

CS2102 Database Systems

Semester 1 2019/2020

Assignment 04

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10 MARK

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REMINDER: The choices on Exemplify may be randomized.

1 Questions

Question 1. [0.5 marks]

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

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 $F = \{AB \rightarrow CDE, AC \rightarrow DE, CD \rightarrow AE, BE \rightarrow D\}$.

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 $\{______\}, \{______\}, \{______\}$.



Question 3. [0.5 marks]

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

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 $F = \{AB \rightarrow CDE, AC \rightarrow DE, CD \rightarrow AE, BE \rightarrow D\}$.

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. $CDE \rightarrow A$



Functional Dependencies and Normal Forms

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 $F = \{AB \rightarrow CDE, AC \rightarrow DE, CD \rightarrow AE, BE \rightarrow D\}$.

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.

$R_1(\text{____}), R_2(\text{____}), R_3(\text{____})$



Question 7. [2 marks]

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

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) [_____].



The decompositions are $\{R_1(\text{____}), R_2(\text{____}), R_3(\text{____}), R_4(\text{____})\}$.

Question 8. [1 mark]

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

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 including the use of [Given] if necessary.

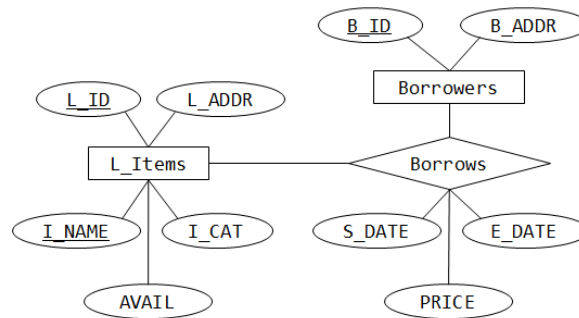
_____ \rightarrow _____	[_____]
_____ \rightarrow _____	[_____]
_____ \rightarrow _____	[_____]
_____ \rightarrow _____	[_____]
$AE \rightarrow ABCDE$	[_____]



Functional Dependencies and Normal Forms

Question 9. [1 mark]

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

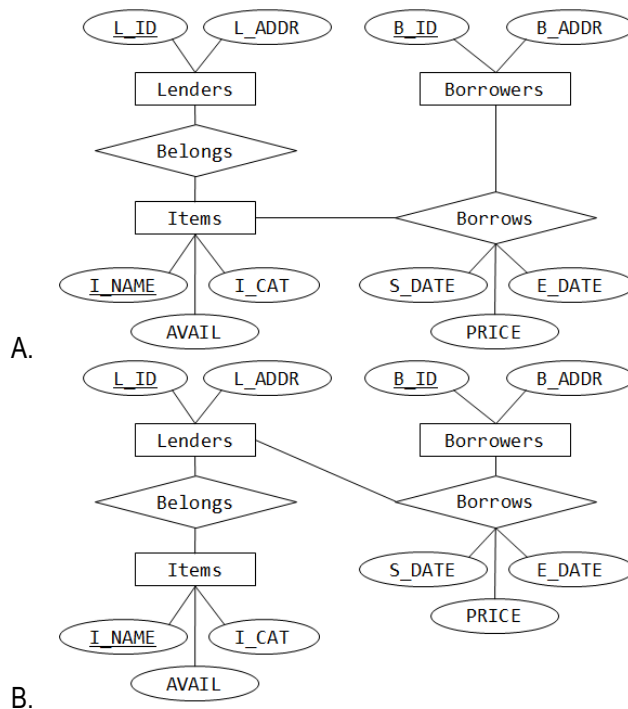


- A. The decomposition of *ALL_STUFF* into $\{L_Items, Borrowers, Borrows\}$ is a lossless-join decomposition
- B. The decomposition of *ALL_STUFF* into $\{L_Items, Borrowers, Borrows\}$ is a dependency-preserving decomposition
- C. The decomposition of *ALL_STUFF* into $\{L_Items, Borrowers, Borrows\}$ 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

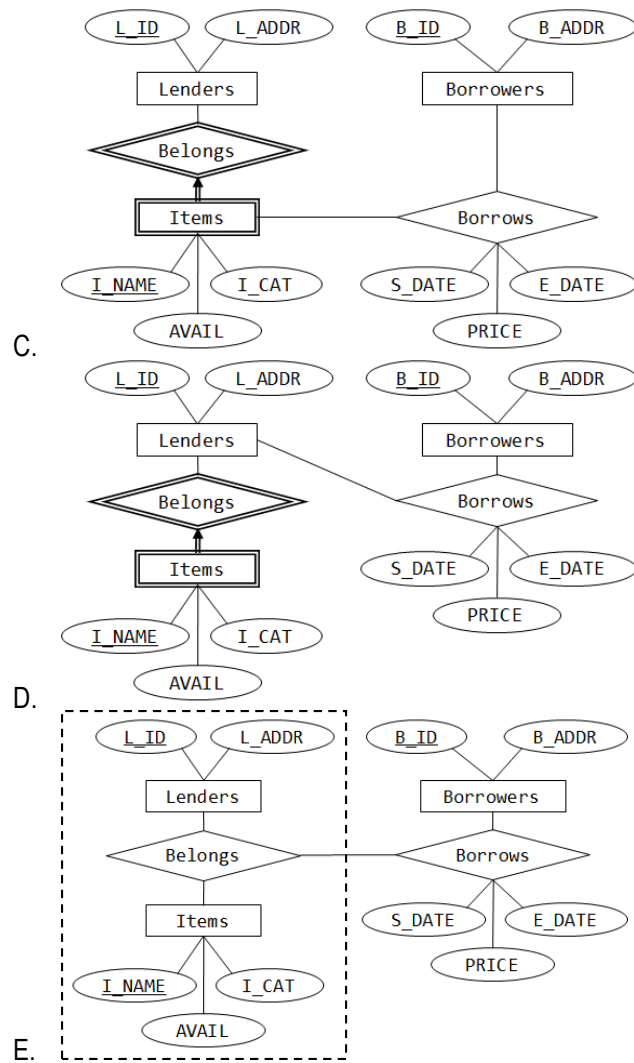
Question 10. [0.5 mark]

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).



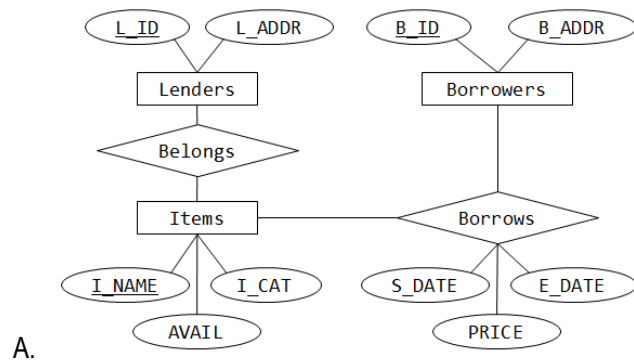
Functional Dependencies and Normal Forms



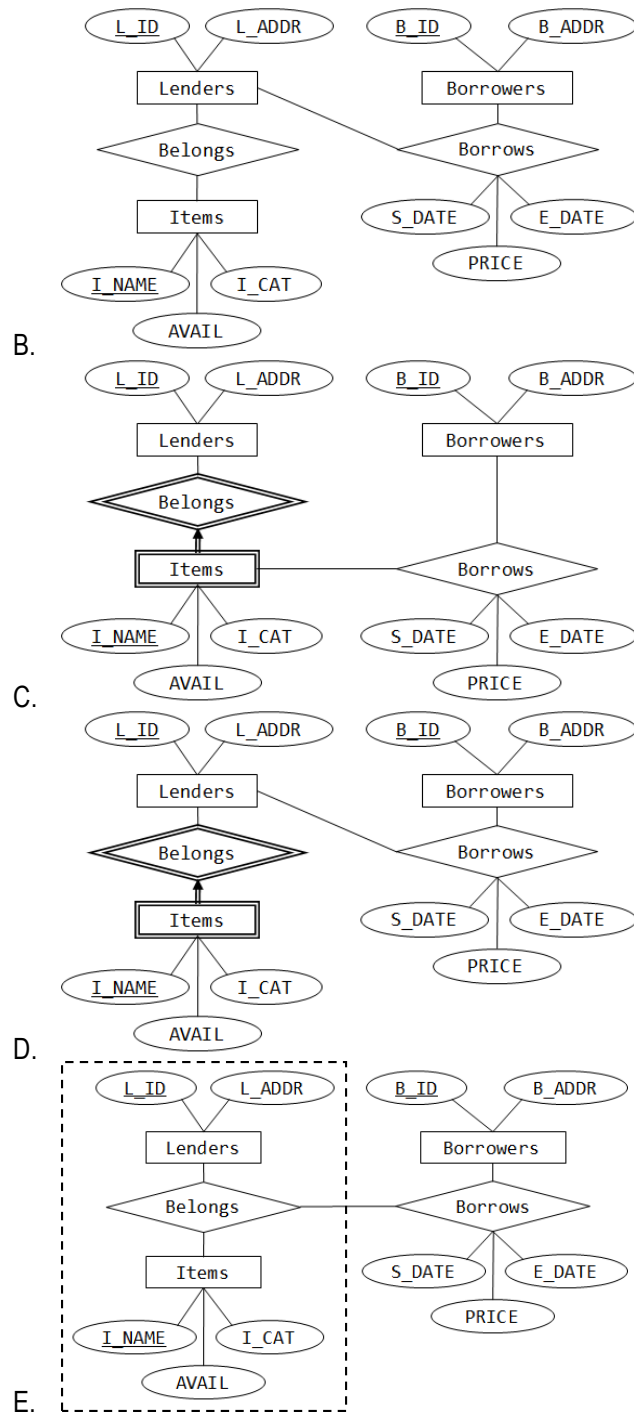
Question 11. [0.5 mark]

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).



Functional Dependencies and Normal Forms



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

