Database Systems, CSCI 4380-01
Homework # 2
Due Monday September 20, 2021 at 11:59:59 PM

Homework Statement. This homework is worth 5% of your total grade. It has 10 questions with 10 points for each question. You are required to complete at least 4 questions (equivalent of 2 points). Any points that you did not complete will be added to Midterm #1. (For example, if you only solved 4 queries worth 2 points, your Midterm #1 will be worth 3% more).

Remember, practice is extremely important to do well in this class. I recommend that not only you solve this homework in its entirety, but also work on homeworks from past semesters, which can be found here:

`http://cs.rpi.edu/~sibel/DBS_Past_Materials/`

This homework aims to test normalization theory and a tiny bit more of relational algebra.

Database Description. This is the same board game dataset from last hw, loosely based on the `boardgamegeek` site. Refer to hw1 about any details for the following relations:

`games(gameid, name, year, publisher, min_players, max_players, min_age_rec, playtime_min, playtime_max, iscooperative, description, link)`
`gametypes(gameid, gametype)`
`gamecategories(gameid, category)`
`gamemechanics(gameid, mechanic)`
`gamedesigners(gameid, designername)`
`onlinegamesites(siteid, url, price_per_month, notes)`
`gamesonsite(siteid, gameid, isfree, min_players, max_players)`
`gameprices(gameid, storename, price)`
`gamereviews(gameid, userid, review_text, review_date, stars, num_likes)`
`awardsnominations(gameid, awardname, year, iswinner)`

Question 1. Write the following queries using relational algebra. You may use any valid relational algebra expression, break into multiple steps as needed. However, please make sure that your answers are well-formatted and are easily readable. Also, pay attention to the attributes required in the output!

(a) Return the `gameid, name` and `designername` of games that are either in `'Exploration'` or `'Adventure'` categories, but not in both categories.

(b) Return the `gameid, name` of games that are available in exactly two online sites.

Suppose you are given the following set of functional dependencies for relation $R(A, B, C, D, E, F, G, H)$.

$$\mathcal{F} = \{AB \rightarrow CD, AC \rightarrow DE, EF \rightarrow AG\}$$

which is decomposed into $R1(A, C, D, E)$, $R2(A, B, C)$ and $R3(A, B, F, G, H)$.

Use this relation to answer questions 2,3 and 4.

Question 2. Is this decomposition lossless? Show your work using the Chase decomposition algorithm.

Question 3. Find the projection of $\mathcal{F}$ into each decomposed relation, $R1, R2, R3$, given by F_1, F_2, F_3.

Additionally, check whether the decomposition is dependency preserving or not. Explain your answer. To do this, you must find if $F_1 \, union \, F_2 \, union \, F_3$ is equivalent to the original set, $\mathcal{F}$.

Question 4. Use the BCNF decomposition for the above set of functional dependencies, by decomposing using $AC \rightarrow DE$ first.

For each relation in the decomposition, show the functional dependencies and the key for that relation. Check if they are in BCNF.

If any of the resulting relations are not in BCNF, do any extra steps of BCNF decomposition to find relations that are in BCNF.

Question 5. You are given the following relation with the stated rules.

Restaurants(restaurant_name, state, street, city, zip, latitude, longitude, url, review_id, review_text, cuisine_type)

Given a restaurant_name and state, url is fixed, alternative given a URL, the restaurant name and state are fixed.

A given state, street, city and zip address has a specific latitude and longitude.

A latitude and longitude together also determine state, street, city and zip values.

Given a review_id, the review_text is fixed.

Given a URL, latitude and longitude, revivew_id is fixed.

1. List all the rules as functional dependencies. Make sure your final set of functional dependences are minimal.
2. List all keys for this relation.
3. State whether it is in BCNF or 3NF.
4. If it is not in 3NF, use the 3NF decomposition to convert it to relations in 3NF. Show your work by finding the functional dependencies projected into each relation, their keys and whether they are also in BCNF or not.
5. Discuss briefly if all the relations are in 4NF or not, why and why not.

SUBMISSION INSTRUCTIONS. Submit a single PDF or Text document for this homework using Submitty. No other format and no hand written homeworks please. No late submissions will be allowed.

If the Submitty for homework submissions is not immediately available, we will announce when it becomes available on Submitty.