

CSCI 4380 Fall 2021 Exam # 1

Student SGP6 DFM1

TOTAL POINTS

89.5 / 100

QUESTION 1

1 Question 1(a) 8 / 10

- ✓ - 0 pts checked
- 0 pts Correct
- 1 pts missing/incorrect selection (low deck feature)
- 1 pts missing/selection (NY state)
- 1 pts missing/incorrect selection (zero mileage)
- ✓ - 1 pts missing/incorrect selection (startdate)
10/05/2021
 - 2 pts missing or incorrect join (Trucks or TruckFeatures)
 - 2 pts missing or incorrect join (Rentals with the rest)
- ✓ - 1 pts missing/incorrect projection
 - 1 pts minor syntax errors
 - 2 pts incorrect logic (extra joins that change the meaning of query, etc.)
- 10 pts completely incorrect/missing

QUESTION 2

2 Question 1(b) 10 / 10

- ✓ - 0 pts checked
- ✓ - 0 pts Correct
- 1 pts missing/incorrect selection (large size)
- 2 pts missing or incorrect join (Rentals and Stores)
- 5 pts missing or incorrect join (Trucks with Stores and rest)
- 1 pts partially incorrect join (Rentals and Trucks, missing join condition)
- 2 pts partially incorrect join (Rentals and Trucks, missing renaming/projection)
- 2 pts missing/incorrect projection
- 1 pts minor syntax errors
- 2 pts incorrect logic (extra joins that change the meaning of query, etc.)

QUESTION 3

3 Question 1(c) 10 / 10

- ✓ - 0 pts checked
- ✓ - 0 pts Full credits
- 2 pts -2 missing or incorrect join (Pick up stores for Rental)
- 2 pts -2 missing or incorrect join (Drop off store for Rental)
- 1 pts -1 missing or incorrect join/select condition (state for pickup/dropoff)
- 1 pts -1 incorrect computation of non-renters (not all users, only renters)
- 3 pts -3 missing set subtraction/incorrect logic
- 2 pts -2 incorrect set subtraction (relations do not have the same schema/set subtraction before projection/subtracting different state dropoff/pickup, etc.)
- 1 pts -1 minor syntax errors
- 2 pts -2 other incorrect logic (extra joins that change the meaning of query, etc.)
- 10 pts -10 completely incorrect/missing

QUESTION 4

4 Question 2(a) 6.5 / 12

- 0 pts Correct
 - missing/incorrect fd, item -> itemtype description price
- ✓ - 3 pts fully
 - 1.5 pts partially
 - missing/incorrect fd, item store_id -> isavailable
 - 3 pts fully
 - ✓ - 1.5 pts partially
 - missing/incorrect fd, itemtype -> pickupfee deliveryfee

- 3 pts fully
- 1.5 pts partially
- 1 pts missing one attribute on the right side
- ✓ - 1 pts missing/incorrect key {item, store_id}
- 1 pts BCNF conclusion is incorrect wrt to fds
- 2 pts BCNF conclusion is not explained/incorrect explanation
- 1 pts BCNF explanation is insufficient / is logically flawed

QUESTION 5

5 Question 2(b) 12 / 12

- (i)
- 2 pts completely incorrect/missing
 - 1 pts incorrect/missing explanation

- (ii)
- 2 pts completely incorrect/missing
 - 1 pts incorrect/missing explanation

- (iii)
- 1 pts incorrect key
 - 2 pts incorrect 3NF conclusion
 - 1 pts incorrect/missing 3NF explanation

✓ - 0 pts Correct

- 1 pts incorrect/missing (helperid, username, mdate, task)

(username, mdate, street, state, city, zip, hours)
{username mdate → street state city zip hours}

- 1 pts incorrect/missing (username, mdate, street, state, city, zip, hours)

- 0.5 pts incorrect/missing fd username mdate → street state city zip hours

(helperid, name, phone) {helperid → name phone}

- 1 pts incorrect/missing (helperid, name, phone)

- 0.5 pts incorrect/missing fd helperid → name phone

(username, task, rate) {username task → rate}

- 1 pts incorrect/missing (username, task, rate)

- 0.5 pts incorrect/missing fd username task → rate

QUESTION 6

6 Question 2(c) 12 / 12

- ✓ - 0 pts Correct
- 2 pts Incorrect key
- 1.5 pts incorrect 4NF conclusion
- 1.5 pts incorrect 4NF explanation
- 2 pts incorrect BCNF conclusion
- 2 pts incorrect BCNF explanation
- 1.5 pts BCNF decomposition, (id,from,to,rate,size) is wrong/missing
- 1.5 pts BCNF decomposition, (id, feat, exstore) is wrong/missing
- 1 pts Minor errors in BCNF decomposition
- 0.5 pts Partially incorrect 4NF explanation
- 12 pts Completely incorrect/missing

QUESTION 7

7 Question 3 4 / 6

- 0 pts Factually correct, but shallow explanation
- 0 pts Correct and meaningful explanation
- ✓ - 2 pts Factually incorrect statements
- 6 pts Completely incorrect/missing

QUESTION 8

8 Question 4 12 / 12

- ✓ - 0 pts Correct
- ✓ - 0 pts Checked by TA
- 12 pts Completely incorrect or missing
- 3 pts First table is partially incorrect
- 5 pts All FDs are applied incorrectly
- 3 pts Some FDs are applied incorrectly
- 2 pts At least one FD is applied incorrectly
- 3 pts Missed application of FDs, leading to incorrect conclusion
- 3 pts Conclusion is missing or incorrect based on table
- 1 pts Conclusion is not explained

QUESTION 9

9 Question 5 15 / 16

- 0 pts Correct
- 16 pts Completely wrong / missing

✓ - **1 pts** one or two cardinalities are wrong

- **2 pts** three or more cardinalities are wrong

- **1 pts** one entity wrong or some keys are missing;
many attributes are missing

- **3 pts** multiple entities wrong or many
keys/attributes are missing

- **1 pts** one missing relationship

- **2 pts** two missing relationships

- **3 pts** three or four missing relationships

Write your answers in the box below only. Do not write on the back or outside the box.

Database Systems — CSci 4380

Midterm Exam #1

October 4, 2021

RCS ID: wangy58

@rpi.edu

Name: Yihang Wang

RIN #: 661956357

Rules. The exam is 110 minutes for a total of 100 points. Open book and notes. During the exam, you can refer back to the text books you already have with you or on your computer, any notes I have made available, and any course notes you took. You may not use a search engine to search outside of your personal notes and books.

Until the exam is over for everyone, you may not discuss the exam with anyone else in any form, shape, and on any platform. You may not receive help from anyone during the exam, and you may not provide answers or questions to anyone until the exam is over.

Read questions carefully and make any reasonable assumptions.

Question 1 (10*3=30 points). You are given the following database. The data model is described in detail in the last page of the exam.

```
stores(storeid, street, state, city, zip)
trucks(license, state, year, mileage, size)
truck_features(license, feature)
renters(username, password, fname, lname)
rentals(rentalid, license, pickup_storeid, dropoff_storeid, username, startdate, enddate, price)
```

- (a) Return the license plate and of size all trucks with a 'low deck' feature registered in the 'NY' state, that have zero mileage and is due to be picked up on '10/05/2021'.

R1 = project_{license} (select_{feature = 'low deck'} (truck_features))

R2 = select_{state = 'NY' and mileage = 0} (trucks * R1)

R3 = project_{lirene} (R2)

R4 = project_{lirene} (select_{enddate = '10/05/2021'} (R3 * rentals))

Return R4

Write your answers in the box below only. Do not write on the back or outside the box.

- (b) Return the license plate of all 'large' size trucks that are being picked up from a store in a state that is different than the state the truck is registered under.

$R1 = \text{project.} \{ \text{license} \} (\text{select-} \{ \text{size} = \text{'large'} \} \{ \text{trucks} \})$

$R2 (\text{license, storeid, state}) = \text{project.} \{ \text{license, storeid, state} \} (R1 \times \text{stores})$

$R3 (\text{license, storeid, state}, \text{pickup_storeid}) = \text{project.} \{ \text{license, storeid, state, pickup_storeid} \} (R2 \times \text{rentals})$

$R4 (\text{license, storeid, state}, \text{pickup_storeid, pickup_state}) = \text{project.} \{ \text{license, storeid, state, pickup_storeid, pickup_state} \} (\text{select-} \{ \text{license} = \text{license} \text{ and state} <> \text{state} \} \text{ and pickup_storeid} = \text{storeid}) (R3 \times \text{stores})$

$R5 (\text{license}) = \text{project.} \{ \text{license} \} R4$

Return R5.

- (c) Return the first and last name of all renters who never had a rental in which the drop off store was in the same state as the pick up store.

$R1 (\text{username, pickup state}) = \text{project.} \{ \text{username, state} \} (\text{select-} \{ \text{pickup store id} = \text{storeid} \} \{ \text{rentals} \times \text{stores} \})$

$R2 (\text{username, dropoff state}) = \text{project.} \{ \text{username, state} \} (\text{select-} \{ \text{dropoff store id} = \text{storeid} \} \{ \text{rentals} \times \text{stores} \})$

$R3 (\text{username}) = \text{project.} \{ \text{username} \} (\text{select-} \{ \text{pickup state} = \text{dropoff state} \})$

$(R1 \times R2) - R3$

$R4 (\text{username}) = \text{project.} \{ \text{username} \} (\text{renters})$

$R5 (\text{fname, lname}) = \text{project.} \{ \text{fname, lname} \} (R4 \times \text{renters})$

Return R5.

Write your answers in the box below only. Do not write on the back or outside the box.

Question 2 (12*3=36 points). Suppose you are given the following relations to add to the data model in the appendix. Answer questions regarding each additional relation below. Please do not use abbreviations' attribute names are shortened to make writing easier.

- (a) The truck company also sells many moving supplies like boxes, bags, tape, etc.

Supplies(item, itemtype, store_id, isavailable, description, price, pickupfee, deliveryfee)

For each item, there is a specific item type, description, and price.

Whether a specific item is available or not depends on the store as not all stores carry all the items.

An item's pickup and delivery fee depends solely on the item type.

(i) List all functional dependencies that are implied by the above description.

(ii) Based on your functional dependencies, list all the keys and state whether this relation is in BCNF or not. Explain why or why not.

(i) $\{store_id \rightarrow isavailable\}, (itemtype \rightarrow pickupfee, deliveryfee)$

(ii) keys: item, itemtype, description, price, store_id

for $store_id \rightarrow isavailable / store_id$ (not superkey)

Thus they are not in BCNF

- (b) We store a new relation for booking some help for moving for various tasks, provided by helpers (helperid, name, phone) and booked by users (username) for a specific task.

~~MovingHelp(helperid, name, phone, username, task, mdate, street, state, city, zip, rate, hours)~~

~~helperid → name phone~~

~~username mdate → street state city zip hours~~

~~username task → rate~~

~~PKQ Can a user book helpers on multiple dates? Answer yes/no and provide a one sentence explanation.~~

~~(ii) Can a user pay two different helpers a different price for the same task? Answer yes/no and provide a one sentence explanation.~~

~~(iii) What are the keys? Is this relation in 3NF? Please explain why or why not.~~

~~(iv) If the relation is not in 3NF, use the 3NF decomposition to find relations that are in 3NF. List each relation and the projected functional dependencies.~~

(i) Yes, since mdate is not in any of right-hand-sided fds.

(ii) No, since for a specific username and task, rate is unique.
(username task → rate)

(iii) Keys helperid, username, mdate, task

for helperid → name, phone: helperid is not super key
and (name, phone) are not primekey attributes
so it is not in 3NF

(iv) R1 (helperid, name, phone) {helperid → name, phone}

R2 (username, mdate, street, state, city, zip, hours) {username, mdate → street, state, city, zip, hours}

R3 (username, task, rate) {username, task → rate}

No relation can be removed..

add one key to contain all the attributes of one of keys.

R4 (helperid, username, mdate, task)

- (c) We store rental rates for a specific truck size and specific truck features (ifeat). Some stores may be excluded from a given rate (exstore).

$\text{RentalRates(id, from, to, rate, size, ifeat, exstore)}$

This relation has the following functional dependencies:

$\text{id} \rightarrow \text{from to rate size}$
 $\text{id} \Rightarrow \text{ifeat}$
 $\text{id} \Rightarrow \text{exstore}$

- (i) What are the key(s)?
- (ii) Is this relation in BCNF? Explain why or why not.
- (iii) If it is not in BCNF, use BCNF decomposition to get relations that are in BCNF.
- (iv) For all the resulting relations after BCNF decomposition, list if they are in 4NF or not. If not, explain how they can be made into 4NF.

(i) Keys: $\text{id, ifeat, exstore}$

(ii) No, for $\text{id} \rightarrow \text{from to rate size}$: id is not superkey
so it is not in BCNF.

(iii) take $\text{id} \rightarrow \text{from to rate size}$ out.

$\text{id} \neq \{\text{id, from, to, rate, size}\}$ $\text{id} \rightarrow \text{from to rate size}$
 $R_1(\text{id, from, to, rate, size})$ $F_1 = \{\text{id} \rightarrow \text{from to rate size}\}$
 $R_2(\text{id, ifeat, exstore})$ Both in BCNF.

(iv) $\text{id} \Rightarrow \text{ifeat}$ Both fds are not all attributes, this relation is not in
 $\text{id} \Rightarrow \text{exstore}$ (take R2 decompose) 4NF.

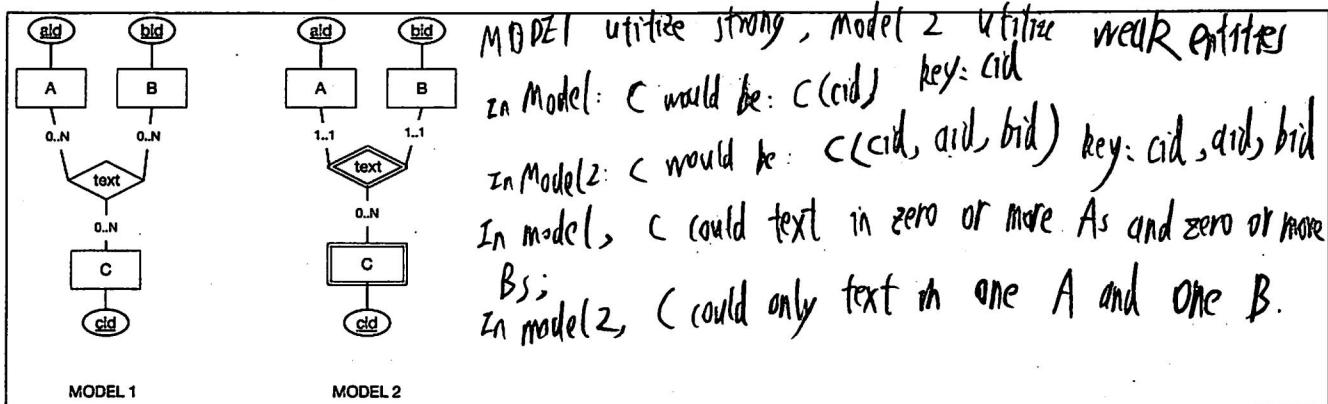
$R_3(\text{id, ifeat})$ $\text{id} \Rightarrow \text{ifeat}$
key: id, ifeat in 4NF

$R_4(\text{id, exstore})$ $\text{id} \Rightarrow \text{exstore}$ in 4NF
key: id, exstore

so final result : $R_1(\text{id, from, to, rate, size})$ $F_1 = \{\text{id} \rightarrow \text{from to rate size}\}$
 $R_2(\text{id, ifeat})$ $F_2 = \{\text{id} \Rightarrow \text{ifeat}\}$
 $R_4(\text{id, exstore})$ $F_3 = \{\text{id} \Rightarrow \text{exstore}\}$

Write your answers in the box below only. Do not write on the back or outside the box.

Question 3 (6 points). You are given two alternate models in the following Entity-Relationship diagram. In which ways are these models similar or different? Give a short explanation.



Question 4 (12 points). You are given:

Relation $R(A, B, C, \bar{D}, E, F, G)$ with $F = \{\bar{A}C \rightarrow EF, EG \rightarrow A, BF \rightarrow CD, CG \rightarrow D, CE \rightarrow G\}$

and decomposition: $R1(A, B, C, E), R2(A, B, E), R3(C, E, F, G), R4(A, B, C, D)$.

Determine whether this decomposition is lossy or not using the Chase Decomposition algorithm. Show your work.

	A	B	C	D	E	F	G	
R1	a	b	c	d1	e	f1	g1	\Rightarrow applies $AC \rightarrow EF$ in R4
R2	a	b	c2	d2	e	f2	g2	$R4 \downarrow a \ b \ c \ d \ e \ f \ g4$
R3	a3	b3	c	d3	e	f	g	\Rightarrow applies $BF \rightarrow CD$ in R4
R4	a	b	c	d	e4	f4	g4	$R4 \downarrow a \ b \ c \ d \ e \ f \ g$ ↑ no subscripts! so this is lossy
	\Rightarrow applies $CE \rightarrow G$ in R1							
R1	a	b	c	d1	e	f1	g	
	\Rightarrow applies $EG \rightarrow A$ in R3							
R3	a	b3	c	d3	e	f	g	
	\Rightarrow applies $AC \rightarrow EF$ in R1							
R1	a	b	c	d1	e	f	g	

Write your answers in the box below only. Do not write on the back or outside the box.

Question 5 (16 points). Create an Entity-Relationship diagram for the following database, capturing all the requirements below precisely. Make sure you list all the relevant attributes, underlining the keys. For each relationship, mark the participation constraints clearly (one-to-one, one-to-many, or many-to-many). If you do not find a natural key for an entity, feel free to add an id attribute.

You are creating a database that will be the next big social media hit. It is for audio only.

In this database, you store users. Each user has an email, name, password, a phone number, rank of importance and whether active or not. Emails are unique in the database. A user may invite another user. For each invitation, there is a specific date. Users may invite many users, but each user is invited by a single user. A user may block zero or more users, and users may be blocked by zero or more users.

There are topics. For each topic, there is a unique name. Topics also have a description. Topics can be related to zero or more topics.

There are rooms, identified with an id. Each room has a name and a moderator which is a user.

There are events. Events take place on a specific start and end date and time. Event have titles and rating. Each event takes place in a specific room, but rooms can have many events. On a given start and end date and time, there may be many events but only one in a specific room. Each event has one or more topics and each topic can be related to multiple events. For each event, there are users who are participants in a discussion. For each event, there are also users who are listeners. Participants can be many for each event, and events can have many participants. Listener can also be many for each event, and events can have many listeners.

There are recordings. For each recording, there is an id, duration and an audio file. Each recording is for a specific event.

Please draw your answer in the box on the next page.

