

DASC 5333 Database Systems for Data Science
CSCI 4333 Design of Database Systems
Spring 2023
Suggested Solution to Homework #7

[1] See the separate file.

[2]

- [a] $R(A,B,C,D) \{A \rightarrow C, C \rightarrow A\}$
- [b] $R(A,B,C,D) \{A \rightarrow BD, C \rightarrow D\}$
- [c] $R(A,B,C,D) \{AB \twoheadrightarrow CD, D \rightarrow C\}$
- [d] $R(A,B,C,D) \{A \rightarrow BC, BC \rightarrow D\}$
- [e] $R(A,B,C,D) \{A \rightarrow B, B \rightarrow C, C \rightarrow D, C \rightarrow A\}$

[a] $R(A,B,C,D) \{A \rightarrow C, C \rightarrow A\}$
CK:[1] ABD, [2] CBD
Highest NF: 3NF
Reason: All attributes are prime and thus R is in 3NF. Both FD violates BCNF.

[b] $R(A,B,C,D) \{A \rightarrow BD, C \rightarrow D\}$
CK:[1] AC
Highest NF: 1NF
Reason: $C \rightarrow D$ violates 2NF as C is a proper subset of AC, and D is non-prime.

[c] $R(A,B,C,D) \{AB \twoheadrightarrow CD, D \rightarrow C\}$
CK:[1] AB
Highest NF: 2NF
Reason: $D \rightarrow C$ violates 3NF as D is not a SK and C is non-prime.

[d] $R(A,B,C,D) \{A \rightarrow BC, BC \rightarrow D\}$
CK:[1] A
Highest NF: 2NF
Reason: $BC \rightarrow D$ violates 3NF as BC are not a superkey and D is non-prime.

[e] $R(A,B,C,D) \{A \rightarrow B, B \rightarrow C, C \rightarrow D, C \rightarrow A\}$
CK:[1] A, [2] B, [3] C
Highest NF: BCNF
Reason: LHS of all FD are candidate keys.

[3] (a) FD:

FD1: stuld \rightarrow stulname,

FD2: studId, semester -> dormName, dormRoom, mealPlan

FD3: dormName, dormRoom, semester -> dormFee

FD4: mealPlan, semester -> mealFee

(b) CK: {studId, semester}

(c) 1NF. FD1 violates 2NF. FD3 and FD4 violate 3NF.

(d) Decomposition into BCNF component relations:

Student(studId, studName, ..) { studId -> studName }

DormFee(dormName, dormRoom, semester, dormFee) {dormName, dormRoom, semester -> dormFee }

MealFee(mealPlan, semester, mealFee) { mealPlan, semester -> mealFee }

StudentSemester(studId, semester, dormName, dormRoom, mealPlan) { studId, semester -> dormName, dormRoom, mealPlan }

[4] For $R(A,B,C,D,E)$, $F = \{B \rightarrow CD, A \rightarrow C, D \rightarrow E\}$

(a) Candidate key: [1] AB; prime attributes: A,B; non-prime attributes: C, D, E

(b) 1NF. $A \rightarrow C$ and $B \rightarrow CD$ violate 2NF.

(c) Decomposition:

$R_1(B,C,D)$ { $B \rightarrow CD$ } in BCNF

$R_2(A,C)$ { $A \rightarrow C$ } in BCNF

$R_3(D,E)$ { $D \rightarrow E$ } in BCNF

$R_4(A,B)$ {} in BCNF

[5] Given that for $R(A,B,C,D)$:

1. R has two candidate keys
2. A is a superkey.

How many superkeys can R have. A is also a CK.

There are three scenarios. Without the loss of generality:

1. CK: [1] $B \rightarrow$ Number of SK = 12 (A, AB, AC, AD, ABC, ABD, ACD, ABCD, B, BC, BD, BCD)
2. CK: [1] $BC \rightarrow$ Number of SK = 10 (A, AB, AC, AD, ABC, ABD, ACD, ABCD, BC, BCD)
3. CK: [1] $BCD \rightarrow$ Number of SK = 9 (A, AB, AC, AD, ABC, ABD, ACD, ABCD, BCD)

Thus, the number SK: {9,10,12}