

Exercise 3

Question 1

Consider a relation $R(A,B,C,D,E)$ with the following dependencies:

$AB \rightarrow C$

$CD \rightarrow E$

$DE \rightarrow B$

Is AB a candidate key of this relation? If not, is ABD ? Explain your answer.

Question 2

Consider the relation R , which has attributes that hold schedules of courses and sections at a university; $R = \{ \text{Course_no}, \text{Sec_no}, \text{Offering_dept}, \text{Credit_hours}, \text{Course_level}, \text{Instructor_ssn}, \text{Semester}, \text{Year}, \text{Days_hours}, \text{Room_no}, \text{No_of_students} \}$. Suppose that the following functional dependencies hold on R :

$\{ \text{Course_no} \} \rightarrow \{ \text{Offering_dept}, \text{Credit_hours}, \text{Course_level} \}$

$\{ \text{Course_no}, \text{Sec_no}, \text{Semester}, \text{Year} \} \rightarrow \{ \text{Days_hours}, \text{Room_no}, \text{No_of_students}, \text{Instructor_ssn} \}$

$\{ \text{Room_no}, \text{Days_hours}, \text{Semester}, \text{Year} \} \rightarrow \{ \text{Instructor_ssn}, \text{Course_no}, \text{Sec_no} \}$

Try to determine which sets of attributes form keys of R .

Question 3

Consider the following relations for an order-processing application database at ABC, Inc.

ORDER (O#, Odate, Cust#, Total_amount)

ORDER_ITEM(O#, I#, Qty_ordered, Total_price, Discount%)

Assume that each item has a different discount. The Total_price refers to one item, Odate is the date on which the order was placed, and the Total_amount is the amount of the order. If we apply a natural join on the relations ORDER_ITEM and ORDER in this database, what does the resulting relation schema RES look like? What will be its key? Is RES in 2NF? Is it in 3NF? Why or why not? (State assumptions, if you make any.)

Question 4

Consider the following relation for published books:

BOOK (Book_title, Authorname, Book_type, Listprice, Author_affil, Publisher)

Author_affil refers to the affiliation of the author. Suppose the following dependencies exist:

$\text{Book_title} \rightarrow \text{Publisher}, \text{Book_type}$

$\text{Book_type} \rightarrow \text{Listprice}$

$\text{Author_name} \rightarrow \text{Author_affil}$

(a) What normal form is the relation in? Explain your answer.

(b) Decompose the relation into a set of 3NF relations if it is not in 3NF.

Question 5

Consider the relation REFRIG (MODEL#, YEAR, PRICE, MANUF_PLANT, COLOR), which is abbreviated as REFRIG(M, Y, P, MP, C), and the following set of F of functional dependencies: $F = \{M \rightarrow MP, \{M, Y\} \rightarrow P, MP \rightarrow C\}$

(a) Evaluate each of the following as a candidate key for REFRIG, giving reasons why it can or cannot be a key: $\{M\}$, $\{M, Y\}$, $\{M, C\}$

(b) Based on the above key determination, state whether the relation REFRIG is in 3NF and in BCNF, giving proper reasons.

(c) Consider the decomposition of REFRIG into $D = \{R_1(M, Y, P), R_2(M, MP, C)\}$. Is this decomposition lossless? Show why.

Question 6

Consider a relation $R(A, B, C, D, E, G, H)$ and its FD set $F = \{AB \rightarrow CD, E \rightarrow D, ABC \rightarrow DE, E \rightarrow AB, D \rightarrow AG, ACD \rightarrow BE\}$. Answer the following questions and justify your answers.

1) List all the candidate keys for R .

2) Determine the highest normal form of R with respect to F .

Question 7

Consider a relation $R(A, B, C, D, E, G, H)$ and its FD set $F = \{AB \rightarrow CD, E \rightarrow D, ABC \rightarrow DE, E \rightarrow AB, D \rightarrow AG, ACD \rightarrow BE\}$. Answer the following questions and justify your answers.

1) Is the decomposition $\{ABCD, DEGH\}$ (with the same FD set F) of R lossless-join?

2) Find a minimal cover F_m for F .

Question 8

Consider a relation $R(A, B, C, D, E, G, H)$ and its FD set $F = \{AB \rightarrow CD, E \rightarrow D, ABC \rightarrow DE, E \rightarrow AB, D \rightarrow AG, ACD \rightarrow BE\}$. Answer the following questions and justify your answers.

1) Decompose into a set of 3NF relations if it is not in 3NF. Make sure your decomposition is dependency-preserving and lossless-join.

2) Decompose it into a collection of BCNF relations if it is not in BCNF. Make sure your decomposition is lossless-join.

Question 9

Consider a relation $R(A, B, C, D, E, K, G, H, I, J)$ and its FD set

$F = \{A \rightarrow H, G \rightarrow A, E \rightarrow D, D \rightarrow AG, E \rightarrow HI, AB \rightarrow CD, ABC \rightarrow EK, ACD \rightarrow KG\}$.

1) Find a minimal cover F_m for F .

2) List the candidate keys for R .

3) Is the decomposition $\{ABC, DEKG, HIJ\}$ (with the same FD set F) of R lossless-join? Justify your answer.

4) Determine the highest normal form of R with respect to F . Justify your answer.

Question 10

Consider a relation $R(A,B,C,D,E,K,G,H,I,J)$ and its FD set

$F = \{A \rightarrow H, G \rightarrow A, E \rightarrow D, D \rightarrow AG, E \rightarrow HI, AB \rightarrow CD, ABC \rightarrow EK, ACD \rightarrow KG\}$.

1) Decompose R into a set of 3NF relations if it is not in 3NF. Make sure your decomposition is dependency-preserving and lossless-join. Justify your answers.

2) Decompose R into a collection of BCNF relations if it is not in BCNF. Ensure that your decomposition is lossless-join and briefly justify your answers.