CS2102 Database Systems

Semester 1 2019/2020

Assignment 04

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

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. $CDE \rightarrow A$

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(____), R_2(____), R_3(____)

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(____), R_2(____), R_3(____), R_4(____)}.

Question 8. [1 mark]

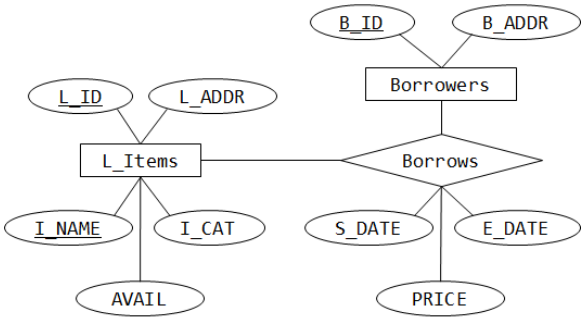
Consider a relation schema $R(A, B, C, D, E)$ with functional dependencies $F = \{AB \rightarrow D,\ A \rightarrow BC,\ B \rightarrow C,\ BE \rightarrow D\}$.

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

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

Question 9. [1 mark]

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



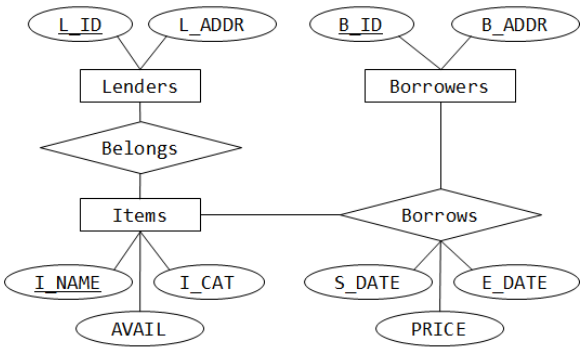
A. The decomposition of ALL_STUFF into $\{L\_Items,\ Borrowers,\ Borrows\}$ is a lossless-join decomposition
B. The decomposition of ALL_STUFF into $\{L\_Items,\ Borrowers,\ Borrows\}$ is a dependency-preserving decomposition
C. The decomposition of ALL_STUFF into $\{L\_Items,\ Borrowers,\ Borrows\}$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

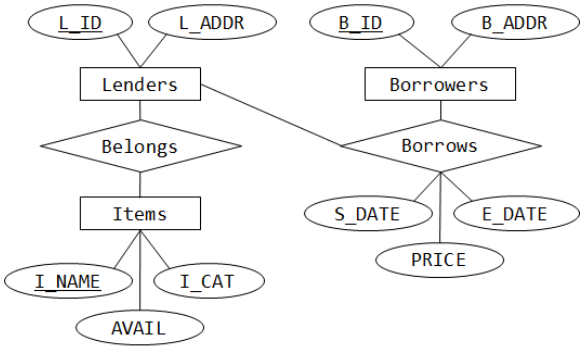
Consider only the problem description attached. Select all the ER diagrams (*in which entity-sets and relationship sets is a decomposition*) that are lossless-join decompositions of ALL_STUFF.

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

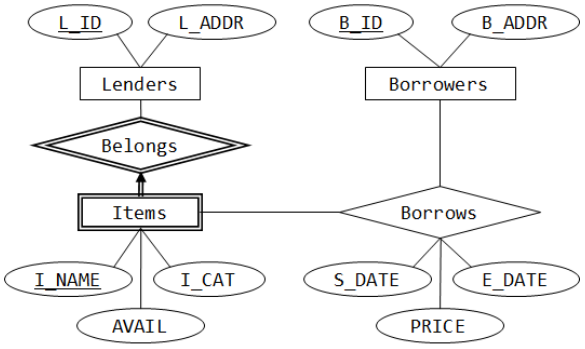
A.



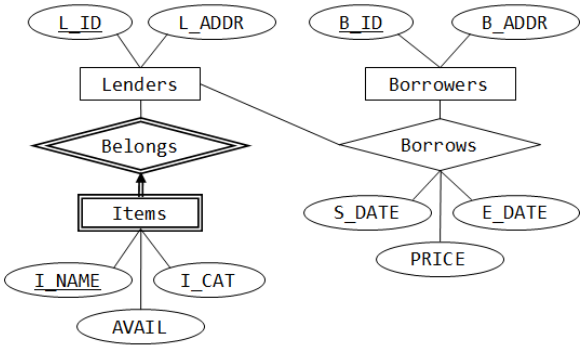
B.



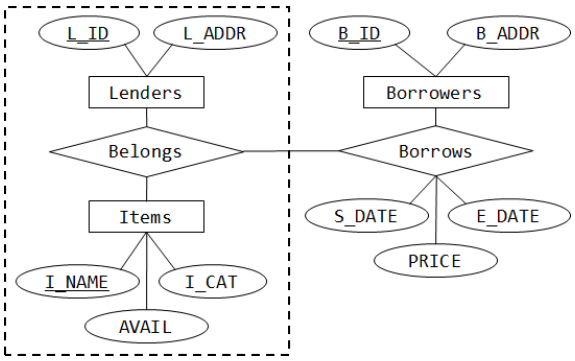
C.



D.



E.

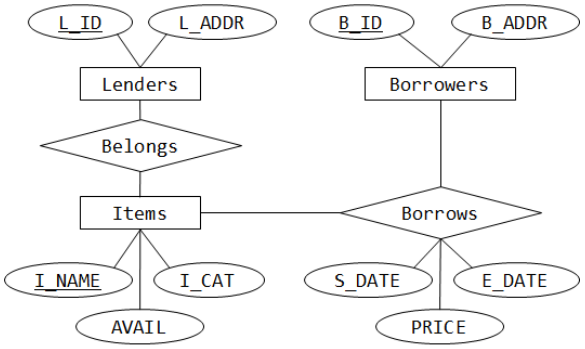


Question 11. [0.5 mark]

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).

A.



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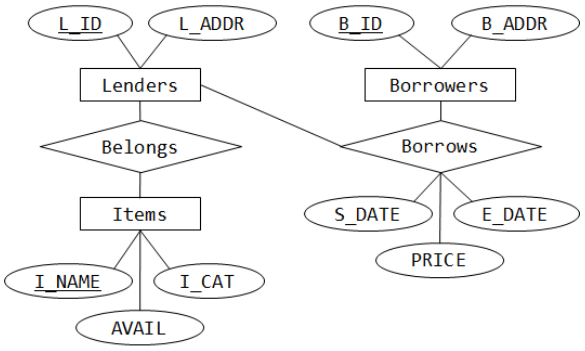

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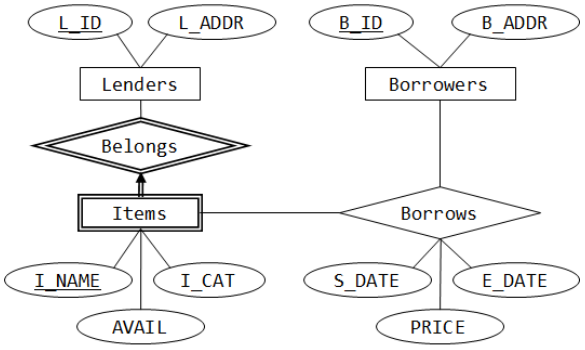

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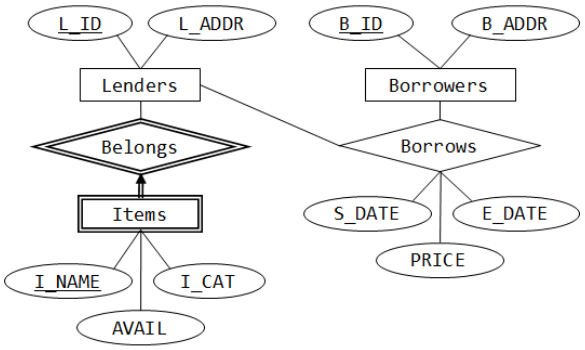
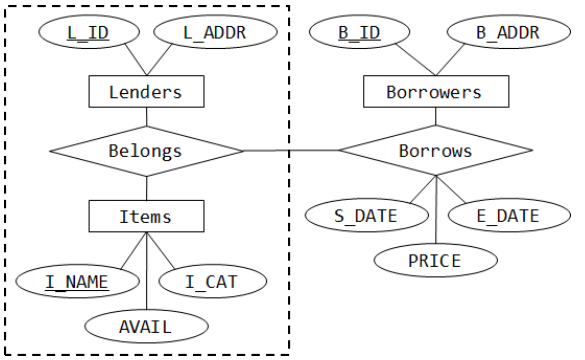


E.

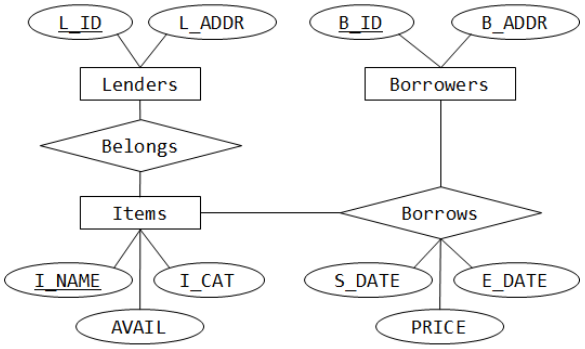


Question 12. [1 mark]

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).

A.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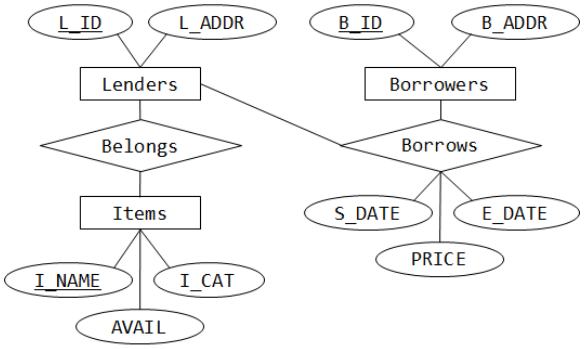
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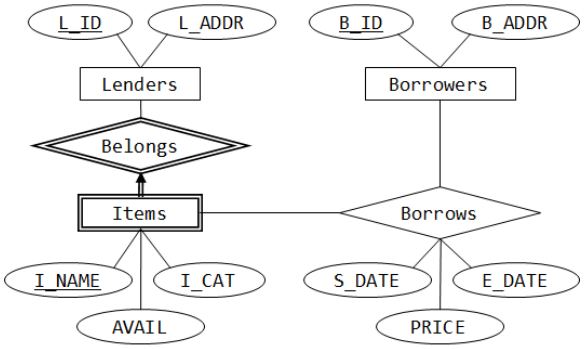
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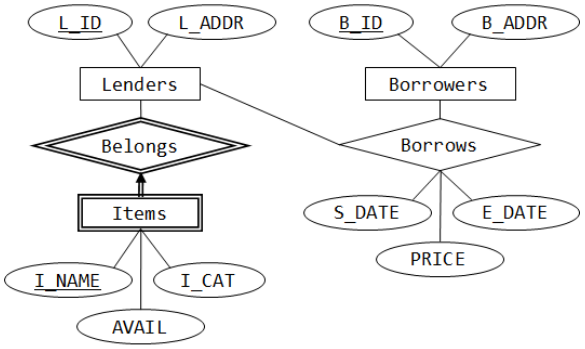
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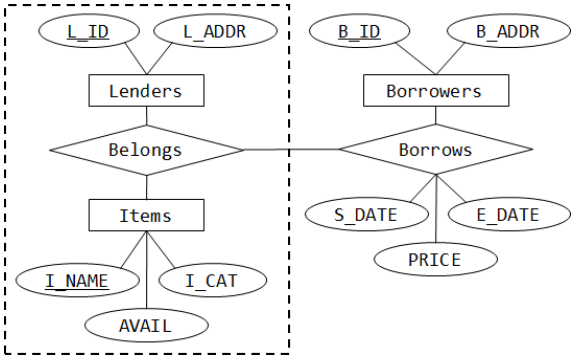
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