (eid, ename, DOB, rating, salary) and FD are {eid → ename DOB rating, rating → salary}

Sol : eid is CK.

eid → ename DOB rating

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Not SK ∴ Forms redundancy

eid	ename	DOB	rating	Salary
e1			8	50k
e2			8	50k
e3			8	50k
e4			10	70k

Redundancy ✓

rating → salary

Since salary depends on rating

Topic: Properties of Decomposition

Ex3 : R (Sid, Sname, DOB) and FD is Sid → Sname DOB

SK

Topic: Properties of Decomposition

Ex3 : R (Sid, Sname, DOB) and FD is Sid → Sname DOB

Sol : Sid is CK.

Topic: Properties of Decomposition

Ex3 : R (Sid, Sname, DOB) and FD is Sid → Sname DOB

Sol : Sid is CK.

Sid → Sname DOB

↓

SK ∴ No redundancy occurs

Topic: Properties of Decomposition

Ex4 : R (ABCDE) and FDs are {AB → C, B → D, D → E, AE → F, C → A}

Topic: Properties of Decomposition

Ex4 : R (ABCDE) and FDs are {AB → C, B → D, D → E, AE → F, C → A}

Sol : C key are AB, BC

Topic: Properties of Decomposition

Ex4 : R (ABCDE) and FDs are {AB → C, B → D, D → E, AE → F, C → A}

Sol : C key are AB, BC

Except AB → C all other FD's form redundancy because the determinants are not super keys.

Topic: Normal Forms

Four points to remember about FD's that forms Redundancy:

1. Proper subset of Candidate key → Non Prime

Topic: Normal Forms

Four points to remember about FD's that forms Redundancy:

1. Proper subset of Candidate key → Non Prime
2. Non Prime Attribute → Non Prime Attribute

Topic: Normal Forms

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1. Proper subset of Candidate key → Non Prime
2. Non Prime Attribute → Non Prime Attribute
3. {Combination of Proper Subset of CK & Non-Prime Attribute} → Non Prime Attributes

Topic: Normal Forms

Four points to remember about FD's that forms Redundancy:

1. Proper subset of Candidate key → Non Prime
2. Non Prime Attribute → Non Prime Attribute
3. {Combination of Proper Subset of CK & Non-Prime Attribute} → Non Prime Attributes
4. Proper subset of CK → Proper subset of Some Other CK

Topic: Normal Forms

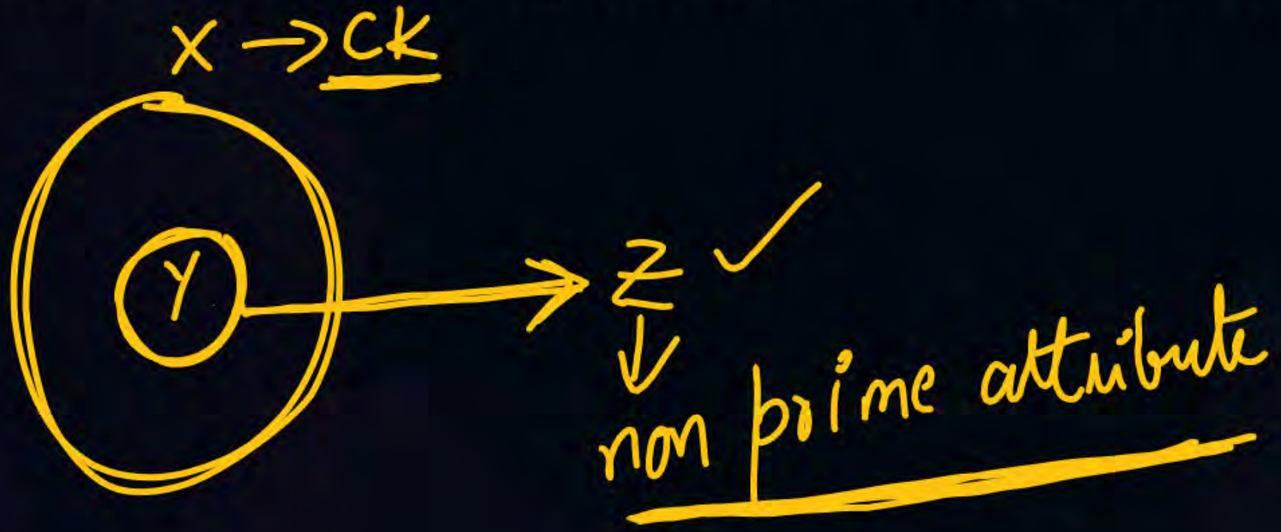
- Partial Dependency:

Topic: Normal Forms

- Partial Dependency:

  Partial dependency for a relation R with Candidate Key X,

  $Y \rightarrow Z$ is called partial dependency where $Y \subset X$ and Z is non prime attribute.



Topic: Normal Forms

- Partial Dependency:

  Partial dependency for a relation R with Candidate Key X,

  $Y \rightarrow Z$ is called partial dependency where $Y \subset X$ and Z is non prime attribute.

  Y → Z

  Y: Part of Ckey X

  Z: Non-Prime Attribute

Topic: Normal Forms

- Partial Dependency:

  Partial dependency for a relation R with Candidate Key X,

  $Y \rightarrow Z$ is called partial dependency where $Y \subset X$ and Z is non prime attribute.

Y	→	Z
Part of Ckey X		Non-Prime Attribute

(ii) Second Normal Form (2NF):

- R is in 2 NF iff there are no partial dependencies in R.

Topic: Normal Forms

(iii) Third Normal Form (3NF):

Topic: Normal Forms

(iii) Third Normal Form (3NF):

- Relation R is in 3NF iff every Non-trivial FD. $X \rightarrow Y$ follows

  (i) X must be Super key of R

Topic: Normal Forms

(iii) Third Normal Form (3NF):

- Relation R is in 3NF iff every Non-trivial FD. $X \rightarrow Y$ follows

  (i) X must be Super key of R

  or

  (ii) Y must be prime attribute of R

Topic: Normal Forms

(iii) Third Normal Form (3NF):

- Relation R is in 3NF iff every Non-trivial FD. $X \rightarrow Y$ follows

  (i) X must be Super key of R

  or

  (ii) Y must be prime attribute of R

$$X \quad \rightarrow \quad Y$$

SK (or) Prime Attr.

Topic: Properties of Decomposition

Ex : R (ABC) and FDs are {AB → C, C → A}

Topic: Properties of Decomposition

Ex : R (ABC) and FDs are {AB → C, C → A}

Sol : The CK are AB, BC

Topic: Properties of Decomposition

Ex : R (ABC) and FDs are {AB → C, C → A}

Sol : The CK are AB, BC

AB → C, C → A

↓ ↓

SK Prime Attr.

Topic: Properties of Decomposition

Ex : R (ABC) and FDs are {AB → C, C → A}

Sol : The CK are AB, BC

AB → C, C → A are in 3NF

↓ ↓

SK Prime Attr.

Topic: Properties of Decomposition

Ex : R (ABC) and FDs are {AB → C, C → A}

Sol : The CK are AB, BC

AB → C, C → A are in 3NF

AB → C : Sk

C → A : Prime Attr.

But C → A forms redundancy, because

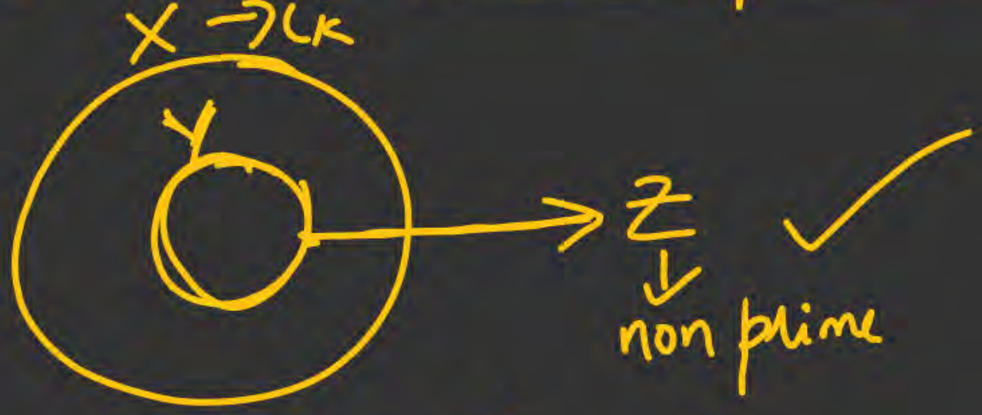
C → A

C : Part of CK

A : Part of CK

SK

II NF :- No partial dependencies ✓



✓

10 times

III NF :- X → Y

X ↓ SK of Y ✓ prime

BCNF :- X → Y ✓

X → Super key

5 min

PA ↓ any attribute of a CK

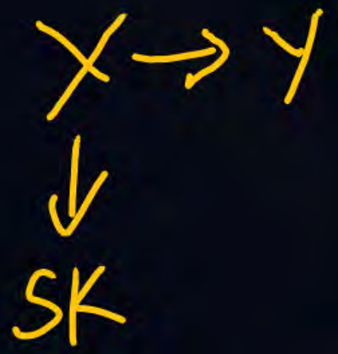
Topic: Normal Forms

- Proper Subset of Ckey → Proper Subset of other Ckey is allowed in 3NF but it forms redundancy.
- To remove redundancies of Non-trivial FD's completely, we should go for BCNF.

Topic: Normal Forms

(iv) BOYCE – CODD NORMAL FORM (BCNF):

- Relation R is in BCNF, iff for every Non-trivial FD X → Y in R, X should be a Super key.



Topic: Normal Forms

(iv) BOYCE – CODD NORMAL FORM (BCNF):

- Relation R is in BCNF, iff for every Non-trivial FD $X \rightarrow Y$ in R, X should be a Super key.

$X \rightarrow Y$ this is Non Trivial FD ✓

Topic: Normal Forms

(iv) BOYCE – CODD NORMAL FORM (BCNF):

- Relation R is in BCNF, iff for every Non-trivial FD $X \rightarrow Y$ in R, X should be a Super key.

$X \rightarrow Y$ this is Non Trivial FD

↓

SK

Topic: Highest NF

- For the before example

  R(ABCDE) and FD's {AB → C, B → D, D → E, AE → F, C → A}

  Lets Find the highest NF

Topic: Highest NF

AB → Prime attr
AB and BC are CKs

- For the before example

  R(ABCDE) and FD's {AB → C, B → D, D → E, AE → F, C → A}

  Lets Find the highest NF

Topic: Highest NF

AB and BC are CKs

- For the before example

  R(ABCDE) and FD's {AB → C, B → D, D → E, AE → F, C → A}

  Lets Find the highest NF

  AB → C

  B → D

  D → E

  AE → F

  C → A

Topic: Highest NF

AB and BC are CKs

- For the before example

  R(ABCDE) and FD's {AB → C, B → D, D → E, AE → F, C → A}

	2NF	
AB → C	✓	AB is Super key
B → D		
D → E		
AE → F		
C → A		

Topic: Highest NF

AB and BC are CKs

- For the before example

  R(ABCDE) and FD's {AB → C, B → D, D → E, AE → F, C → A}

	2NF	
AB → C	✓	AB is Super key
B → D	×	B is propersubset of Ck
D → E		
AE → F		
C → A		

Topic: Highest NF

AB and BC are CKs

- For the before example

  R(ABCDE) and FD's {AB → C, B → D, D → E, AE → F, C → A}

2NF

AB → C	✓
B → D	✗
D → E	✓
AE → F	
C → A	

AB is Super key

B is propersubset of Ck

Both are non primes

Topic: Highest NF

AB and BC are CKs

- For the before example

  R(ABCDE) and FD's {AB → C, B → D, D → E, AE → F, C → A}

2NF

AB → C	✓	AB is Super key
B → D	✗	B is propersubset of Ck
D → E	✓	Both are non primes
AE → F	✓	AE is not SK
C → A		

Topic: Highest NF

AB and BC are CKs

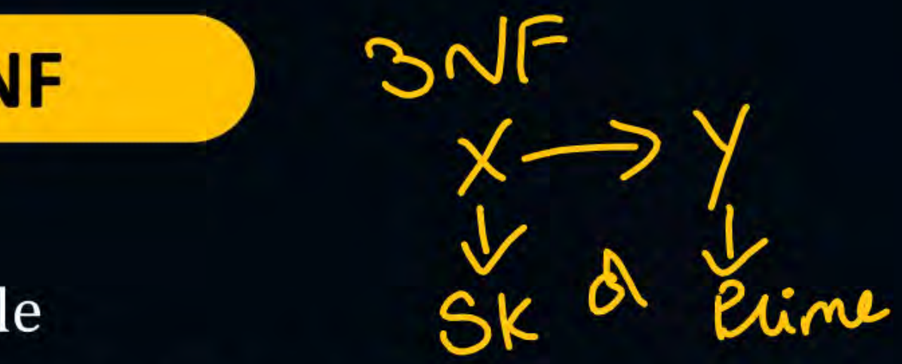
- For the before example

  R(ABCDE) and FD's {AB → C, B → D, D → E, AE → F, C → A}

~~2NF~~

AB → C	✓	AB is Super key
~~B → D~~	×	B is propersubset of Ck
D → E	✓	Both are non primes
AE → F	✓	AE is not SK
C → A	✓	Proper Subset of CK → proper subset of another CK

Topic: Highest NF



AB and BC are CKs

- For the before example

R(ABCDE) and FD's {AB → C, B → D, D → E, AE → F, C → A}

	2NF	3NF	
AB → C	✓	✓	AB is Super key
B → D	×		
D → E	✓		
AE → F	✓		
C → A	✓		

Topic: Highest NF

AB and BC are CKs

- For the before example

  R(ABCDE) and FD's {AB → C, B → D, D → E, AE → F, C → A}

	2NF	3NF	
AB → C	✓	✓	AB is Super key
B → D	×	×	B is propersubset of Ck,
D → E	✓		not in 2NF, so not in 3NF
AE → F	✓		
C → A	✓		

Topic: Highest NF

AB and BC are CKs

- For the before example

  R(ABCDE) and FD's {AB → C, B → D, D → E, AE → F, C → A}

	2NF	3NF	
AB → C	✓	✓	AB is Super key
B → D	×	×	B is propersubset of Ck
D → E	✓	×	D is not Sk and E is not prime
AE → F	✓		
C → A	✓		

Topic: Highest NF

AB and BC are CKs

- For the before example

  R(ABCDE) and FD's {AB → C, B → D, D → E, AE → F, C → A}

	2NF	3NF	
AB → C	✓	✓	AB is Super key
B → D	×	×	B is propersubset of Ck
D → E	✓	×	D is not Sk and E is not prime
AE → F	✓	×	AE is not Sk and F is not prime
C → A	✓		

Topic: Highest NF

- For the before example

  R(ABCDE) and FD's {AB → C, B → D, D → E, AE → F, C → A}

AB and BC are CKs

	2NF	3NF	
AB → C	✓	✓	AB is Super key
B → D	×	×	B is propersubset of Ck
D → E	✓	×	D is not Sk and E is not prime
AE → F	✓	×	AE is not Sk and F is not prime
C → A	✓	✓	Proper → Proper
			Subset of Ck → Subset of Ck

Topic: Highest NF

- For the before example

  R(ABCDE) and FD's {AB → C, B → D, D → E, AE → F, C → A}

  1NF

  AB and BC are CKs

	2NF	3NF	
AB → C	✓	✓	AB is Super key
B → D	×	×	B is propersubset of Ck
D → E	✓	×	D is not Sk and E is not prime
AE → F	✓	×	AE is not Sk and F is not prime
C → A	✓	✓	Proper → Proper
			Subset of Ck Subset of Ck

- All 4 FDs are not allowed in BCNF, because none of the determinant are Skeys.

Topic: Highest NF

Recalling the points to remember about Redundancy:

(i) $X \rightarrow Y$ FD of Relation R forms redundancy iff

- $X \rightarrow Y$ is Non- trivial FD

and

- X is not Super Key of R

$X \rightarrow Y$
↓
Not SK

(ii) $X \rightarrow Y$ FD of Relation R doesnt form redundancy iff

- $X \rightarrow Y$ is a trivial FD ($X \supseteq Y$)

or

- X is Super Key of R

Topic: Highest NF

Recalling the points to remember about Redundancy:

(i) $X \rightarrow Y$ FD of Relation R forms redundancy iff

- $X \rightarrow Y$ is Non- trivial FD

and

- X is not Super Key of R

(ii) $X \rightarrow Y$ FD of Relation R doesnt form redundancy iff

- $X \rightarrow Y$ is a trivial FD ($X \supseteq Y$)

or

- X is Super Key of R

Redundancy Rules

(i) is not allowed in BCNF

(ii) is allowed

Topic: Highest NF

Summary: For a non trivial FD $X \rightarrow Y$ to be in XNF, it is as follows:

1NF	No Multivalued allowed
2NF	X should not be a part of Ckey AND
	Y should not be a Non-Prime Attribute
	i.e., $X \rightarrow Y$ should not be a partial dependency
3NF	X should be a Super key OR
	Y should be a prime attribute
BCNF	X should be a Super key

Topic: Highest NF

Summary: For a non trivial FD $X \rightarrow Y$ to be in XNF, it is as follows:

1NF	No Multivalued allowed
2NF	No PD or $(\text{Proper subset of CK})^+$ = only prime attributes
3NF	X should be a Super key OR Y should be a prime attribute
BCNF	X should be a Super key

Inspiring Stories : Rani Abbakka Chowta

Background: **Queen of a port town on the Arabian Sea (1500s).**

Struggles: **Portuguese fleets wanted her coast and trade.**

Achievements: **Beat back multiple naval attacks; formed sea-side alliances; jailed only after years of war.**

Impact: **Coastal icon, proof that a small port can resist an empire.**

Topic: Important Question Asked in GATE

#Q. Find the highest NF given a Relation R and its Functional Dependencies.

Topic: Important Question Asked in GATE

#Q. Find the highest NF given a Relation R and its Functional Dependencies.

Sol.: Step 1: Find all Candidate keys (because we need to find the prime attributes further)

Topic: Important Question Asked in GATE

#Q. Find the highest NF given a Relation R and its Functional Dependencies.

Sol.: Step 1: Find all Candidate keys (because we need to find the prime attributes further)

Step 2: Find the highest NF.

Topic: Examples on Finding Highest NF

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AB^{+} = ABCDE

No proper subset of ABC forms CK ∴ ABC is CK

Topic: Examples on Finding Highest NF

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No proper subset of ABC forms CK ∴ ABC is CK

Check for prime attr on right side of the FDs

From ABD → C Replace C with ABD

Topic: Examples on Finding Highest NF

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From ABD → C Replace C with ABD

ABC = AB (ABD)

= ABD^+ = ABDCE

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ABC^+ = ABCDE

No proper subset of ABC forms CK ∴ ABC is CK

Check for prime attr on right side of the FDs

From ABD → C Replace C with ABD

ABC = AB (ABD)

= ABD^+ = ABDCE

No proper subset of ABD forms CK, ∴ ABD is also a CK.

Topic: Examples on Finding Highest NF

Ex1: R (ABCDE) {ABD → C, BC → D, CD → E}, Find the highest NF.

Sol Cont: ∴ ABD, ABC are Candidate keys.

∴ The prime attributes are ABCD, Non Prime attr is E. So no other Cks possible

ABCD

Topic: Examples on Finding Highest NF

Ex1: R (ABCDE) {ABD → C, BC → D, CD → E}, Find the highest NF.

Sol Cont: ∴ ABD, ABC are Candidate keys.

∴ The prime attributes are ABCD, Non Prime attr is E.

Checking highest NF for all FDs from the highest to lowest NF.

ABD → C	BC → D	CD → E
Sk	Partial Sk	Partial Sk
Prime Attribute	Partial Sk	Non Prime

Topic: Examples on Finding Highest NF

Ex1: R (ABCDE) {ABD → C, BC → D, CD → E}, Find the highest NF.

Sol Cont: ∴ ABD, ABC are Candidate keys.

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Checking highest NF for all FDs from the highest to lowest NF.

	ABD → C		BC → D		CD → E	
	Sk	Prime Attribute	Partial Sk	Partial Sk	Partial Sk	Non Prime
BCNF		✓		×		×

Topic: Examples on Finding Highest NF

Ex1: R (ABCDE) {ABD → C, BC → D, CD → E}, Find the highest NF.

Sol Cont: ∴ ABD, ABC are Candidate keys.

∴ The prime attributes are ABCD, Non Prime attr is E.

Checking highest NF for all FDs from the highest to lowest NF.

X → Y
X ↓ Sk, Y ↓ Prime

	ABD → C		BC → D		CD → E	
	Sk	Prime Attribute	Partial Sk	Partial Sk	Partial Sk	Non Prime
BCNF		✓	×		×	✓
3NF		✓	✓		×	✓

Topic: Examples on Finding Highest NF

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	ABD → C		BC → D		CD → E	
	Sk	Prime Attribute	Partial Sk	Partial Sk	Partial Sk	Non Prime
BCNF		✓		×		×
3NF		✓		✓		×

Topic: Examples on Finding Highest NF

Ex1: R (ABCDE) {ABD → C, BC → D, CD → E}, Find the highest NF.

Sol Cont:

- For 2NF, check if all proper Subsets of Ck closure → only prime attribute

Topic: Examples on Finding Highest NF

Ex1: R (ABCDE) {ABD → C, BC → D, CD → E}, Find the highest NF.

Sol Cont:

- For 2NF, check if all proper Subsets of Ck closure → only prime attribute

  ABD ⇒ $A^+ = A$, $B^+ = B$, $D^+ = D$, $AB^+ = AB$, $BD^+ = BD$, $AD^+ = AD$

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  ABD ⇒ $A^+ = A$, $B^+ = B$, $D^+ = D$, $AB^+ = AB$, $BD^+ = BD$, $AD^+ = AD$

  ABC ⇒ $A^+ = A$, $B^+ = B$, $C^+ = C$, $AC^+ = AC$, $BC^+ = BCDE$, $AB^+ = AB$

  ⇓

  BC → E

Topic: Examples on Finding Highest NF

Ex1: R (ABCDE) {ABD → C, BC → D, CD → E}, Find the highest NF.

Sol Cont:

- For 2NF, check if all proper Subsets of Ck closure → only prime attribute

  $ABD \Rightarrow A^+ = A, B^+ = B, D^+ = D, AB^+ = AB, BD^+ = BD, AD^+ = AD$

  $ABC \Rightarrow A^+ = A, B^+ = B, C^+ = C, AC^+ = AC, BC^+ = BCDE, AB^+ = AB$

  Here, $BC^+ = BCDE$

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  E is a Non prime attribute

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  $ABC \Rightarrow A^+ = A, B^+ = B, C^+ = C, AC^+ = AC, BC^+ = BCDE, AB^+ = AB$

  Here, $BC^+ = BCDE$

  E is a Non prime attribute

- The Relation is not in 2NF.

  The Relation's highest NF is 1NF

Topic: Examples on Finding Highest NF

Ex2: R (ABCD) and FDs {AB → C, BC → D}, what is the highest NF?

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Sol: Finding the Ckeys:

AB should be part of Ck because its is not derived.

AB^+ = ABCD

AB is CK since no proper subsets of AB are CKs

No other Ckeys are possible

Topic: Examples on Finding Highest NF

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Sol: Finding the Ckeys:

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AB^+ = ABCD

AB is CK since no proper subsets of AB are CKs

No other Ckeys are possible

Now lets check for the highest NF

Topic: Examples on Finding Highest NF

Ex2: R (ABCD) and FDs {AB → C, BC → D}, what is the highest NF?

Sol Cont.:

Topic: Examples on Finding Highest NF

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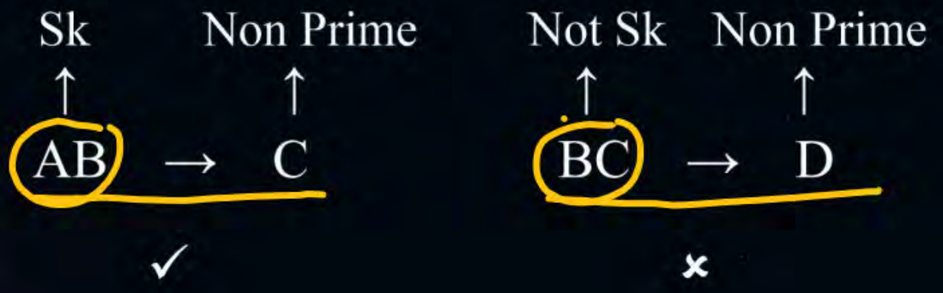
Sol Cont.:



Topic: Examples on Finding Highest NF

Ex2: R (ABCD) and FDs {AB → C, BC → D}, what is the highest NF?

Sol Cont.:

	Sk	Non Prime	Not Sk	Non Prime
	AB	→ C	BC	→ D
BCNF	✓		×	
3NF	✓		×	✓

Topic: Examples on Finding Highest NF

Ex2: R (ABCD) and FDs {AB → C, BC → D}, what is the highest NF?

AB

Sol Cont.:

	Sk		Non Prime	Not Sk		Non Prime
	↑		↑	↑		↑
	AB	→	C	BC	→	D
BCNF		✓			×	
3NF		✓			×	

Now checking for 2NF

Topic: Examples on Finding Highest NF

Ex2: R (ABCD) and FDs {AB → C, BC → D}, what is the highest NF?

Sol Cont.:

	Sk		Non Prime	Not Sk		Non Prime
	↑		↑	↑		↑
	AB	→	C	BC	→	D
BCNF	✓			×		
3NF	✓			×		

2NF Test: $\left(\text{Proper Subset of Ck}\right)^{+} \rightarrow$ Only Prime Attribute

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BCNF	✓			×		
3NF	✓			×		

2NF Test: $\left(\text{Proper Subset of Ck}\right)^{+} \rightarrow$ Only Prime Attribute

$A^+ = A$, $B^+ = B$ and AB^+ is not a proper subset of AB.

Topic: Examples on Finding Highest NF

Ex2: R (ABCD) and FDs {AB → C, BC → D}, what is the highest NF?

Sol Cont.:

	Sk		Non Prime	Not Sk		Non Prime
	↑		↑	↑		↑
	AB	→	C	BC	→	D
BCNF	✓			×		
3NF	✓			×		

2NF Test: $\left(\text{Proper Subset of Ck}\right)^{+} \rightarrow$ Only Prime Attribute

$A^+ = A$, $B^+ = B$ and AB^+ is not a proper subset of AB.

$\therefore$ The Relation's highest NF is 2NF.

Topic: Examples on Finding Highest NF

Ex3: R (ABCD), FDs are {AB → C, C → A, AC → D}, Find highest NF.

Topic: Examples on Finding Highest NF

Ex3: R (ABCD), FDs are {AB → C, C → A, AC → D}, Find highest NF.

Sol: CKs of relation contains B.

$AB^+ = ABCD$

Topic: Examples on Finding Highest NF

Ex3: R (ABCD), FDs are {AB → C, C → A, AC → D}, Find highest NF.

Sol: CKs of relation contains B.

$AB^+ = ABCD$ For AB $\Rightarrow A^+ = A, B^+ = B$

$\therefore$ AB is CK

Topic: Examples on Finding Highest NF

Ex3: R (ABCD), FDs are {AB → C, C → A, AC → D}, Find highest NF.

Sol: CKs of relation contains B.

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$\therefore$ AB is CK

(from C → A)

Topic: Examples on Finding Highest NF

Ex3: R (ABCD), FDs are {AB → C, C → A, AC → D}, Find highest NF.

Sol: CKs of relation contains B.

$AB^+ = ABCD$ For AB $\Rightarrow A^+ = A, B^+ = B$

$\therefore$ AB is CK

(from C → A) $CB^+ = ABCD$

Topic: Examples on Finding Highest NF

Ex3: R (ABCD), FDs are {AB → C, C → A, AC → D}, Find highest NF.

Sol: CKs of relation contains B.

$AB^+ = ABCD$ For AB $\Rightarrow A^+ = A, B^+ = B$

$\therefore$ AB is CK

(from C → A) $CB^+ = ABCD$ For CB $\Rightarrow C^+ = AC, B^+ = B$

$\therefore$ CB is CK

Topic: Examples on Finding Highest NF

Ex3: R (ABCD), FDs are {AB → C, C → A, AC → D}, Find highest NF.

Sol: CKs of relation contains B.

$AB^+ = ABCD$ For AB $\Rightarrow A^+ = A, B^+ = B$

$\therefore$ AB is CK

(from C → A) $CB^+ = ABCD$ For CB $\Rightarrow C^+ = AC, B^+ = B$

$\therefore$ CB is CK

$DB^+ = DB \rightarrow$ Not CK

Topic: Examples on Finding Highest NF

Ex3: R (ABCD), FDs are {AB → C, C → A, AC → D}, Find highest NF.

Sol: CKs of relation contains B.

$AB^+ = ABCD$ For AB $\Rightarrow A^+ = A, B^+ = B$

$\therefore$ AB is CK

(from C → A) $CB^+ = ABCD$ For CB $\Rightarrow C^+ = AC, B^+ = B$

$\therefore$ CB is CK

$DB^+ = DB \rightarrow$ Not CK

$\therefore$ AB and BC are possible CKs

Topic: Examples on Finding Highest NF

Ex3: R (ABCD), FDs are {AB → C, C → A, AC → D}, Find highest NF.

Sol Cont.:

Sk		Prime	Not Sk		Prime	Not Sk		Non Prime
↑		↑	↑		↑	↑		↑
AB	→	C	C	→	A	AC	→	D

AB and BC are CKs

Topic: Examples on Finding Highest NF

Ex3: R (ABCD), FDs are {AB → C, C → A, AC → D}, Find highest NF.

Sol Cont.:

	Sk		Prime	Not Sk		Prime	Not Sk		Non Prime
	↑		↑	↑		↑	↑		↑
	AB	→	C	C	→	A	AC	→	D
BCNF		✓			×			×	

AB and BC are CKs

Topic: Examples on Finding Highest NF

Ex3: R (ABCD), FDs are {AB → C, C → A, AC → D}, Find highest NF.

Sol Cont.:

	Sk		Prime	Not Sk		Prime	Not Sk		Non Prime
	↑		↑	↑		↑	↑		↑
	AB	→	C	C	→	A	AC	→	D
BCNF	✓			×			×		
3NF	✓			✓ (A is prime)			×		

AB and BC are CKs

Topic: Examples on Finding Highest NF

Ex3: R (ABCD), FDs are {AB → C, C → A, AC → D}, Find highest NF.

Sol Cont.:

	Sk		Prime	Not Sk		Prime	Not Sk		Non Prime
	↑		↑	↑		↑	↑		↑
	AB	→	C	C	→	A	AC	→	D
BCNF	✓			×			×		
3NF	✓			✓ (A is prime)			×		

AB and BC are CKs

2NF Test: $(\text{Proper Subset of Ck})^{+} \rightarrow$ Prime Attribute

Topic: Examples on Finding Highest NF

Ex3: R (ABCD), FDs are {AB → C, C → A, AC → D}, Find highest NF.

Sol Cont.:

	Sk		Prime	Not Sk		Prime	Not Sk		Non Prime
	AB	→	C	C	→	A	AC	→	D
BCNF	✓			×			×		
3NF	✓			✓ (A is prime)			×		

AB and BC are CKs

2NF Test: $\left(\text{Proper Subset of Ck}\right)^{+} \rightarrow$ Prime Attribute

For AB, => $A^+ = A$, $B^+ = B$

For BC, => $B^+ = B$, $C^+ = AC$

Topic: Examples on Finding Highest NF

$C^+ = CAD$ $C \rightarrow D$ ✓

Ex3: R (ABCD), FDs are {AB → C, C → A, AC → D}, Find highest NF.

Sol Cont.:

	Sk		Prime	Not Sk		Prime	Not Sk		Non Prime
	AB	→	C	C	→	A	AC	→	D
BCNF	✓			×			×		
3NF	✓			✓ (A is prime)			×		

AB and BC are CKs

1NF

2NF Test: $\left(\text{Proper Subset of Ck}\right)^+ \rightarrow$ Prime Attribute

X 2NF

For AB, => $A^+ = A$, $B^+ = B$

For BC, => $B^+ = B$, $C^+ = ACD$

2NF

$C \rightarrow A$ (A ↓ prime)

None of them derive Non-prime Attributes ∴ Relation's highest NF is 2NF.

Inspiring Stories : D. Bisoi & C. Bisoi

Background: **Kandha tribal leaders from Ganjam.**

Struggles: **British rule and forest control hit tribes hard.**

Achievements: **kept resistance alive across hills.**

Impact: **Stand for tribal rights in coastal-hill Odisha history.**

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Ex4: R (ABCDEF) and FD's are {AB → C, C → DE, E → F, F → B}

Find highest NF.

Topic: Examples on Finding Highest NF

Ex4: R (ABCDEF) and FD's are {AB → C, C → DE, E → F, F → B}

Find highest NF.

Sol: The Ck has to have A as its part.

Topic: Examples on Finding Highest NF

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AB^+ = ABCDEF No proper subsets are CKs, so AB is CK

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(from F → B)

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Find highest NF.

Sol: The Ck has to have A as its part.

AB^+ = ABCDEF No proper subsets are CKs, so AB is CK

(from F → B) AF^+ = AFBCDE No proper subsets are CKs, so AF is CK

Topic: Examples on Finding Highest NF

Ex4: R (ABCDEF) and FD's are {AB → C, C → DE, E → F, F → B}

Find highest NF.

Sol: The Ck has to have A as its part.

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(from E → F)

Topic: Examples on Finding Highest NF

Ex4: R (ABCDEF) and FD's are {AB → C, C → DE, E → F, F → B}

Find highest NF.

Sol: The Ck has to have A as its part.

AB^+ = ABCDEF No proper subsets are CKs, so AB is CK

(from F → B) AF^+ = AFBCDE No proper subsets are CKs, so AF is CK

(from E → F) AE^+ = AEFBCD No proper subsets are CKs, so AE is CK

Topic: Examples on Finding Highest NF

Ex4: R (ABCDEF) and FD's are {AB → C, C → DE, E → F, F → B}

Find highest NF.

Sol: The Ck has to have A as its part.

AB^+ = ABCDEF No proper subsets are CKs, so AB is CK

(from F → B) AF^+ = AFBCDE No proper subsets are CKs, so AF is CK

(from E → F) AE^+ = AEFBCD No proper subsets are CKs, so AE is CK

Checking for AC^+ = ACDEFB No proper subsets are CKs, so AC is CK

Topic: Examples on Finding Highest NF

Ex4: R (ABCDEF) and FD's are {AB → C, C → DE, E → F, F → B}

Find highest NF.

Sol: The Ck has to have A as its part.

	AB^+ = ABCDEF	No proper subsets are CKs, so AB is CK
(from F → B)	AF^+ = AFBCDE	No proper subsets are CKs, so AF is CK
(from E → F)	AE^+ = AEFBCD	No proper subsets are CKs, so AE is CK
Checking for	AC^+ = ACDEFB	No proper subsets are CKs, so AC is CK
Checking for	AD^+ = AD	→ Not a Ck

Topic: Examples on Finding Highest NF

Ex4: R (ABCDEF) and FD's are {AB → C, C → DE, E → F, F → B}

Find highest NF.

Sol: The Ck has to have A as its part.

AB^+ = ABCDEF No proper subsets are CKs, so AB is CK

(from F → B) AF^+ = AFBCDE No proper subsets are CKs, so AF is CK

(from E → F) AE^+ = AEFBCD No proper subsets are CKs, so AE is CK

Checking for AC^+ = ACDEFB No proper subsets are CKs, so AC is CK

Checking for AD^+ = AD → Not a Ck

No other possibilities

Topic: Examples on Finding Highest NF

Ex4: R (ABCDEF) and FD's are {AB → C, C → DE, E → F, F → B}

Find highest NF. AB AF, AE, AC are CKs

A B C E F

Sol Cont.: Lets check for Highest NF

Sk		Prime	Not Sk	Non Prime	Prime	Not Sk		Prime	Not Sk		Prime
↑		↑	↑	↑	↗	↑		↑	↑		↑
AB	→	C	C	→	D E	E	→	F	F	→	B

Topic: Examples on Finding Highest NF

Ex4: R (ABCDEF) and FD's are {AB → C, C → DE, E → F, F → B}

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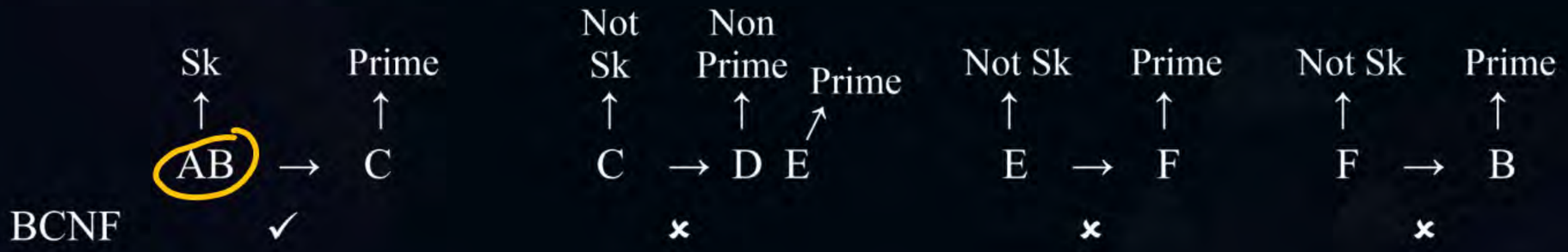
Sol Cont.: Lets check for Highest NF



Topic: Examples on Finding Highest NF

Ex4: R (ABCDEF) and FD's are {AB → C, C → DE, E → F, F → B}

Find highest NF. AB AF, AE, AC are CKs

Sol Cont.: Lets check for Highest NF

	AB → C	C → DE		E → F	F → B
	Sk → Prime	Not Sk → Non Prime, Prime		Not Sk → Prime	Not Sk → Prime
BCNF	✓	×		×	×
		C → E	C → D		
3NF	✓	✓	×	✓	✓

Topic: Examples on Finding Highest NF

Ex4: R (ABCDEF) and FD's are {AB → C, C → DE, E → F, F → B}

Find highest NF.

Sol Cont.:

2NF Test: $\left(\text{Proper Subset of Ck}\right)^{+} \rightarrow$ Prime Attribute

Topic: Examples on Finding Highest NF

Ex4: R (ABCDEF) and FD's are {AB → C, C → DE, E → F, F → B}

Find highest NF.

Sol Cont.:

2NF Test: $\left(\text{Proper Subset of Ck}\right)^{+} \rightarrow$ Prime Attribute

For AB, $A^+ = A, B^+ = B$ For AC, $A^+ = A, C^+ = CDE$

For AE, $A^+ = A, E^+ = EF$ For AF, $A^+ = A, F^+ = FB$

Topic: Examples on Finding Highest NF

Ex4: R (ABCDEF) and FD's are {AB → C, C → DE, E → F, F → B}

Find highest NF.

Sol Cont.:

2NF Test: $\left(\text{Proper Subset of Ck}\right)^{+} \rightarrow$ Prime Attribute

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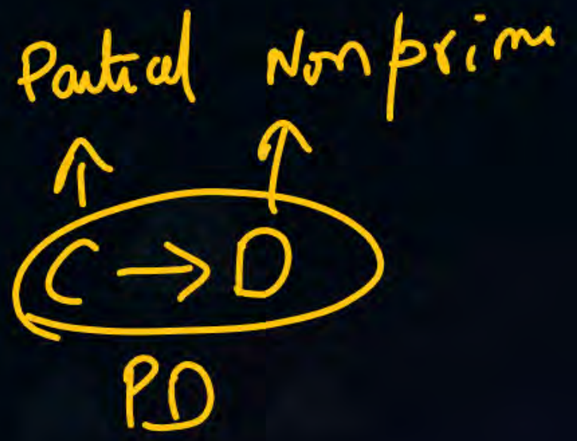

C → D, where D is Non-Prime Attribute

Topic: Examples on Finding Highest NF

Ex4: R (ABCDEF) and FD's are {AB → C, C → DE, E → F, F → B}

Find highest NF.

Sol Cont.:

2NF Test: $\left(\text{Proper Subset of Ck}\right)^{+} \rightarrow$ Prime Attribute

For AB, $A^+ = A, B^+ = B$ For AC, $A^+ = A, C^+ = CDE$

For AE, $A^+ = A, E^+ = EF$ For AF, $A^+ = A, F^+ = FB$

C → D, where D is Non-Prime Attribute

- The relation is not in 2NF ✓
- The highest NF is 1NF ✓

Topic: Examples on Finding Highest NF

Ex5: R (ABCDEF) and FD's are {AB → C, C → D, CD → AE, DE → F, EF → B}

What is highest NF?

Topic: Examples on Finding Highest NF

Ex5: R (ABCDEF) and FD's are {AB → C, C → D, CD → AE, DE → F, EF → B}

What is highest NF?

Sol: Already solved in examples of CKs, the CK's are AB, AEF, ADE, C

ABCDEF

Topic: Examples on Finding Highest NF

Ex5: R (ABCDEF) and FD's are {AB → C, C → D, CD → AE, DE → F, EF → B}

What is highest NF?

Sol: Already solved in examples of CKs, the CK's are AB, AEF, ADE, C

Sk	Prime	Sk	Non Prime	Sk		Not Sk	Prime	Not Sk	Prime
↑	↑	↑	↑	↑		↑	↑	↑	↑
AB	→ C	C	→ D	CD	→ AE	DE	→ F	EF	→ B

Topic: Examples on Finding Highest NF

Ex5: R (ABCDEF) and FD's are {AB → C, C → D, CD → AE, DE → F, EF → B}

What is highest NF?

Sol: Already solved in examples of CKs, the CK's are AB, AEF, ADE, C

	AB → C	C → D	CD → AE	DE → F	EF → B
	Sk → Sk, Prime	Sk → Non Prime	Sk	Not Sk → Prime	Not Sk → Prime
BCNF	✓	✓	✓	×	×

Topic: Examples on Finding Highest NF

Ex5: R (ABCDEF) and FD's are {AB → C, C → D, CD → AE, DE → F, EF → B}

What is highest NF?

Sol: Already solved in examples of CKs, the CK's are AB, AEF, ADE, C

SK
CD

	Sk / Prime	Sk / Non Prime	Sk	Not Sk / Prime	Not Sk / Prime
	AB → C	C → D	CD → AE	DE → F	EF → B
BCNF	✓	✓	✓	×	×
3NF	✓	✓	✓	✓	✓

Topic: Examples on Finding Highest NF

Ex5: R (ABCDEF) and FD's are {AB → C, C → D, CD → AE, DE → F, EF → B}

What is highest NF?

Sol: Already solved in examples of CKs, the CK's are AB, AEF, ADE, C

	AB → C	C → D	CD → AE	DE → F	EF → B
	Sk, Prime	Sk, Non Prime	Sk	Not Sk, Prime	Not Sk, Prime
BCNF	✓	✓	✓	×	×
3NF	✓	✓	✓	✓	✓

The highest NF is 3NF. All Attributes are Prime.

Hence, 3NF never fails for such cases, but the relation may not be in BCNF.

Topic: Examples on Finding Highest NF

Ex6: R (ABCDE) and FD's are {A → B, B → C, C → D, D → A}

What is highest NF?

Topic: Examples on Finding Highest NF

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Sol: CKs are AE, DE, CE, BE. ABCDE

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All are prime attr so, the relation is in 3NF

let's check

Not Sk		Prime		Not Sk		Prime		Not Sk		Prime		Not Sk		Prime
↑		↑		↑		↑		↑		↑		↑		↑
A	→	B		B	→	C		C	→	D		D	→	A

Topic: Examples on Finding Highest NF

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Sol: CKs are AE, DE, CE, BE.

All are prime attr so, the relation is in 3NF

let's check

	A → B	B → C	C → D	D → A
	Not Sk ↑ A	Not Sk ↑ B	Not Sk ↑ C	Not Sk ↑ D
	Prime ↑ B	Prime ↑ C	Prime ↑ D	Prime ↑ A
BCNF	×	×	×	×

Topic: Examples on Finding Highest NF

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let's check

	Not Sk → Prime			
	A → B	B → C	C → D	D → A
BCNF	×	×	×	×
3NF	✓	✓	✓	✓

Topic: Examples on Finding Highest NF

Ex6: R (ABCDE) and FD's are {A → B, B → C, C → D, D → A}

What is highest NF?

Sol: CKs are AE, DE, CE, BE.

All are prime attr so, the relation is in 3NF

let's check

	Not Sk → Prime			
	A → B	B → C	C → D	D → A
BCNF	×	×	×	×
3NF	✓	✓	✓	✓

Therefore the highest NF is 3NF.

Topic: Examples on Finding Highest NF

Ex7: R (ABCD) and FD's are {A → B, B → AC, C → D}

What is highest NF?

Topic: Examples on Finding Highest NF

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What is highest NF?

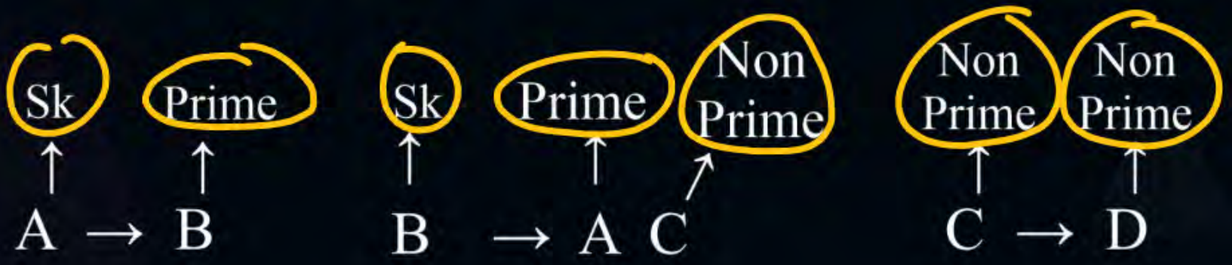
Sol: CKs are A, B.

Topic: Examples on Finding Highest NF

Ex7: R (ABCD) and FD's are {A → B, B → AC, C → D}

What is highest NF?

Sol: CKs are A, B.



Topic: Examples on Finding Highest NF

Ex7: R (ABCD) and FD's are {A → B, B → AC, C → D}

What is highest NF?

Sol: CKs are A, B.

	A → B	B → A	B → C	C → D
	Sk → Prime	Sk → Prime	Sk → Non Prime	Non Prime → Non Prime
BCNF	✓	✓	✓	✗

Topic: Examples on Finding Highest NF

Ex7: R (ABCD) and FD's are {A → B, B → AC, C → D}

What is highest NF?

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	A → B	B → A	B → C	B → AC	C → D
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BCNF	✓	✓	✓	✓	✗
3NF	✓	✓	✓	✓	✗

Topic: Examples on Finding Highest NF

Ex7: R (ABCD) and FD's are {A → B, B → AC, C → D}

What is highest NF?

A, B

A, B

Sol Cont.:

2NF Test: $\left(\text{Proper Subset of Ck}\right)^{+} \rightarrow$ Prime Attribute

- No proper subsets possible for simple attribute.

The relation highest NF is 2NF.

Topic: Examples on Finding Highest NF

Ex7: R (ABCD) and FD's are {A → B, B → AC, C → D}

What is highest NF?

Sol Cont.:

2NF Test: $\left(\text{Proper Subset of Ck}\right)^{+} \rightarrow$ Prime Attribute

- No proper subsets possible for simple attribute.

  The relation highest NF is 2NF.

- If all Ckeys of the relation are simple Ckeys then the relation is always in 2NF, may or may not be in 3NF and BCNF.

Topic: Highest NF Decomposition

#Q. Relational Schema R with no Non Trivial FD's what is the highest NF of R(ABC)?

Topic: Highest NF Decomposition

#Q. Relational Schema R with no Non Trivial FD's what is the highest NF of R(ABC)?

Sol: If no non-trivial FD's are present, then

CKey = ABC

Topic: Highest NF Decomposition

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Sol: If no non-trivial FD's are present, then

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- If there are no Non trivial FD's No Redundancy over FD's of R.

Topic: Highest NF Decomposition

#Q. Relational Schema R with no Non Trivial FD's what is the highest NF of R(ABC)?

Sol: If no non-trivial FD's are present, then

CKey = ABC

- If there are no Non trivial FD's No Redundancy over FD's of R.

{No Non Trivial FD's in R} ⇒ {No Redundancy over FD's in R}

Topic: Highest NF Decomposition

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Sol: If no non-trivial FD's are present, then

CKey = ABC

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⇕

Relation R is in BCNF (may or may not be in 4NF)

Topic: Highest NF Decomposition

#Q. Relational Schema R with no Non Trivial FD's what is the highest NF of R(ABC)?

Sol: If no non-trivial FD's are present, then

CKey = ABC

- If there are no Non trivial FD's No Redundancy over FD's of R.

{No Non Trivial FD's in R} ⇒ {No Redundancy over FD's in R}

⇕

Relation R is in BCNF (may or may not be in 4NF)

∴ The highest NF is BCNF

Topic: Highest NF Decomposition

#Q. Relational Schema R with only two attributes Relation R is always in ___ for R(AB)

A $\{A \rightarrow B\}$

B $\{B \rightarrow A\}$

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

D No Nontrivial FDs

Topic: Highest NF Decomposition

#Q. Relational Schema R with only two attributes Relation R is always in ___ for R(AB)

A $\{A \rightarrow B\}$ **B** $\{B \rightarrow A\}$ **C** $\{A \rightarrow B, B \rightarrow A\}$ **D** No Nontrivial FDs

Sol: (a) CK = A, ∴ in BCNF

Topic: Highest NF Decomposition

#Q. Relational Schema R with only two attributes Relation R is always in ___ for R(AB)

A $\{A \rightarrow B\}$ **B** $\{B \rightarrow A\}$ **C** $\{A \rightarrow B, B \rightarrow A\}$ **D** No Nontrivial FDs

Sol: (a) CK = A, $\therefore$ in BCNF

(b) CK = B, in BCNF

Topic: Highest NF Decomposition

#Q. Relational Schema R with only two attributes Relation R is always in ___ for R(AB)

A $\{A \rightarrow B\}$ **B** $\{B \rightarrow A\}$ **C** $\{\underline{A} \rightarrow B, \underline{B} \rightarrow A\}$ **D** No Nontrivial FDs

Sol: (a) CK = A, $\therefore$ in BCNF

(b) CK = B, in BCNF

(c) CK = A, B, also in BCNF

Topic: Highest NF Decomposition

#Q. Relational Schema R with only two attributes Relation R is always in ___ for R(AB)

A $\{A \rightarrow B\}$ **B** $\{B \rightarrow A\}$ **C** $\{A \rightarrow B, B \rightarrow A\}$ **D** No Nontrivial FDs

Sol: (a) CK = A, $\therefore$ in BCNF

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(c) CK = A and B, also in BCNF

(d) CK = AB, also in BCNF

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Sol: (a) CK = A, $\therefore$ in BCNF

(b) CK = B, in BCNF

(c) CK = A and B, also in BCNF

(d) CK = AB, also in BCNF

$\Rightarrow$ The Relation is also in 4NF. Because relation with 2 attributes doesn't form any redundancy over FD, or over MVD.

Topic: Highest NF Decomposition

Decomposition of Relation into Higher NF:

⇒ Decompose the Relation into 2NF, 3NF, BCNF with Lossless join & Dependency preserving Decomposition

Topic: Highest NF Decomposition

2NF Decomposition:

For a Relation R(...XY) and FD's are {...X → Y} and X → Y is a partial dependency.

Topic: Highest NF Decomposition

2NF Decomposition:

For a Relation R(...XY) and FD's are {...X → Y} and X → Y is a partial dependency.

R(....XY)

X^+ =(XY...)

R_2(XY...)

Topic: Highest NF Decomposition

2NF Decomposition:

For a Relation R(...XY) and FD's are {...X → Y} and X → Y is a partial dependency.

R(....XY)

$X^+ = (XY...)$

$R_2(XY...)$

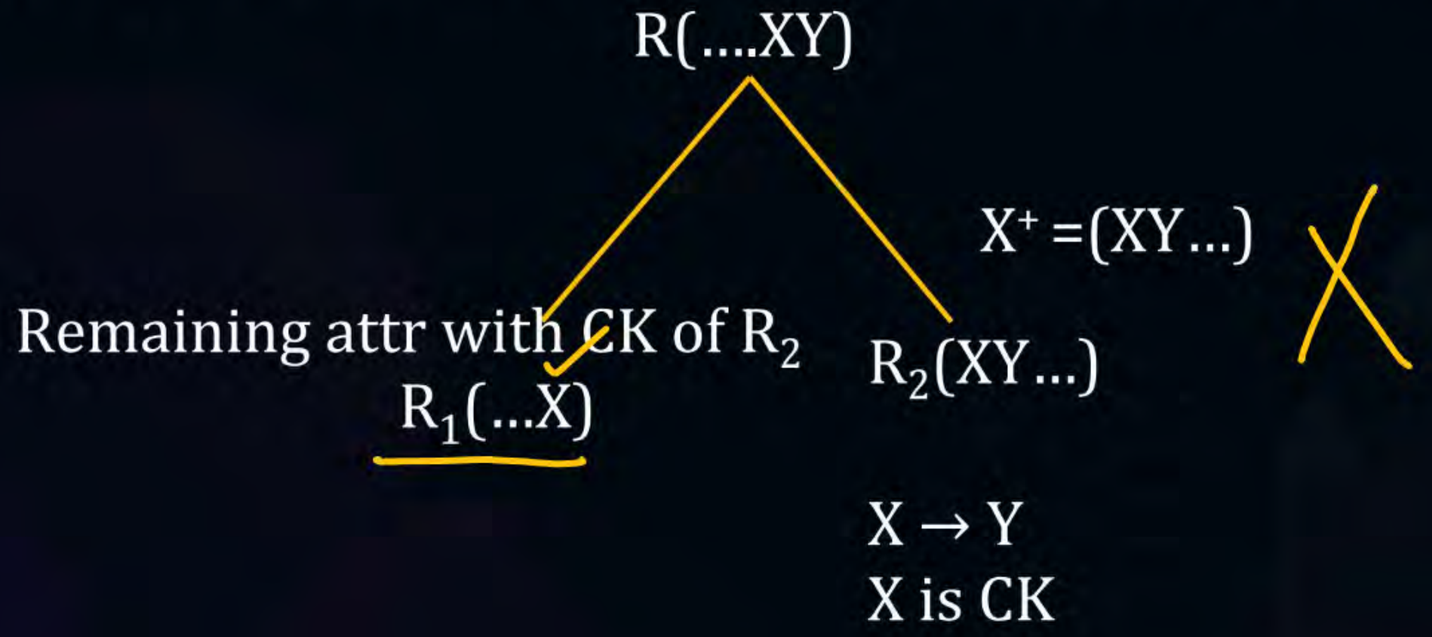
X → Y

X is CK

Topic: Highest NF Decomposition

2NF Decomposition:

For a Relation R(...XY) and FD's are {...X → Y} and X → Y is a partial dependency.



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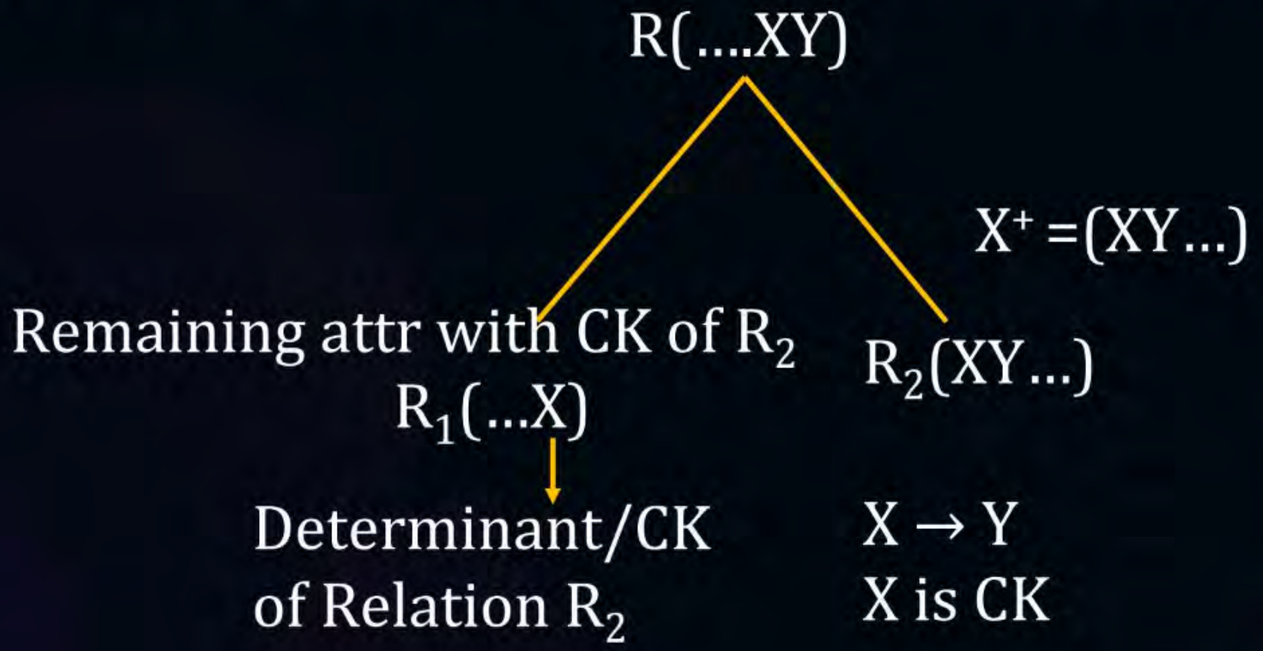

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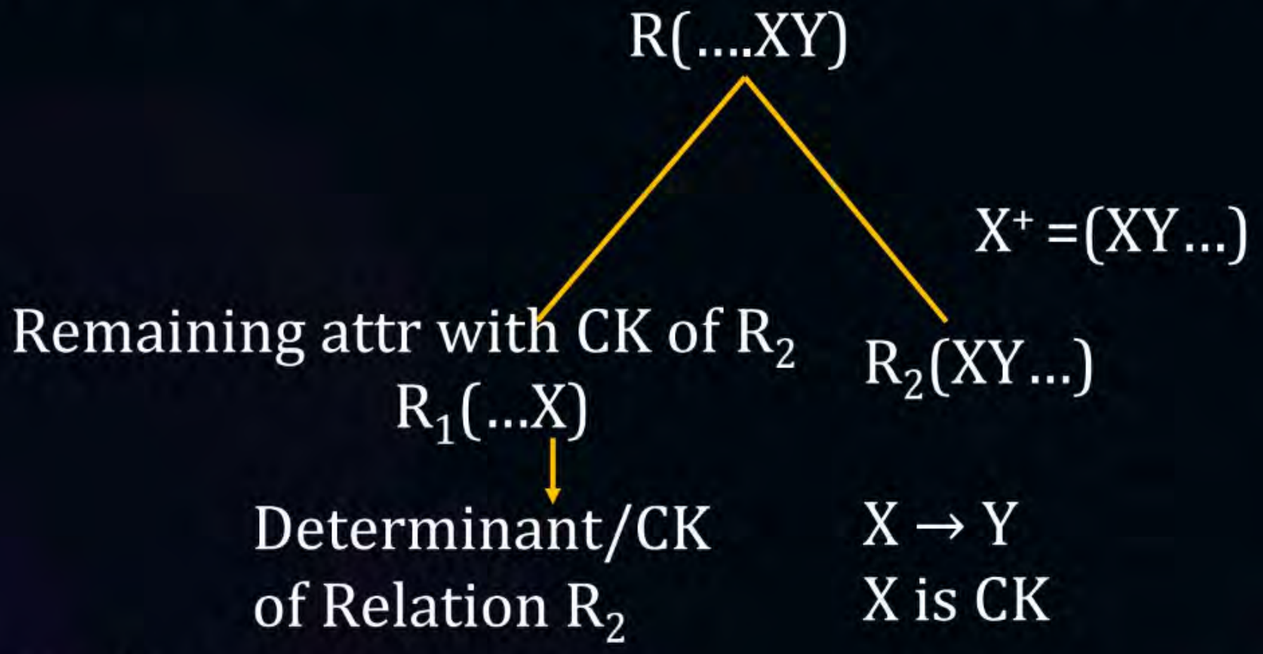

X is common attribute .

Topic: Highest NF Decomposition

2NF Decomposition:

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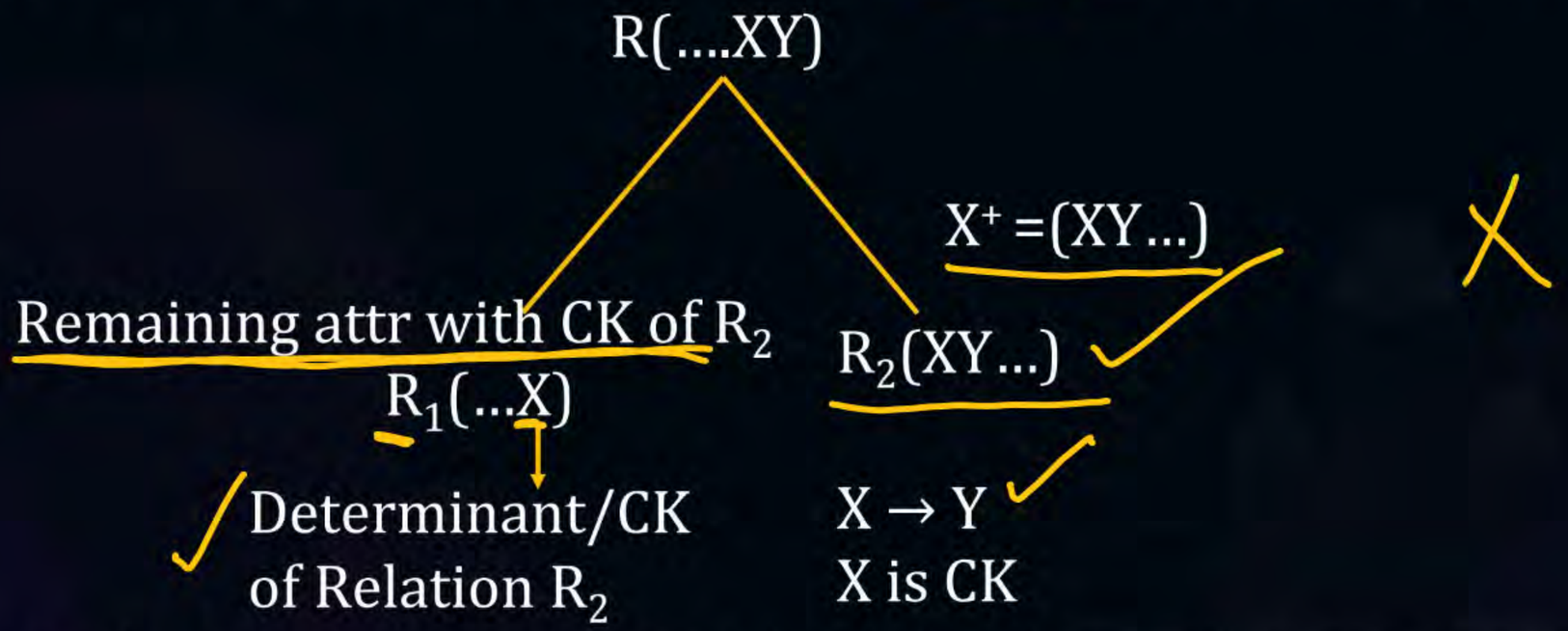

X is common attribute . ∴ The decomposition is lossless and dependency preserving, No Partial dependencies.

Topic: Highest NF Decomposition

#Q. R(Sid, Sname, DOB, Cid) {Sid → Sname, DOB}. Decompose into 2NF.

Topic: Highest NF Decomposition

#Q. R(Sid, Sname, DOB, Cid) {Sid → Sname, DOB}. Decompose into 2NF.

PD

Sol: SidCid is CK

Topic: Highest NF Decomposition

#Q. R(Sid, Sname, DOB, Cid) {Sid → Sname, DOB}. Decompose into 2NF.

Sol: SidCid is CK

Sid → SnameDOB is a partial dependency.

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Sol: SidCid is CK

Sid → SnameDOB is a partial dependency.

Now take closure of Sid.

Sid^+ = Sid, Sname, DOB

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∴ R_2(Sid, Sname, DOB)

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Now Sid → SnameDOB holds for R_2 and it is not partial dependency.

Topic: Highest NF Decomposition

#Q. R(Sid, Sname, DOB, Cid) {Sid → Sname, DOB}. Decompose into 2NF.

Sol: SidCid is CK

Sid → SnameDOB is a partial dependency.

Now take closure of Sid.

Sid^+ = Sid, Sname, DOB

∴ R_2(Sid, Sname, DOB)

Now Sid → SnameDOB holds for R_2 and it is not partial dependency.

- Now remaining all attributes are in one relation i.e.

R_1(SidCid) along with common attribute.

Topic: Highest NF Decomposition

#Q. R(Sid, Sname, DOB, Cid) {Sid → Sname, DOB}. Decompose into 2NF.

Sol Cont.: In this relation CK is SidCid.

R(Sid, Sname, DOB, Cid)

R_1(Sid, Cid)

R_2(Sid, Sname, DOB)

Sid → Sname, DOB

Topic: Highest NF Decomposition

#Q. R(Sid, Sname, DOB, Cid) {Sid → Sname, DOB}. Decompose into 2NF.

Sol Cont.: In this relation CK is SidCid. R(Sid, Sname, DOB, Cid)

R_1(Sid, Cid)

R_2(Sid, Sname, DOB)

Sid → Sname, DOB

Sid is common attribute, and CK of one table so lossless join decomposition.

Topic: Highest NF Decomposition

#Q. R(Sid, Sname, DOB, Cid) {Sid → Sname, DOB}. Decompose into 2NF.

Sol Cont.: In this relation CK is SidCid. R(Sid, Sname, DOB, Cid)

R_1(Sid, Cid)

R_2(Sid, Sname, DOB)

Sid → Sname, DOB

Sid is common attribute, and CK of one table so lossless join decomposition.

All dependencies are followed & satisfied. Therefore Dependency preserving.

Topic: Highest NF Decomposition

#Q. R(Sid, Sname, DOB, Cid) {Sid → Sname, DOB}. Decompose into 2NF.

Sol Cont.: In this relation CK is SidCid. R(Sid, Sname, DOB, Cid)

R_1(Sid, Cid)

R_2(Sid, Sname, DOB)

Sid → Sname, DOB

Sid is common attribute, and CK of one table so lossless join decomposition.

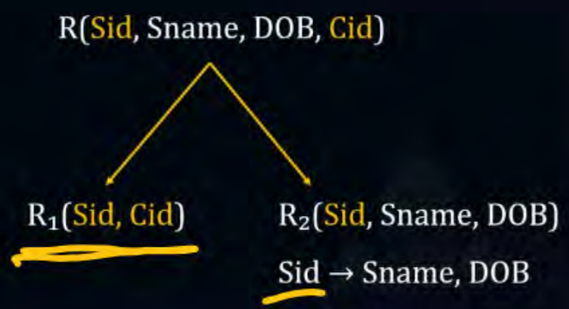
All dependencies are followed & satisfied. Therefore Dependency preserving.

- No partial dependencies present, so the relation is in 2NF.

Topic: Highest NF Decomposition

#Q. R(Sid, Sname, DOB, Cid) {Sid → Sname, DOB}. Decompose into 2NF.

Sol Cont.:



Extension: Now for R_1(SidCid) no non-trivial FDs are possible.

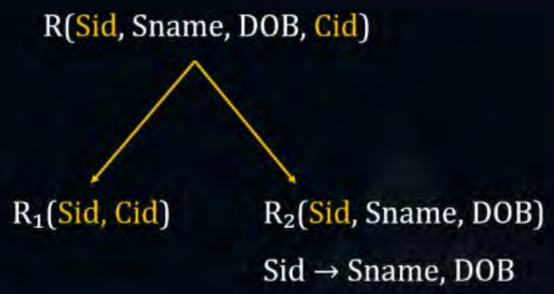
R_1(Sid, Cid) No dup BCNF

R_2(Sid Sname DOB) Sid → Sname, DOB SK BCNF

Topic: Highest NF Decomposition

#Q. R(Sid, Sname, DOB, Cid) {Sid → Sname, DOB}. Decompose into 2NF.

Sol Cont.:



Extension: Now for R_1(SidCid) no non-trivial FDs are possible.

∴ The relation R_1 is in 3NF and as well as in BCNF.

For R_2(Sid, Sname, DOB), the FDs are Sid → Sname, DOB.

Here Sid is CK,

Topic: Highest NF Decomposition

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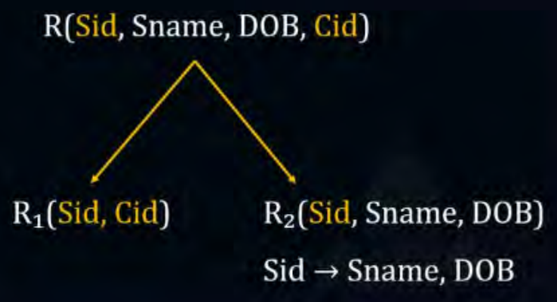
Sol Cont.:



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Here Sid is CK,

∴ The relation is in 3NF & BCNF.

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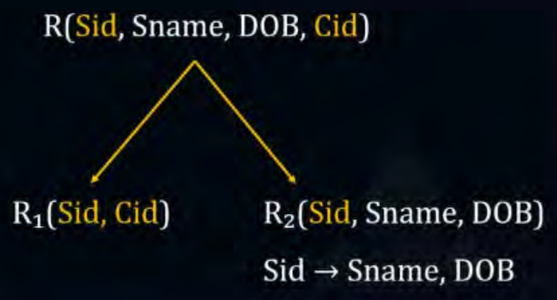

Extension: Now for R_1(SidCid) no non-trivial FDs are possible.

∴ The relation R_1 is in 3NF and as well as in BCNF.

For R_2(Sid, Sname, DOB), the FDs are Sid → Sname, DOB.

Here Sid is CK,

∴ The relation is in 3NF & BCNF.

Also Sid in R_1 is FK that refers to Sid in R_2 which is CK.

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C → D, B → E, E → F}

Sol: CKey = AB

Prime attributes = AB Non-prime attributes = CDEF

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C → D, B → E, E → F}

Sol: CKey = AB

Prime attributes = AB Non-prime attributes = CDEF

B is partial CK in B → E.

Decomposing this into 2NF:

B^+ = BEF

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C → D, B → E, E → F}

Sol: CKey = AB

Prime attributes = AB Non-prime attributes = CDEF

B is partial CK in B → E.

Decomposing this into 2NF:

B^+ = BEF ⇒ R_2(BEF), B is CK.

B → E

E → F

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C → D, B → E, E → F}

Sol Cont.:

Remaining attr forms other R_1(ABCD), AB is CK along with CK.

{AB → C, C → D}

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C → D, B → E, E → F}

Sol Cont.:

Remaining attr forms other R_1(ABCD), AB is CK along with CK.

{AB → C, C → D}

B is common, so lossless join.

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C → D, B → E, E → F}

Sol Cont.:

Remaining attr forms other R_1(ABCD), AB is CK along with CK.

{AB → C, C → D}

B is common, so lossless join.

All dependencies are followed, ∴ dependency preserving.

Topic: Highest NF Decomposition

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Sol Cont.:

Remaining attr forms other R_1(ABCD), AB is CK along with CK.

{AB → C, C → D}

B is common, so lossless join.

All dependencies are followed, ∴ dependency preserving.

No partial dependencies. ∴ Relation is in 2NF.

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C → D, B → E, E → F}

Sol Cont.:

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C → D, B → E, E → F}

Sol Cont.:

- B is FK in R_1 that refers to B(CK) in R_2.

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C → D, B → E, E → F}

Sol Cont.:

- B is FK in R_1 that refers to B(CK) in R_2.

R(ABCDEF)

B+
A+
AB

B ✓

R_1(ABCD)

{AB → C, C → D}

Not in 3NF because of C → D ✓

R_2(BEF)

{B → E, E → F}

Not in 3NF due to E → F

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C → D, B → E, E → F}

Sol Cont.: 2NF requires 2 tables & one FK.

$R_1(ABCD)$

$AB \rightarrow C$, $C \rightarrow D$

$C^+ = CD$

$R_{12}(CD)$

$C \rightarrow D$

In 3NF

$R_2(BEF)$

$B \rightarrow E$, $E \rightarrow F$

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C → D, B → E, E → F}

Sol Cont.: 2NF requires 2 tables & one FK.

R_1(ABCD)
AB → C, C → D

R_2(BEF)
B → E, E → F

$C^+ = CD$

R_{11} (ABC)
AB → C
In 3NF

R_{12}(CD)
C → D
In 3NF

Common Attribute

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C → D, B → E, E → F}

Sol Cont.: 2NF requires 2 tables & one FK.

$R_1(ABCD)$
$AB \rightarrow C$, $C \rightarrow D$

$C^+ = CD$

$R_{11}(\underline{ABC})$
$AB \rightarrow C$
In 3NF

Common Attribute

$R_{12}(\underline{C}D)$
$C \rightarrow D$
In 3NF

$R_2(\underline{B}EF)$
$B \rightarrow E$, $E \rightarrow F$

$E^+ = EF$

$R_{22}(\underline{E}F)$
$E \rightarrow F$
In 3NF

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C → D, B → E, E → F}

Sol Cont.: 2NF requires 2 tables & one FK.

$R_1(ABCD)$
$AB \rightarrow C$, $C \rightarrow D$

$C^+ = CD$

$R_{11}(\underline{ABC})$
$AB \rightarrow C$
In 3NF

$R_{12}(\underline{C}D)$
$C \rightarrow D$
In 3NF

Common Attribute

$R_2(BEF)$
$B \rightarrow E$, $E \rightarrow F$

$E^+ = EF$

$R_{21}(\underline{BE})$
$B \rightarrow E$
In 3NF

$R_{22}(\underline{E}F)$
$E \rightarrow F$
In 3NF

Common Attribute

BCNF

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C → D, B → E, E → F}

Sol Cont.: 2NF requires 2 tables & one FK.

$R_1(ABCD)$
$AB \rightarrow C$, $C \rightarrow D$

$C^+ = CD$

R_{11} ($\underline{ABC}$)
$AB \rightarrow C$
In 3NF

Common Attribute

$R_{12}(\underline{C}D)$
$C \rightarrow D$
In 3NF

$R_2(BEF)$
$B \rightarrow E$, $E \rightarrow F$

$E^+ = EF$

R_{21} ($\underline{B}E$)
$B \rightarrow E$
In 3NF

Common Attribute

$R_{22}(\underline{E}F)$
$E \rightarrow F$
In 3NF

Now, the decomposition is loss less, dependency preserving, 3NF and also in BCNF.

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C → D, B → E, E → F}

Sol Cont.:

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C→D, A→E, B→F, F→G}

Sol: AB is CK

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C→D, A→E, B→F, F→G}

Sol: AB is CK

A → E, B → F are partial dependencies. R is in 1NF but not in 2NF.

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C→D, A→E, B→F, F→G}

Sol: AB is CK

A → E, B → F are partial dependencies. R is in 1NF but not in 2NF.

2NF Decomposition:

$A^+ = AE$ ✓

$R_2(AE)$

$B^+ = BFG$ ✓

$R_3(BFG)$

Remaining Attr along with CK.

$R_1(ABCD)$

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C→D, A→E, B→F, F→G}

Sol: AB is CK

A → E, B → F are partial dependencies. R is in 1NF but not in 2NF.

2NF Decomposition:

Remaining Attr along with CK.

$A^+ = AE$

$R_2(AE)$

$A \rightarrow E$

A is CK

in 3NF

$B^+ = BFG$

$R_3(BFG)$

$B \rightarrow F, F \rightarrow G$

B is CK

Not in 3NF

$R_1(ABCD)$

$AB \rightarrow C$

$C \rightarrow D$

Not in 3NF becoz of

$C \rightarrow D$

Topic: Highest NF Decomposition

This decomposition is lossless, dependency preserving and is in 2NF because of no PD.

#Q. R(ABCDEF) {AB → C, C→D, A→E, B→F, F→G}

Sol: AB is CK

A → E, B → F are partial dependencies. R is in 1NF but not in 2NF.

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A is CK

in 3NF

$B^+ = BFG$

$R_3(BFG)$

$B \rightarrow F, F \rightarrow G$

B is CK

Not in 3NF

$R_1(ABCD)$

$AB \rightarrow C$

$C \rightarrow D$

Not in 3NF becoz of $C \rightarrow D$

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C→D, A→E, B→F, F→G}

Sol Cont. :

$R_1(\underline{AB}CD)$ ✓
$AB \rightarrow C$, $C \rightarrow D$

$R_2(\underline{A}E)$
$A \rightarrow E$

$R_3(\underline{B}FG)$ ✓
$B \rightarrow F$, $F \rightarrow G$

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C→D, A→E, B→F, F→G}

Sol Cont. :

$R_1(\underline{AB}CD)$
$AB \rightarrow C$, $C \rightarrow D$

$R_2(\underline{A}E)$
$A \rightarrow E$

$R_3(\underline{B}FG)$
$B \rightarrow F$, $F \rightarrow G$

$C^+ = CD$

$R_{12}(CD)$
$C \rightarrow D$

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C→D, A→E, B→F, F→G}

Sol Cont. :

$R_1(\underline{AB}CD)$
$AB \rightarrow C$, $C \rightarrow D$

$R_2(\underline{A}E)$
$A \rightarrow E$

$R_3(\underline{B}FG)$
$B \rightarrow F$, $F \rightarrow G$

$C^+ = CD$

$R_{11}(\underline{AB}C)$
$AB \rightarrow C$

$R_{12}(CD)$
$C \rightarrow D$

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C→D, A→E, B→F, F→G}

Sol Cont. :

$R_1(\underline{AB}CD)$
$AB \rightarrow C$, $C \rightarrow D$

$C^+ = CD$

$R_{11}(\underline{AB}C)$
$AB \rightarrow C$

$R_{12}(\underline{C}D)$
$C \rightarrow D$

$R_2(\underline{A}E)$
$A \rightarrow E$

$R_3(\underline{B}FG)$
$B \rightarrow F$, $F \rightarrow G$

$F^+ = FG$

$R_{32}(\underline{F}G)$
$F \rightarrow G$

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C→D, A→E, B→F, F→G}

Sol Cont. :

$R_1(\underline{AB}CD)$
$AB \rightarrow C$, $C \rightarrow D$

$C^+ = CD$

$R_{11}(\underline{AB}C)$
$AB \rightarrow C$

$R_{12}(\underline{C}D)$
$C \rightarrow D$

$R_2(\underline{A}E)$
$A \rightarrow E$

$R_3(\underline{B}FG)$
$B \rightarrow F$, $F \rightarrow G$

$F^+ = FG$

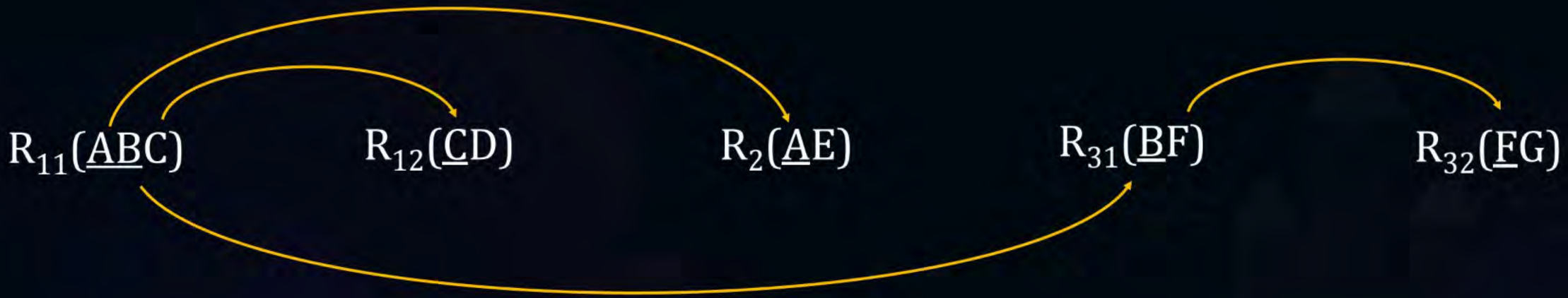
$R_{31}(\underline{B}F)$
$B \rightarrow E$

$R_{32}(\underline{F}G)$
$F \rightarrow G$

Topic: Highest NF Decomposition

#Q. R(ABCDEF) {AB → C, C→D, A→E, B→F, F→G}

Sol Cont. : Now, the Relations decomposition is in 3NF and is BCNF.



Topic: Highest NF Decomposition

A small observation to make:

- To store in 1NF, only one table is enough. But there will be a very high redundancy.
- After the decomposition, redundancy decreases but the number of tables increases.

Inspiring Stories : Dr. Julião Menezes

Background: **Goan doctor from Assolna.**

Struggles: **Portuguese rule silenced voices.**

Achievements: **Hosted and worked with Ram Manohar Lohia in 1946; sparked Goa's mass movement.**

Impact: **A catalyst for Goa's freedom movement on the Konkan coast.**

Topic: Highest NF Decomposition

#Q. R(ABCDE) {AB → C, BC→A, AC → B}

Sol: CK are {ABDE, BCDE , ACDE}

Topic: Highest NF Decomposition

#Q. R(ABCDE) {AB → C, BC→A, AC → B}

Sol: CK are {ABDE, BCDE , ACDE}

	AB → C	BC → A	AC →B
BCNF	×	×	×

Topic: Highest NF Decomposition

#Q. R(ABCDE) {AB → C, BC→A, AC → B}

Sol: CK are {ABDE, BCDE , ACDE}

	AB → C	BC → A	AC →B
BCNF	✗	✗	✗
3NF	✓	✓	✓

Highest NF is 3NF.

Topic: Highest NF Decomposition

#Q. R(ABCDE) {AB → C, BC→A, AC → B}

Sol Cont. :

BCNF decomposition:

All 3 FD's are failed for BCNF and all can be handled in a same relation due to same attributes.

Topic: Highest NF Decomposition

#Q. R(ABCDE) {AB → C, BC→A, AC → B}

Sol Cont. :

BCNF decomposition:

All 3 FD's are failed for BCNF and all can be handled in a same relation due to same attributes. $AB^+ = ABC$

$R_2(ABC)$ $R_1(ABDE)$

Topic: Highest NF Decomposition

#Q. R(ABCDE) {AB → C, BC→A, AC → B}

Sol Cont. :

BCNF decomposition:

All 3 FD's are failed for BCNF and all can be handled in a same relation due to same attributes. $AB^+ = ABC$

$R_2(ABC)$ $R_1(ABDE)$ Can be any one of AB, BC, AC

Topic: Highest NF Decomposition

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All 3 FD's are failed for BCNF and all can be handled in a same relation due to same attributes. $AB^+ = ABC$

$R_2(ABC)$ $R_1(ABDE)$ Can be any one of AB, BC, AC

AB → C No non-trivial FD's.

BC → A ∴ This is in BCNF.

AC → B

AB, BC, AC are CK.

Topic: Highest NF Decomposition

#Q. R(ABCDE) {AB → C, BC→A, AC → B}

Sol Cont. :

BCNF decomposition:

All 3 FD's are failed for BCNF and all can be handled in a same relation due to same attributes. $AB^+ = ABC$

$R_2(ABC)$ $R_1(ABDE)$ Can be any one of AB, BC, AC

$AB \rightarrow C$ No non-trivial FD's.

$BC \rightarrow A$ ∴ This is in BCNF.

$AC \rightarrow B$

AB, BC, AC are CK.

∴ The decomposition satisfies lossless join, dependency preserving and is in BCNF.

Topic: Highest NF Decomposition

#Q. R(ABCDE) {AB → C, BC→A, AC → B}

Sol Cont. :

Topic: Highest NF Decomposition

#Q. R(ABC) {AB → C, C→ A}

Sol: AB , BC are CK.

Topic: Highest NF Decomposition

#Q. R(ABC) {AB → C, C→ A}

Sol: AB , BC are CK.

	AB → C	C → A
BCNF	✓	✗

Topic: Highest NF Decomposition

#Q. R(ABC) {AB → C, C→ A}

Sol: AB , BC are CK.

	AB → C	C → A
BCNF	✓	✗
3NF	✓	✓

The highest normal form of relation is 3NF.

Topic: Highest NF Decomposition

#Q. R(ABC) {AB → C, C→ A}

Sol Cont.: BCNF decomposition:

R(ABC) {AB → C, C →A }

$C^+ = CA$

R1(BC)
No non trivial FD
(BCNF)

R_2(CA)
C → A
(BCNF)

Topic: Highest NF Decomposition

#Q. R(ABC) {AB → C, C→ A}

Sol Cont.: BCNF decomposition:

R(ABC) {AB → C, C →A }

$C^+ = CA$

R1(BC)
No non trivial FD
(BCNF)

R_2(CA)
C → A
(BCNF)

- The relation is lossless join but not DP due to the AB→ C.

Topic: Highest NF Decomposition

#Q. R(ABC) {AB → C, C→ A}

Sol Cont.: BCNF decomposition:

R(ABC) {AB → C, C →A }

$C^+ = CA$

R1(BC)
No non trivial FD
(BCNF)

R_2(CA)
C → A
(BCNF)

- The relation is lossless join but not DP due to the AB→ C.

To preserve AB → C, make a relation R_3(ABC) for $AB^+ = ABC$.

Topic: Highest NF Decomposition

#Q. R(ABC) {AB → C, C→ A}

Sol Cont.:

Now,

$R_3(ABC)$

$AB \rightarrow C$

$C \rightarrow A$

This is lossless join, DP & Not in BCNF.

BCNF ✓ ✗

DP ✗ ✓

Topic: Highest NF Decomposition

#Q. R(ABC) {AB → C, C→ A}

Sol Cont.:

Now,

$R_3(ABC)$

$AB \rightarrow C$

$C \rightarrow A$

This is lossless join, DP & Not in BCNF.

∴ The relation cannot be in BCNF, the highest decomposition is in 3NF.

Topic: Highest NF Decomposition

#Q. R(ABCD) {ABC → D, D → B}

Sol: ABC and ACD are CK due to D→B the R is in 3NF but not in BCNF.

Topic: Highest NF Decomposition

#Q. R(ABCD) {ABC → D, D → B}

Sol: ABC and ACD are CK due to D→B the R is in 3NF but not in BCNF.

R(ABCD)

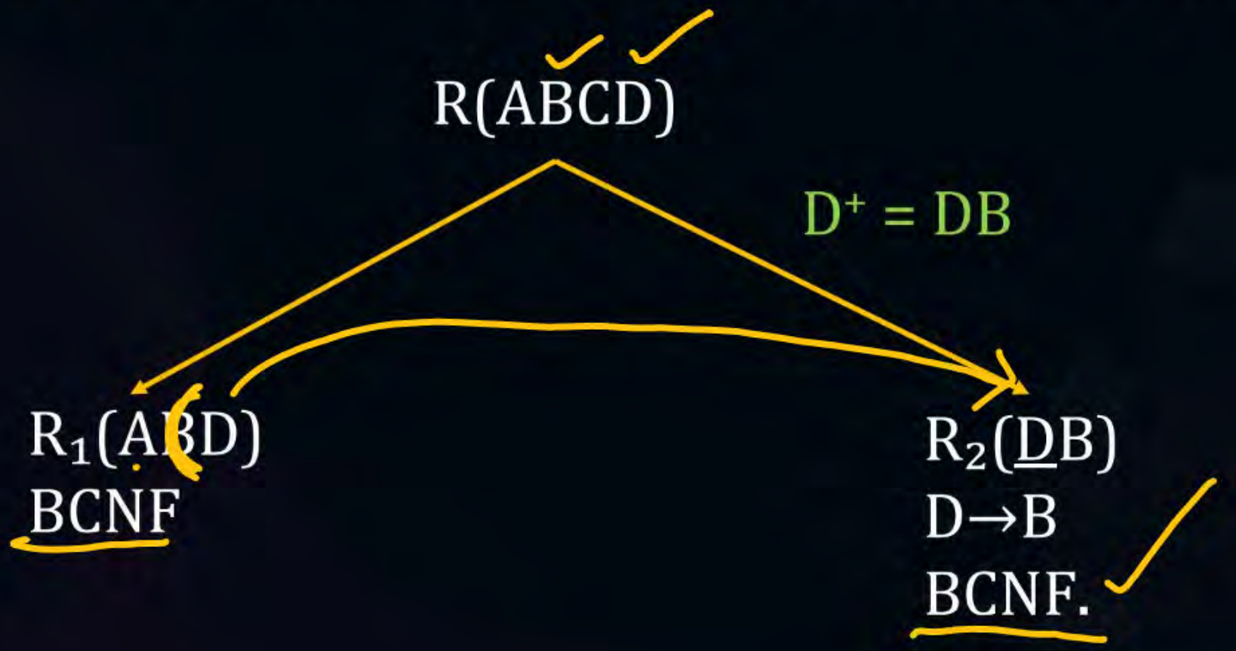
$D^+ = DB$

$R_2(DB)$
D→B
BCNF.

Topic: Highest NF Decomposition

#Q. R(ABCD) {ABC → D, D → B}

Sol: ABC and ACD are CK due to D→B the R is in 3NF but not in BCNF.



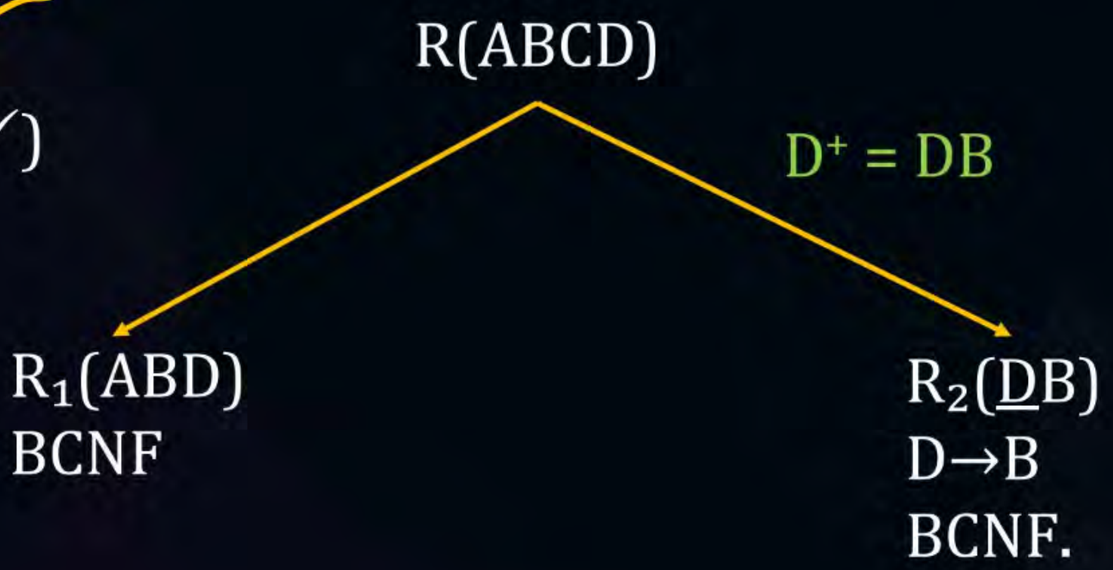
Topic: Highest NF Decomposition

#Q. R(ABCD) {ABC → D, D → B}

Sol: ABC and ACD are CK due to D→B the R is in 3NF but not in BCNF.

LLJ (✓) DP (✗) BCNF(✓)

ABC → D is lost



Topic: Highest NF Decomposition

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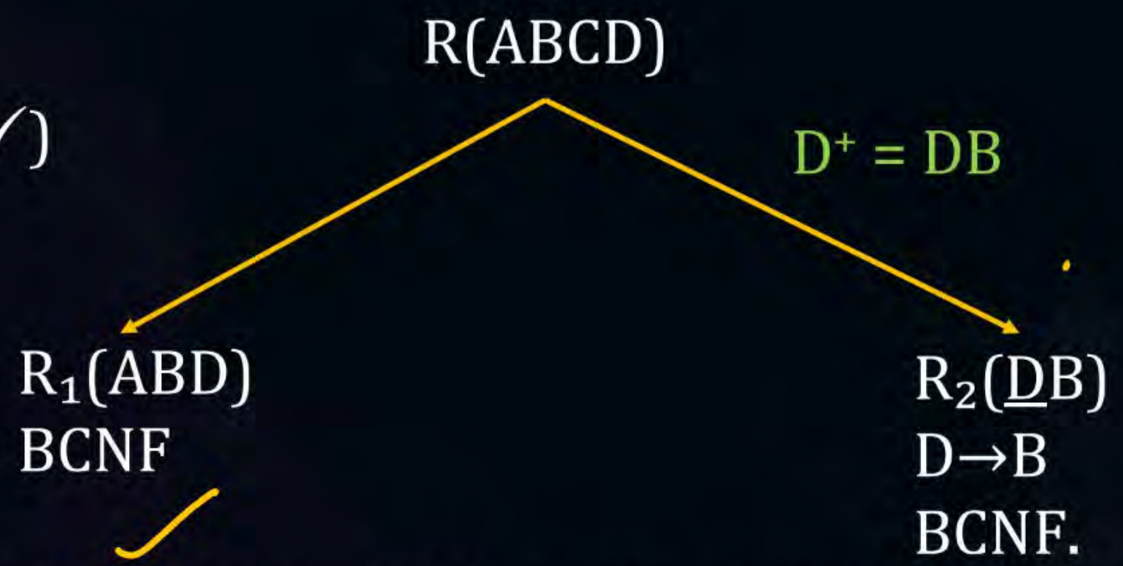

- $(ABC)^+$ = ABCD if R(ABCD) is one table again, again D → B comes under R which is again not in BCNF. ∴ The highest NF is 3NF.

Topic: Highest NF Decomposition

Conclusion:

Goals of DB design based on Normalization	1NF	2NF	3NF	BCNF	4NF
Lossless join decomposition	✓	✓	✓	✓	May not
Dependency Preserving	✓	✓	✓	May not	May not
0% redundancy	No	No	No	{yes over FD's} {No over MVD's}	Yes over FD's/ MVD's

Telegram channel

@RBRSIRPW

THANK - YOU