CS2102

Database Systems

L12: Revision

FD

Quiz #1

Question

Consider the attribute mapping on the right. Given the following requirement, which functional dependency captures this requirement?

Each shop can sell at most one product

Attribute	Letter
User	U
Product	P
Shop	S
Cost	C
Date	D

	Choice	Comment	
A	{P,D} → {S}	*NO*	✗
B	{P} → {U}	*NO*	✗
C	{U,P,S,D} → {C}	*NO*	✗
D	{S} → {P}	*YES*	✓
E	{P} → {S}	*NO*	✗

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Quiz #2

Question

Consider the attribute mapping on the right. Given the following requirement, which functional dependency captures this requirement?

No two different users can buy the same product

Attribute	Letter
User	U
Product	P
Shop	S
Cost	C
Date	D

	Choice	Comment	
A	{P,D} → {S}	*NO*	✗
B	{P} → {U}	*YES*	✓
C	{U,P,S,D} → {C}	*NO*	✗
D	{S} → {P}	*NO*	✗
E	{P} → {S}	*NO*	✗

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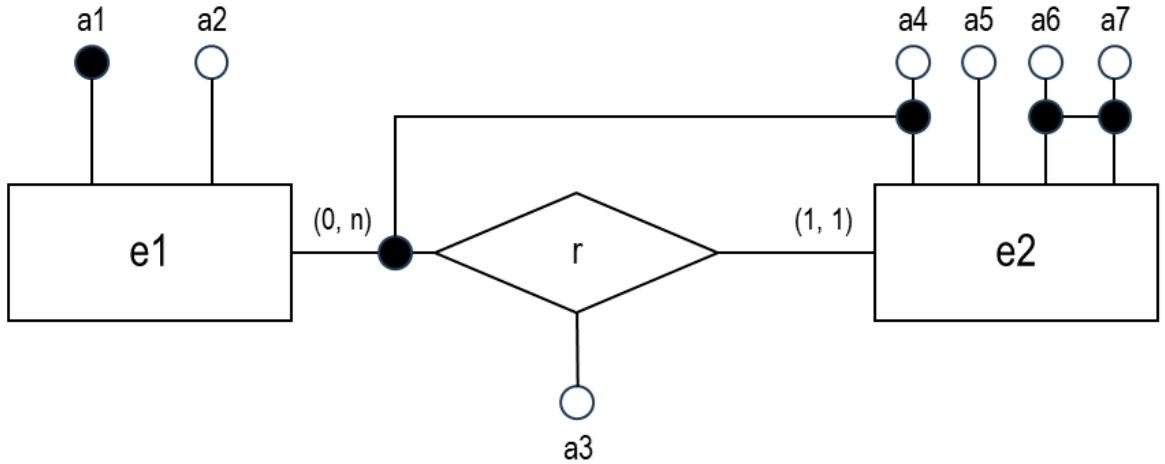
Quiz #3

Question

Consider the entity-relationship diagram on the right. Which functional dependency holds?



	Choice	Comment	
A	{a1} → {a4}	*NO: this is key of e1*	✗
B	{a4} → {a1}	*NO: this is partial key*	✗
C	{a4} → {a5,a6,a7}	*NO: this is partial key*	✗
D	{a6,a7} → {a1}	*YES: this is not partial key*	✓
E	None of the above	*NO*	✗

FD

Quiz #4

Question

Consider the functional dependency below. Which table on the right is a valid table with respect to the functional dependency below?

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

T1

A	B	C
1	1	1
1	2	1
2	2	1

T2

A	B	C
1	1	1
1	1	1
2	2	2

T2

A	B	C
2	2	2
1	1	1
1	2	1

T2

A	B	C
1	1	1
2	1	2
1	2	1

	Choice	Comment	
A	T1	*NO: see row 1 and 2*	✗
B	T2	*YES: not proper because of duplicate but valid*	✓
C	T3	*NO: see tow 2 and 3*	✗
D	T4	*NO: see tow 1 and 3*	✗

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

Reduce complexity in checking

- Superkeys
- Candidate keys
- Prime attributes
- BCNF violation
- 3NF violation

2. Compute Minimal Cover

Reduce complexity in computing

- Attribute closure
- Projection
- Lossless-join
- Dependency preserving
- 3NF synthesis

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

2. Compute Minimal Cover

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

Singleton

$\{A\}^+$

$\{B\}^+$

$\{C\}^+$

$\{D\}^+$

$\{E\}^+$

2. Compute Minimal Cover

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

Singleton

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

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

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

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

$\{E\}^+ = \{E\}$

2. Compute Minimal Cover

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

Singleton

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

2. Compute Minimal Cover

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

Pair $\{B\}$

2. Compute Minimal Cover

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

Pair $\{B\}$

$\{A,C\}^+$

$\{A,D\}^+$

$\{A,E\}^+$

$\{C,D\}^+$

$\{C,E\}^+$

$\{D,E\}^+$

2. Compute Minimal Cover

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

Pair $\{B\}$

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

2. Compute Minimal Cover

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

Pair $\{B\}$

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

2. Compute Minimal Cover

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

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

2. Compute Minimal Cover

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

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

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

2. Compute Minimal Cover

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

Ans: {A,D} {A,C} {B}

2. Compute Minimal Cover

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

Ans: {A,D} {A,C} {B}

2. Compute Minimal Cover

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

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

Ans: {A,D} {A,C} {B}

2. Compute Minimal Cover

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

Consider $\{C,E\} \rightarrow \{D\}$

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

Ans: {A,D} {A,C} {B}

2. Compute Minimal Cover

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

Consider $\{C,E\} \rightarrow \{D\}$
Can we remove C?

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

Ans: {A,D} {A,C} {B}

2. Compute Minimal Cover

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

Consider $\{C,E\} \rightarrow \{D\}$
Can we remove C?

$\{E\}^+ = \{E\} \not\supseteq \{D\}$
$\Rightarrow$ cannot remove C

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

Ans: {A,D} {A,C} {B}

2. Compute Minimal Cover

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

Consider $\{C,E\} \rightarrow \{D\}$
Can we remove E?

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

Ans: {A,D} {A,C} {B}

2. Compute Minimal Cover

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

Consider $\{C,E\} \rightarrow \{D\}$
Can we remove E?

$\{C\}^+ = \{C,D,E\} \supseteq \{D\}$
$\Rightarrow$ can remove E

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

Ans: {A,D} {A,C} {B}

2. Compute Minimal Cover

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

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

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

2. Compute Minimal Cover

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

Consider

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

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

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

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

2. Compute Minimal Cover

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

Consider

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

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

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

Ans: {A,D} {A,C} {B}

2. Compute Minimal Cover

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

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

Ans: {A,D} {A,C} {B}

2. Compute Minimal Cover

{C} → {E}
{B} → {E}
{B} → {A}

{C} → {D}
{B} → {C}

{A,D} → {B}
{A,D} → {C}

Consider {C} → {E}, can we remove this?
First assume no {C} → {E}

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

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

2. Compute Minimal Cover

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

Consider $\{C\} \rightarrow \{E\}$, can we remove this?
First assume no $\{C\} \rightarrow \{E\}$

$\{C\}^+ = \{C,D\} \not\supseteq \{E\}$

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

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

2. Compute Minimal Cover

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

Consider $\{C\} \rightarrow \{E\}$, can we remove this?
First assume no $\{C\} \rightarrow \{E\}$

$\{C\}^+ = \{C,D\} \not\supseteq \{E\}$
$\Rightarrow$ cannot remove $\{C\} \rightarrow \{E\}$

NF

Example

R = {A, B, C, D, E}
Σ = { {C} → {E}, {B} → {E}, {B} → {A}, {C,E} → {D}, {B,E} → {C}, {A,D} → {B}, {A,D} → {C} }

1. Compute Candidate Key

Ans: {A,D} {A,C} {B}

2. Compute Minimal Cover

{C} → {E}
{B} → {E}
{B} → {A}

{C} → {D}
{B} → {C}

{A,D} → {B}
{A,D} → {C}

Consider {B} → {E}, can we remove this?
First assume no {B} → {E}

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

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

2. Compute Minimal Cover

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

Consider $\{B\} \rightarrow \{E\}$, can we remove this?
First assume no $\{B\} \rightarrow \{E\}$

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

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

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

2. Compute Minimal Cover

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

Consider $\{B\} \rightarrow \{E\}$, can we remove this?
First assume no $\{B\} \rightarrow \{E\}$

$\{B\}^+ = \{A,B,C,D,E\} \supseteq \{E\}$
$\Rightarrow$ can remove $\{B\} \rightarrow \{E\}$

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

Ans: {A,D} {A,C} {B}

2. Compute Minimal Cover

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

Consider $\{B\} \rightarrow \{A\}$, can we remove this?

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

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

2. Compute Minimal Cover

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

Consider $\{C\} \rightarrow \{D\}$, can we remove this?

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

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

2. Compute Minimal Cover

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

Consider $\{B\} \rightarrow \{C\}$, can we remove this?

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

Ans: {A,D} {A,C} {B}

2. Compute Minimal Cover

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

Consider $\{A,D\} \rightarrow \{B\}$, can we remove this?

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

Ans: {A,D} {A,C} {B}

2. Compute Minimal Cover

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

Consider $\{A,D\} \rightarrow \{C\}$, can we remove this?

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

Ans: {A,D} {A,C} {B}

2. Compute Minimal Cover

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

NF

Example

$R = \{A, B, C, D, E\}$
$\Sigma = \{ \{C\} \rightarrow \{E\}, \{B\} \rightarrow \{E\}, \{B\} \rightarrow \{A\}, \{C,E\} \rightarrow \{D\}, \{B,E\} \rightarrow \{C\}, \{A,D\} \rightarrow \{B\}, \{A,D\} \rightarrow \{C\} \}$

1. Compute Candidate Key

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

2. Compute Minimal Cover

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

3. Compute Canonical Cover

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

Key: {B}, {A,C}, {A,D}
Min Cover: {{C} → {E}, {B} → {A}, {C} → {D}, {B} → {C}, {A,D} → {B}}

NF

Quiz #1

R = {A, B, C, D, E}
Σ = { {C} → {E}, {B} → {E}, {B} → {A}, {C,E} → {D}, {B,E} → {C}, {A,D} → {B}, {A,D} → {C} }

Question

Which of the following is **NOT** a superkey of R with Σ?

	Choice	Comment	
A	{B,E}	*NO: {B,E} ⊇ {B}*	✗
B	{A,C,D}	*NO: {A,C,D} ⊇ {A,C}*	✗
C	{C,D,E}	*YES: not superset of any key*	✓
D	{B}	*NO: {B} ⊇ {B}*	✗

Key: {B}, {A,C}, {A,D}
Min Cover: {{C} → {E}, {B} → {A}, {C} → {D}, {B} → {C}, {A,D} → {B}}

NF

Quiz #2

R = {A, B, C, D, E}
Σ = { {C} → {E}, {B} → {E}, {B} → {A}, {C,E} → {D}, {B,E} → {C}, {A,D} → {B}, {A,D} → {C} }

Question

Which of the following is a key of R with Σ?

	Choice	Comment	
A	{B,E}	*NO: {B} is superkey*	✗
B	{A,C,D}	*NO: {A,C}/{A,D} are superkey*	✗
C	{C,D,E}	*NO: not even superkey*	✗
D	{B}	*YES: minimal*	✓

Key: {B}, {A,C}, {A,D}
Min Cover: {{C} → {E}, {B} → {A}, {C} → {D}, {B} → {C}, {A,D} → {B}}

NF

Quiz #3

R = {A, B, C, D, E}
Σ = { {C} → {E}, {B} → {E}, {B} → {A}, {C,E} → {D}, {B,E} → {C}, {A,D} → {B}, {A,D} → {C} }

Question

Find one lossless-join decomposition of R with Σ in **BCNF**. Is it dependency preserving?

Key: {B}, {A,C}, {A,D}
Min Cover: {{C} → {E}, {B} → {A}, {C} → {D}, {B} → {C}, {A,D} → {B}}

NF

Quiz #4

R = {A, B, C, D, E}
Σ = { {C} → {E}, {B} → {E}, {B} → {A}, {C,E} → {D}, {B,E} → {C}, {A,D} → {B}, {A,D} → {C} }

Question

Find one lossless-join dependency preserving decomposition of R with Σ in 3NF.

Theories

Quiz #1

Question

Consider an arbitrary $R = \{A, B, C, D, E, F\}$ with an unknown Σ. Suppose that R is not in 3NF with respect to Σ. What is the maximum number of keys of R with Σ?

	Choice	Comment	
A	1	*NO*	✗
B	5	*NO*	✗
C	10	*YES*	✓
D	15	*NO*	✗
E	20	*NO*	✗
F	25	*NO*	✗
G	30	*NO*	✗
H	32	*NO*	✗

Theories

Quiz #2

Question

Consider an arbitrary relation R. Suppose there are two ***different*** sets of functional dependencies Σ_1 and Σ_2 such that the key of R with Σ_1 is equal to the key of R with Σ_2.

Does it imply that $\Sigma_1 \equiv \Sigma_2$?

	Choice	Comment	
A	Yes	*NO*	✗
B	No	*YES: R = {A,B,C}, Σ1 = {{A} → {B}}, Σ2 = {{C} → {B}}*	✓

Theories

Quiz #3

Question

Consider an arbitrary set of functional dependencies Σ. Further consider **any** two ***minimal cover*** of Σ named Σ_1 and Σ_2.

Does it imply that $\Sigma_1 \cap \Sigma_2 \neq \varnothing$ *(i.e., they share at least one common functional dependency)*?

	Choice	Comment	
A	Yes	*NO*	✗
B	No	*YES: $\Sigma 1$={{A}→{B},{B}→{C},{C}→{A}}, $\Sigma 2$={{A}→{C},{C}→{B},{B}→{A}}*	✓

```
postgres=# exit
Press any key to continue . . .
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