CS377, Fall 2022

Assignment 5

Due: Monday December 5 at 11:59PM on Gradescope [Late submissions: see policy on Canvas]

[60 points] Problem 1: Functional Dependencies and Boyce-Codd Normal Form

You have been hired to improve the design of a database for an online gaming service named Dynamite. The database should hold customer information, game information and sales. Consider the game sales relation R with the following schema:

```
R(saleID, saleTime, gameTitle, gamePublisher, publisherCutPercent,
     quantity, price, customerID, address, creditCardNo)
```

and the functional dependencies S:

- `gameTitle` $\rightarrow$ `price`
- `gameTitle` $\rightarrow$ `gamePublisher`
- `gamePublisher` $\rightarrow$ `publisherCutPercent`
- `customerID` $\rightarrow$ `address`
- `customerID` $\rightarrow$ `creditCardNo`
- `saleID` $\rightarrow$ `saleTime, gameTitle, quantity, price, customerID`

Answer the questions below, while following the same systematic approach and **detailed** steps demonstrated in the long BCNF example available on Canvas (23-exercise-BCNF-long.pdf). You should follow this systematic approach while also utilizing the speed-ups and shortcuts we discussed in class for BCNF decomposition, but always provide a proper justification when you do so! Again, refer to the BCNF example linked above. (Failure to follow this detailed approach will result in a grade penalty for A5.)

You can use the following symbols in your work, for simplicity. But please express the final answer in terms of the original attribute names.

```
A = gameTitle, B = price, C = gamePublisher, D = publisherCutPercent, E = customerID,
F = address, G = creditCardNo, H = saleID, I = saleTime, J = quantity
```

1. [18 points] Which of the functional dependencies in S violate BCNF? Justify your answer.
2. [42 points] Employ the BCNF decomposition algorithm to obtain a lossless decomposition of R into a collection of relations that are in BCNF. Make sure it is clear which relations are in the final decomposition and *project* the dependencies onto each relation in that final decomposition. Because there are choice points in the algorithm, there may be more than one correct answer.

[25 points] Problem 2: FDs and Candidate Keys.

Consider the following relation:

Tuple#	A	B	C
#1	10	b1	c1
#2	10	b2	c2
#3	11	b4	c1
#4	12	b3	c4
#5	13	b1	c1
#6	14	b3	c4

(a) Given the above instance of this relation, which of the following FDs *may hold* in this relation? If a FD cannot hold, explain *why* by specifying exactly the *tuples* that cause the violation:

1. A → B
2. B → C
3. C → B
4. B → A
5. C → A

(b) Does the above relation have a *potential* candidate key? If yes, what is it? If it does not, why not?

[**15 points**] **Problem 3: A decomposition that fails to preserve dependencies.**

Suppose we have a relation: `R(movie, theatre, city)` with the functional dependencies S:

- `theatre` → `city`
- `movie, city` → `theatre`

The FD theatre → city violates BCNF, and applying the BCNF decomposition algorithm, we get two new relations:

- R1(theatre, city) with one FD: theatre → city
- R2(theatre, movie) with no FDs

Create small instances of R1 and R2 that satisfy their own FDs, but when natural-joined together, violate one of the original FDs. You can optionally use the empty tables created in the sample Latex template file 'A5LatexSamples.tex' to answer this question.

Submission Instructions:

- Submit your **typed** answers on Canvas, in a single file named **A5Answers.pdf**. You may use any word-processing software you like, then convert the file with the answers to PDF.
- Many academics use LaTeX. It produces beautifully typeset text and handles mathematical notation well. We uploaded a LaTeX sample file **A5LatexSamples.tex** in the A5 folder on Canvas to give you a good starting point (we strongly encourage you to get some hands-on experience with LaTeX!). Whatever software you choose to use, you need to produce a final document in PDF format, and you must call it 'A5Answers.pdf'.

Honor Code: Solve this assignment without collaborating with classmates and without consulting external/online resources. The assignment is governed by the College Honor Code and Departmental Policy. Remember, any work you submit must be your own; otherwise you risk being investigated by the Honor Council and facing the consequences of that.

Please remember to include the following comment at the beginning of your pdf:

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