Assignment 02

Started: 19 Apr at 20:53

Quiz instructions

Functional Dependencies and Normalization

- Deadline: **20 Apr 2024, 12:00**
- No penalty for late submission until: **25 Apr 2024, 12:00**
- No submission after that

Note the following:

- You have unlimited submission, we will only take the **LATEST** submission
  - **IMPORTANT:** *Once you have started the quiz, you will need to submit because an automated submission will make your latest attempt blank and we will grade only that last blank attempt*
  - We will not take the highest submission to avoid abuse of submissions to try all possible permutations
- There may be multiple answers, we will do the grading offline and not using Canvas quiz
  - The grade you see from the quiz (*if any*) is incorrect because the answer is not set on the Canvas quiz
  - Grading will be done after **25 Apr 2024, 12:00**
  - Marks will be posted after that
  - There are no partial marks.

⣿

For this assignment, we will be using the following relations and set of functional dependencies

- $R(A, B, C, D, E, F)$
- $\Sigma = \{ F \rightarrow DE,\ CE \rightarrow DF,\ CEF \rightarrow D,\ DE \rightarrow AF,\ ABD \rightarrow CF \}$

Note that we are using the shorthand notation where $ABE \rightarrow CD$ means $\{A, B, E\} \rightarrow \{C, D\}$.

⣿

Question 1 1 pts

Select ALL the keys of R with respect to Σ.

Recap that keys are the *minimal* superkeys.

☐
AB

☐
BC

☐
BD

☐
BE

☑
BF

☐
ABC

☑
ABD

☐
ABE

☐
ABF

☐
BCD

☑
BCE

☐
BCF

☑
BDE

☐
BDF

☐
BEF

⣿
Question 2 1 pts

Select ALL prime attributes of R with respect to Σ.

Recap that an attribute A is a prime attribute if it is part of a key of R with respect to Σ.

☑
A

☑
B

☑
C

☑
D

☑
E

☑
F

⣿
Question 3 1 pts

Select ALL functional dependencies that form an ***canonical*** minimal basis of Σ.

We define ***canonical*** minimal basis as a minimal basis such that the FD need not be decomposed (*i.e., we apply Rule of Union for FDs with the same LHD*). Recap the definition of minimal basis below. Our extension is the removal of "decomposed" in condition (2).

1. Every FD in the minimal basis can be derived from Σ, and vice versa.
2. Every FD in the minimal basis is non-trivial and decomposed.
3. If any FD is removed from the minimal basis, then some FD in Σ cannot be derived from the minimal basis.
4. For any FD in the minimal basis, if we remove an attribute from its LHS, then the FD cannot be derived from Σ.

Note that there may be multiple ***canonical*** minimal basis, so you simply have to pick one and select all the functional dependencies in that ***canonical*** minimal basis. To make it clearer, the condition for ***canonical*** minimal basis is shown below. See the changes on condition (2).

1. Every FD in the ***canonical*** minimal basis can be derived from Σ, and vice versa.
2. Every FD in the ***canonical*** minimal basis is non-trivial and Rule of Union have been applied to remove decomposed FD when possible.
3. If any FD is removed from the ***canonical*** minimal basis, then some FD in Σ cannot be derived from the ***canonical*** minimal basis.
4. For any FD in the ***canonical*** minimal basis, if we remove an attribute from its LHS, then the ***decomposed*** version of the FD cannot be derived from Σ.

Hint: As long as a combination of FD satisfies the 4 conditions above, it does not matter how the FDs are computed. So you simply have to check that the 4 conditions above are satisfied for the combination you choose.

☑
$ABD \rightarrow CF$

☐
$ABD \rightarrow C$

☐
$ABD \rightarrow F$

☐

CE → DF

☐

CE → D

☑

CE → F

☑

F → ADE

☐

F → AD

☐

F → AE

☐

F → DE

☐

DE → A

☑

DE → F

⣿

Question 4 1 pts

Using only BCNF decomposition algorithm introduced in CS2102, select ALL fragments (*i.e., decomposed schema*) that forms a BCNF decomposition of R with respect to Σ.

In other words, if R_1 and R_3 are 2 fragments that forms a BCNF decomposition $\{R_1, R_3\}$, then you should select only both in your answer.

Note: There can be multiple possible answers. Your choice should come from the application of our algorithm.

☐

$R_1(A,B,C,D,F)$

- [x] $R_2(A,D,E,F)$
- [ ] $R_3(B,C,E)$
- [x] $R_4(B,C,F)$
- [ ] $R_5(C,D,E)$
- [ ] $R_6(C,D,F)$
- [ ] $R_7(C,E,F)$

Question 5 1 pts

Using only 3NF decomposition (*synthesis*) algorithm introduced in CS2102, select ALL fragments (*i.e., decomposed schema*) that forms a 3NF decomposition of R with respect to Σ.

In other words, if R_1 and R_3 are 2 fragments that forms a 3NF decomposition $\{R_1, R_3\}$, then you should select only both in your answer.

Note: There can be multiple possible answers. Your choice should come from the application of our algorithm.

Hint: If you have correctly computed the *(canonical)* minimal basis, you can use it to form the 3NF decomposition directly.

- [x] $R_1(A,B,C,D,F)$
- [x] $R_2(A,D,E,F)$
- [ ] $R_3(B,C,E)$

☐

$R_4(B,C,F)$

☐

$R_5(C,D,E)$

☐

$R_6(C,D,F)$

☑

$R_7(C,E,F)$

We will now consider one possible decomposition of R into the decomposed schema δ below

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

Question 6 1 pts

Is the decomposition of R into $\delta = \{ R_1, R_2, R_3, R_4 \}$ above a *lossless-join* decomposition?

◉
True

○
False

Question 7 1 pts

Is the decomposition of R into $\delta = \{ R_1, R_2, R_3, R_4 \}$ above a *dependency-preserving* decomposition? Select ALL the functional dependencies below that are not preserved by the decomposition (*i.e., the functional dependencies implied by Σ but not preserved in δ*). Select "*None of the Above"* only if the decomposition is a *dependency-preserving* decomposition.

Hint: For each FD below, check that it can be derived from Σ but not from the union of the projection of Σ on the relations in δ.

☑

BF $\rightarrow$ C

☑

CE → DF

☐

F → DE

☐

CEF → D

☐

DE → AF

☐

CF → A

☑

ABD → CF

☑

BDE → C

☐

None of the Above

We will now consider one possible decomposition of R into the decomposed schema δ below

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

Question 8 1 pts

Is the decomposition of R into $\delta = \{ R_1, R_2, R_3, R_4 \}$ above a *lossless-join* decomposition?

◉
True

○
False

Question 9 1 pts

Is the decomposition of R into δ = { R_1, R_2, R_3, R_4 } above a *dependency-preserving* decomposition? Select ALL the functional dependencies below that are not preserved by the decomposition (*i.e., the functional dependencies implied by Σ but not preserved in δ*). Select "*None of the Above"* only if the decomposition is a *dependency-preserving* decomposition.

Hint: For each FD below, check that it can be derived from Σ but not from the union of the projection of Σ on the relations in δ.

- [ ] BF $\rightarrow$ C
- [ ] CE $\rightarrow$ DF
- [ ] F $\rightarrow$ DE
- [ ] CEF $\rightarrow$ D
- [ ] DE $\rightarrow$ AF
- [ ] CF $\rightarrow$ A
- [ ] ABD $\rightarrow$ CF
- [ ] BDE $\rightarrow$ C
- [x] *None of the Above*

Question 10 1 pts

Select ALL the fragments (*i.e., decomposed schema*) from δ that are in 3NF but not in BCNF.

Hint: Can you find a combined algorithm to check for both 3NF and BCNF at the same time?

- [x] $R_1(A,B,D,F)$
- [ ] $R_2(A,D,E,F)$
- [ ] $R_3(B,C,F)$
- [x] $R_4(C,E,F)$

Saving... Submit quiz