CS2102 Database Systems

Semester 1 2019/2020

Assignment 04 (Possible Answers Bolded)

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10 MARK

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REMINDER: The choices on Examplify may be randomized.

1 Questions

Question 1. [0.5 marks]

Consider a relation schema R(A,B,C,D,E) with functional dependencies $F = \{AB \to CDE, AC \to DE, CD \to AE, BE \to D\}$.

Which of the following are parts of the prime attributes of *R* with respect to *F*?

- **A**. A
- B. *B*
- C. *C*
- D. *D*
- E. *E*

Question 2. [0.5 marks]

Consider a relation schema R(A,B,C,D,E) with functional dependencies $F = \{AB \to CDE, AC \to DE, CD \to AE, BE \to D\}$.

Write down all the keys of R. You simply need to write the attributes (in uppercase) of each key. For instance, if attributes A and C is one possible key of R, you simply write AC.

You may leave any spot blank if you feel that there are fewer than 3 keys.

The set of keys are $\{\{A, B\}, \{B, C, D\}, \{B, C, E\}\}$.

Question 3. [0.5 marks]

Consider a relation schema R(A,B,C,D,E) with functional dependencies $F = \{AB \to CDE, AC \to DE, CD \to AE, BE \to D\}$.

Which of the following set of functional dependencies is/are possible minimal covers of F? Note that if G is a minimal cover of F, then $G \equiv F$ and G contains no redundancies.

- A. $\{AB \rightarrow C, AB \rightarrow D, AB \rightarrow E, BE \rightarrow D, CD \rightarrow A\}$
- B. $\{AB \rightarrow C, AC \rightarrow D, AC \rightarrow E, BE \rightarrow D, CD \rightarrow A\}$
- C. $\{AB \rightarrow C, AC \rightarrow D, BE \rightarrow D, CD \rightarrow A, CD \rightarrow E\}$
- D. $\{AB \rightarrow C, AC \rightarrow D, AC \rightarrow E, BE \rightarrow D\}$
- E. $\{AB \rightarrow C, AC \rightarrow D, BE \rightarrow D, CD \rightarrow A\}$

Question 4. [0.5 marks]

Consider a relation schema R(A,B,C,D,E) with functional dependencies $F = \{AB \to CDE, AC \to DE, CD \to AE, BE \to D\}$.

Select all functional dependencies in F^+ that violates the BCNF property of R.

- A. $AB \rightarrow E$
- B. $AC \rightarrow D$
- C. $ACD \rightarrow E$
- D. $ACE \rightarrow D$
- E. $CDE \rightarrow A$

Question 5. [1 mark]

Consider a relation schema R(A, B, C, D, E) with functional dependencies $F = \{AB \rightarrow CDE, AC \rightarrow DE, CD \rightarrow AE, BE \rightarrow D\}$.

Select a minimal set of fragments below such that:

- Each fragment is in BCNF
- The decomposition formed from all the fragments chosen is a lossless-join decomposition
- The decomposition formed from all the fragments chosen is a dependency-preserving decomposition

The minimal set is a set such that removing any one of the choices will not satisfy the above-mentioned conditions.

- A. $R_1(A, C, D)$
- B. $R_2(A, B, C)$
- C. $R_3(A, C, E)$
- D. $R_4(B, D, E)$
- E. $R_5(A, B, E)$

Question 6. [1 mark]

Consider a relation schema R(A,B,C,D,E) with functional dependencies $F = \{AB \to CDE, AC \to DE, CD \to AE, BE \to D\}$.

Using any minimal cover obtainable from Algorithm #2, find one possible lossless-join and dependency-preserving 3NF decomposition of *R* using Algorithm #7. You are limited to only up to three relations in this decomposition.

$$R_1(A, B, C), R_2(B, D, E), R_3(A, C, D, E)$$

Question 7. [2 marks]

Consider a relation schema R(A,B,C,D,E) with functional dependencies $F = \{AB \to D, A \to BC, B \to C, BE \to D\}$.

We consider BCNF to be better than 3NF. Consider a lossless-join and dependency-preserving decomposition that minimizes redundancies using only either Algorithm #6 for BCNF decomposition or Algorithm #7 (and Algorithm #2 for the minimal cover) for 3NF decomposition. Find the best lossless-join and dependency-preserving decomposition achievable by *R* given *F*. You are limited to only up to four relations in this decomposition.

The best decomposition is (fill in either BCNF or 3NF) [BCNF].

The decompositions are $\{R_1(A, E), R_2(B, D, E), R_3(A, B, D), R_4(B, C)\}$.

Steps:

$$\begin{split} BDE &\to C \text{ violates } R(A,B,C,D,E) \\ B &\to C \text{ violates } R_1(B,C,D,E) \\ A &\to BD \text{ violates } R_2(A,B,D,E) \\ \end{split} \Rightarrow \begin{cases} R_1(B,C,D,E), \quad R_2(A,B,D,E) \\ &\to \{R_2(A,B,D,E), \quad R_3(B,C), \quad R_4(B,D,E)\} \end{cases} \\ &\to \{R_3(B,C), \quad R_4(B,D,E), \quad R_5(A,B,D), \quad R_6(A,E)\} \end{split}$$

Question 8. [1 mark]

Consider a relation schema R(A, B, C, D, E) with functional dependencies $F = \{AB \to D, A \to BC, B \to C, BE \to D\}$.

Using Armstrong's axioms, fill in the steps to show that $F \models AE \rightarrow ABCDE$. You are limited to only up to five steps in the proof <u>including</u> the use of [Given] if necessary.

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A -> BC [Given]
BE -> D [Given]
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School of Computing, National University of Singapore

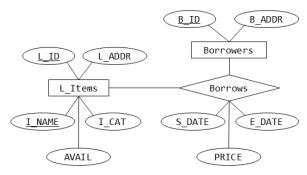
^{**} The same as answer up to renaming

Functional Dependencies and Normal Forms

AE -> ABCE [Augmentation (1) with AE]
ABCE -> ABCDE [Augmentation (2) with ABCE]
AE -> ABCDE [Transitivity (3) and (4)]

Question 9. [1 mark]

Consider only the problem description attached. Given the following ER diagram, select all the statements that are true.

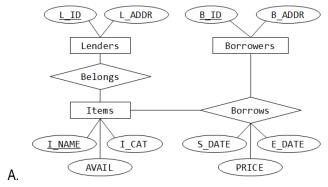


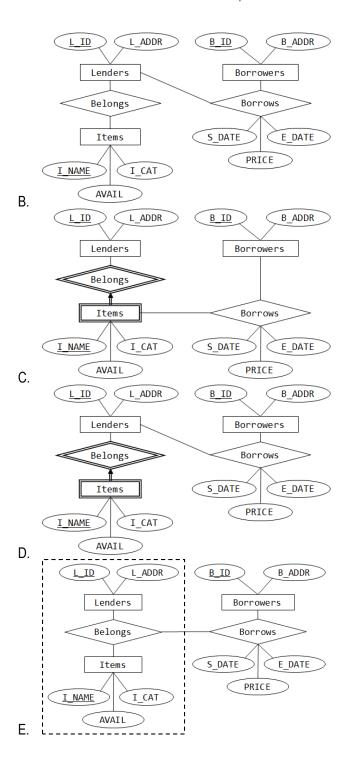
- A. The decomposition of ALL_STUFF into $\{L_Items, Borrowers, Borrows\}$ is a lossless-join decomposition
- B. The decomposition of ALL_STUFF into $\{L_Items, Borrowers, Borrows\}$ is a dependency-preserving decomposition
- C. The decomposition of ALL_STUFF into $\{L_Items, Borrowers, Borrows\}$ is in BCNF
- D. The decomposition of ALL_STUFF into $\{L_Items, Borrowers, Borrows\}$ is in 3NF
- E. None of the above statement is true

Question 10. [0.5 mark]

Consider only the problem description attached. Select all the ER diagrams (*in which entity-sets and relationship sets is a decomposition*) that are lossless-join decompositions of *ALL STUFF*.

In particular, we are only interested in the constraints related to functional dependencies (i.e., we ignore key constraints and total participation constraints).



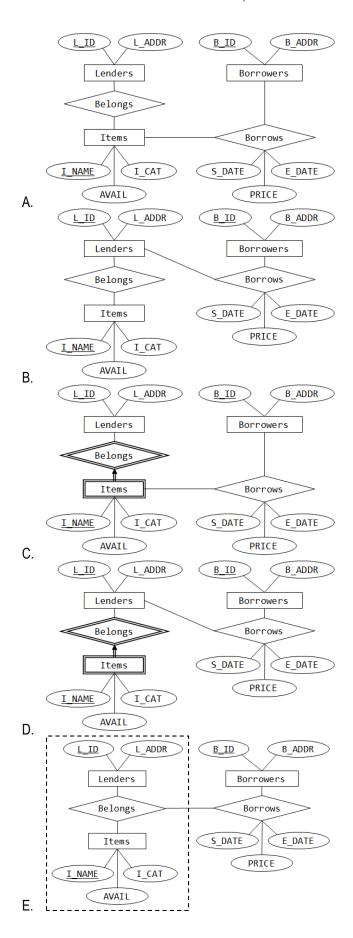


ANS: C

Question 11. [0.5 mark]

Consider only the problem description attached. Select all the ER diagrams (*in which entity-sets and relationship sets is a decomposition*) that are dependency-preserving decompositions of *ALL_STUFF*.

In particular, we are only interested in the constraints related to functional dependencies (i.e., we ignore key constraints and total participation constraints).

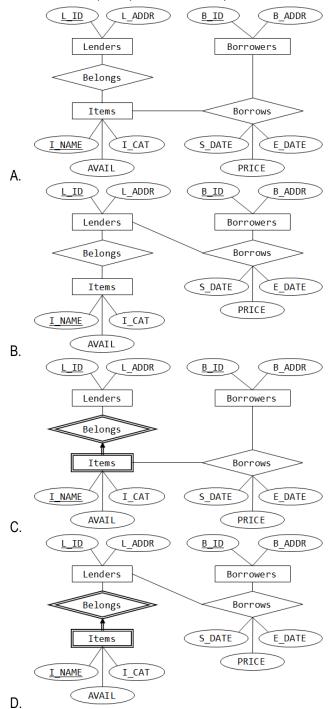


ANS: C

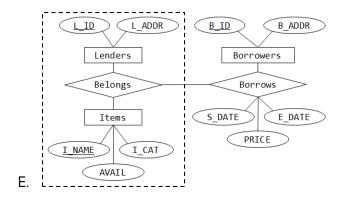
Question 12. [1 mark]

Consider only the problem description attached. Select all the ER diagrams (in which entity-sets and relationship sets is a decomposition) that are in BCNF of ALL_STUFF . We are only interested in whether or not the decompositions (i.e., ER diagrams) are in BCNF, they may or may not be lossless-join and/or dependency-preserving decompositions.

In particular, we are only interested in the constraints related to functional dependencies (i.e., we ignore key constraints and total participation constraints).



Functional Dependencies and Normal Forms



ANS: ABCDE