CSCI235 Database Systems

Normalization in Practice

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Example 1

A relational schema $R = (A, B, C)$

Functional dependencies: $AB \rightarrow C$

Keys ?

If $AB \rightarrow C$ is valid in R and it covers entire relational schema then its left hand side is a minimal key (A, B)

No other minimal keys

Normal form ?

Left hand side of $AB \rightarrow C$ is a minimal key $K = (A, B)$

BCNF

Example 2

A relational schema R =(A, B, C)

Functional dependencies: AB → C, C → B

Keys ?

If AB → C is valid in R and it covers entire relational schema then its left hand side is a minimal key (A, B)

If C → B then through augmentation rule AC → AB

If AC → AB is valid in R and it covers entire relational schema then its left hand side is a minimal key (A, C)

Normal form ?

Not BCNF because left hand side of C → B is not a minimal key

3NF because right hand side of C → B is a prime attribute

Decomposition into BCNF ?

R1 = (B, C), R2 = (A, C) or

R1 = (B, C), R2 = (A, B)

Example 3

A relational schema R = (A, B, C)

Functional dependencies: AB → C, C → B, C → A

Keys ?

If AB → C is valid in R and it covers entire relational schema then its left hand side is a minimal key (A, B)

If C → B and C → A then through union rule C → AB

If C → AB is valid in R and it covers entire relational schema then its left hand side is a minimal key (C)

Normal form ?

BCNF because left hand side of each functional dependency is a minimal key

Example 4

A relational schema R = (A, B, C)

Functional dependencies: A → B

Keys ?

If A → B is valid in R then through augmentation rule AC → BC

If AC → BC is valid in R and it covers entire relational schema then its left hand side is a minimal key (A, C)

Normal form ?

not 2NF because a nonprime attribute B functionally depends (A → B) on a subset of primary key (A, C)

Decomposition into BCNF ?

R1 = (A, B), R2 = (A, C) or

R1 = (A, B), R2 = (B, C)

Example 5

A relation al schema R = (A, B, C)

Functional dependencies: A → B, B → A

Keys ?

If A → B then through augmentation rule AC → BC

If AC → BC is valid in R and it covers entire relational schema then its left hand side is a minimal key (A, C)

If B → A then through augmentation rule BC → AC

If BC → AC is valid in R and it covers entire relational schema then its left hand side is a minimal key (B, C)

Example 5

Normal form ?

Not BCNF because left hand side of $A \rightarrow B$ is not a minimal key

3NF because right hand side of $A \rightarrow B$ is a prime attribute and right hand side of $B \rightarrow A$ is a prime attribute

Decomposition into BCNF ?

R1 = (A, B), R2 = (A, C) or

R1 = (A, B), R2 = (B, C)

Example 6

A relational schema R = (A, B, C)

Functional dependencies: A → B, B → C

Keys ?

If A → B and B → C then through transitivity rule A → C

If A → B and A → C then through union rule A → BC

If A → BC is valid in R and it covers entire relational schema then its left hand side is a minimal key (A)

Normal form ?

Not 3NF because a non prime attribute C is transitively dependent on primary key A

2NF because no nonprime attribute depends on a part of primary key

Example 6

Decomposition into BCNF ?

R1 = (A, B), R2 = (B, C) or

R1 = (A, B), R2 = (A, C)

Example 7

A relational schema R =(A, B, C, D)

Functional dependencies: A → B, A → C, B → D

Keys ?

If A →B and A → C then through union rule A → BC

If A → B and B → D then through transitivity rule A → D

If A → BC and A → D then through union rule A → BCD

If A → BCD is valid in R and it covers entire relational schema then its left hand side is a minimal key (A)

Normal form ?

Not 3NF because a non prime attribute D is transitively dependent on primary key A

2NF because no nonprime attribute depends on a part of primary key

Example 7

Decomposition into BCNF ?

R1 = (A, B, C), R2 = (B, D) or

R1 = (A, B, C), R2 = (A, D)

Example 8

A relational schema R =(A, B, C, D)

Functional dependencies: A → B, B → D, C → B

Keys ?

If A → B and B → D then through transitivity rule A → D

If A → D and A → B then through union rule A → BD

If A → BD then through augmentation rule AC → BCD

If AC → BCD is valid in R and it covers entire relational schema then its left hand side is a minimal key (A, C)

If C → B and B → D then through transitivity rule C → D

If C → D and C → B then through union rule C → BD

If C → BD then through augmentation rule AC → ABD

If AC → BCD is valid in R and it covers entire relational schema then its left hand side is a minimal key (A, C)

Example 8

Normal form ?

Not 2NF because a nonprime attribute B depends on a part of a primary key
(A, C)

Decomposition into BCNF ?

R1 = (A, B), R2 = (B, C), R2 = (B, D)

Example 9

A relational schema R =(A, B, C, D)

Functional dependencies: A → B, A → C, B → A, B → C

Keys ?

If A → B and A → C then through union rule A → BC

If A → BC then through augmentation rule AD → BCD

If AD → BCD is valid in R and it covers entire relational schema then its left hand side is a minimal key (A, D)

If B → A and B → C then through union rule B → AC

If B → AC then through augmentation rule BD → ACD

If BD → ACD is valid in R and it covers entire relational schema then its left hand side is a minimal key (B, D)

Example 9

Normal form ?

Not 2NF because a nonprime attribute C depends on a part of a primary key
(B, D)

Decomposition into BCNF ?

R1 = (A, B), R2 = (B, C), R2 = (A, D)

Example 10

A relational schema R = (A, B, C, D)

Functional dependencies: AB → C, C → D, D → A, D → B

Keys ?

If AB → C and C → D then through transitivity rule AB → D

If AB → D and AB → C then through union rule AB → CD

If AB → CD is valid in R and it covers entire relational schema then its left hand side is a minimal key (A, B)

If D → A and D → B then through union rule D → AB

If D → AB and AB → C then through transitivity rule D → C

If D → C and D → AB then D → ABC

If D → ABC is valid in R and it covers entire relational schema then its left hand side is a minimal key (D)

Example 10

If C → D and D → AB then through transitivity rule C →AB

If C → D and C → AB then through union rule C →ABD

If C → ABD is valid in R and it covers entire relational schema then its left hand side is a minimal key (C)

Normal form ?

BCNF because left hand side of each functional dependency is a superky

Example 11

A relational schema R = (A, B, C, D)

Functional dependencies: A → B, B → C, C → D, D → A

Keys ?

If A → B and B → C then through transitivity rule A → C

If A → C and C → D then through transitivity rule A → D

If A → B and A → C and A → D then through union rule A → BCD

If A →BCD is valid in R and it covers entire relational schema then its left hand side is a minimal key (A)

If B → C and C → D then through transitivity rule B → D

If B → D and D → A then through transitivity rule B → A

If B → C and B → D and B → A then through union rule B → ACD

If B →ACD is valid in R and it covers entire relational schema then its left hand side is a minimal key (B)

Example 11

If C → D and D → A then through transitivity rule C → A

If C → A and A → B then through transitivity rule C → B

If C → A and C → B and C → D then through union rule C → ABD

If C → ABD is valid in R and it covers entire relational schema then its left hand side is a minimal key (C)

If D → A and A → B then through transitivity rule D → B

If D → B and B → C then through transitivity rule D → C

If D → A and D → B and D → C then through union rule D → ABC

If D → ABC is valid in R and it covers entire relational schema then its left hand side is a minimal key (D)

Normal form ?

BCNF because left hand side of each functional dependency is a superky

References

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