# CS-A1155 Databases, Homework 2

**Deadline**: April 30, 2024 at 16:00 (late submission until May 02, 2024 at 10:00 with 75% of the points)

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Please submit the solutions for the theoretical problems to the designated folder in A+ as a pdf file.

Please attend an exercise session (schedule can be found here).

EXERCISES MUST BE DONE INDIVIDUALLY!

At the start of the exercise session you can indicate wether you are willing to present/explain your solutions or not and a student will be picked at random to present, so **please make sure you arrive to your session on time**. If you won't be willing to do so your points for the theoretical problems will not be valid.

We are not trying to punish you by presenting, just making sure you actually did the homework yourself and creating a space for discussions. Thus, you need not have a perfect solution, nor even a correct one.

Note: If you have social anxiety or are unable to present for any reason, you can instead explain your working to the TA and in that case the TA will present the model solution!

Good luck with your homework!

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**Functional dependencies**

*email->name, phone, libCarNum*
*phone->name,email, libCarNum*
*name->phone,phone, email, libraryCardNumber*

1. (3p.) Consider the library database.

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   LibraryCustomer (name, phone, email, libraryCardNumber)   libCarNum->email,phone, name
   LibraryItem (ID, loanPeriod)   id->loanPeriod
   Book (ID, title, author, language, year)   ID ->title, author, language, year
   CD (ID, title, artist, year, length)   ID-> title, artist, year, lenght
   DVD (ID, title, year, length)   ID->title, year, length
   Loan (itemID, libraryCardNumber, startDate, endDate, returned)
   ```
   *libraryCardNumber, itemID -> startDate, endDate, returned*

   List all the non-trivial functional dependencies. You may assume that the emails and phone numbers are unique, and that one person can only own one library card.

2. (3p.) Consider the relation $R(A, B, C, D, E, F)$, and the functional dependencies $A \rightarrow F$, $D \rightarrow C$, $CF \rightarrow BE$, $B \rightarrow DE$. Which of the following functional dependencies can be derived from the listed ones? Justify your answer by computing the closures of the left-hand-sides.

   (a) $AD \rightarrow E$.   *A->F, D->C, CF->BE*

   (b) $BC \rightarrow ABCDEF$.

   (c) $AC \rightarrow BDEF$.   *A->F, CF->BE, B->DE*

3. (4p.) Consider the following table with schema $R(A, B, C, D, E)$ and tuples

   | A | B | C | D | E |
   |------|----|---|------|------|
   | "123" | 14 | 1 | "A" | 0.12 |
   | "123" | 42 | 0 | "A" | 0.12 |
   | "417" | 32 | 0 | "G" | 1.52 |
   | "510" | 14 | 1 | "G" | 0.75 |
   | "810" | 12 | 1 | "C" | 0.75 |
   | "811" | 12 | 1 | "E" | 0.12 |

   Which of the following functional dependencies are possible considering the contents of the table? Justify your answers.

   (a) $A \rightarrow E$.

(b) $E \rightarrow A$.

(c) $D \rightarrow ABE$.

(d) $DC \rightarrow ABCDE$.

(e) $B \rightarrow C$.

(f) $BD \rightarrow E$.

**BCNF**

4. (6 p.) Consider the relational schema $R(A, B, C, D)$, and the dependencies $AB \rightarrow C$, $B \rightarrow D$, $C \rightarrow A$, and $D \rightarrow A$.

   (a) (3p.) Is the relation in BCNF? If not, prove this by counting the closures, and then use the decomposition algorithm until all the relations are in BCNF. Document each step and prove that the decomposed relations are in BCNF.

   (b) (2p.) What functional dependencies hold in the new relations?

   (c) (1p.) List for each relation which attributes form the minimal key.

5. (4p.) Consider the relational schema $R(A, B, C, D, E, F)$ with functional dependencies $AE \rightarrow CF$, $B \rightarrow F$, $C \rightarrow B$, $CDE \rightarrow A$, and $F \rightarrow DE$. Prove that the relation is not in BCNF and use the decomposition algorithm to break it to relations that are in BCNF. Document all the steps and reason why the resulting relations are in BCNF.