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

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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_{license} (R2)

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

Return R4

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(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 = project_{license}(select_{size = 'large'} (trucks))
R2(license, storeid, state) = project_{license, storeid, state} (R1 * stores)
R3(license, storeid, state, pickup_storeid) = project_{license, storeid, state, pickup_storeid} (R2 * rentals)
R4(license, storeid, state, pickup_storeid, pickup_state) = project_{license, storeid, state, pickup_storeid, state} (select_{license = license and state <> state and pickup_storeid = storeid} (R3 X stores)
R5(license) = project_{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(username, pickup state) = project_{username, state} (select_{pickup storeid = storeid} (rentals * stores)
R2(username, dropoff state) = project_{username, state} (select_{dropoff storeid = storeid} (rentals * stores)
R3(username) = project_{username} (select_{pickup state = dropoff state} (R1 * R2)
R4(username) = project_{username} (renters) - R3
R5(fname, lname) = project_{fname, lname} (R4 * renters)
return R5.

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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 → isavailable), (itemtype → pickupfee, deliveryfee)

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

for store_id → isavailable, store_id is not super key.

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`

(i) 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-handsided 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 relations 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).

`RentalRates(id, from, to, rate, size, ifeat, exstore)`

This relation has the following functional dependencies:

`id` → `from to rate size`
`id` ⇒ `ifeat`
`id` ⇒ `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: id, ifeat, exstore

(ii) No. for id → from to rate size. id is not super key so it is not in BCNF.

(iii). take id → from to rate size out.

id += { id, from, to, rate, size } id → from to rate size

R1 (id, from, to, rate, size) F1 = {id → from to rate size}

R2 (id, ifeat, exstore) Both in BCNF.

(iv.) id ⇒ ifeat Both fds are not all attributes, this relation is not in

id ⇒ exstore (take R2 decompose) 4NF.

R3(id, ifeat) id ⇒ ifeat

key: id, ifeat in 4NF

R4(id, exstore) id ⇒ exstore in 4NF

key: id, exstore

so final result : R1 (id, from, to, rate, size) F1 = {id → from to rate size}

R3(id, ifeat) F2 = {id ⇒ ifeat}

R4 (id, exstore) F3 = {id ⇒ exstore}

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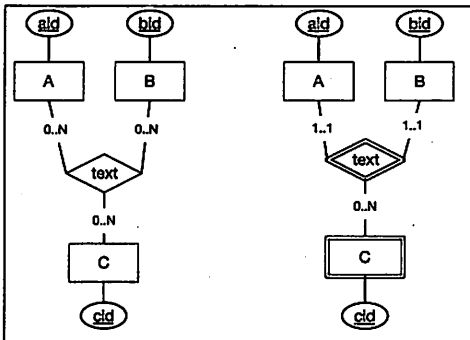
Question 3 (6 points). You are given two alternate models in the following Entity-Relationship diagram. In which ways are these models similar or different? Give a short explanation.



MODEL 1 MODEL 2

MODEL 1 utilize strong, model 2 utilize weak entities
In Model: C would be: C(cid) key: cid
In Model2: C would be: C(cid, aid, bid) key: cid, aid, bid
In model, C could text in zero or more As and zero or more Bs;
In model2, C could only text in one A and one B.

Question 4 (12 points). You are given:
Relation $R(A, B, C, D, E, F, G)$ with $F = \{AC \to EF, EG \to A, BF \to CD, CG \to D, CE \to G\}$

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
R2	a	b	c2	d2	e	f2	g2
R3	a3	b3	c	d3	e	f	g
R4	a	b	c	d	e4	f4	g4

⇒ apply $CE \to G$ in R1

R1	a	b	c	d1	e	f	g

⇒ apply $EG \to A$ in R3

R3	a	b3	c	d3	e	f	g

⇒ apply $AC \to EF$ in R1

R1	a	b	c	d1	e	f	g

⇒ apply $AC \to EF$ in R4

R4	a	b	c	d	e	f	g4

⇒ apply $BF \to CD$ in R4

R1	a	b	c	d	e	f	g

↑ no subscripts! so this is lossless

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.

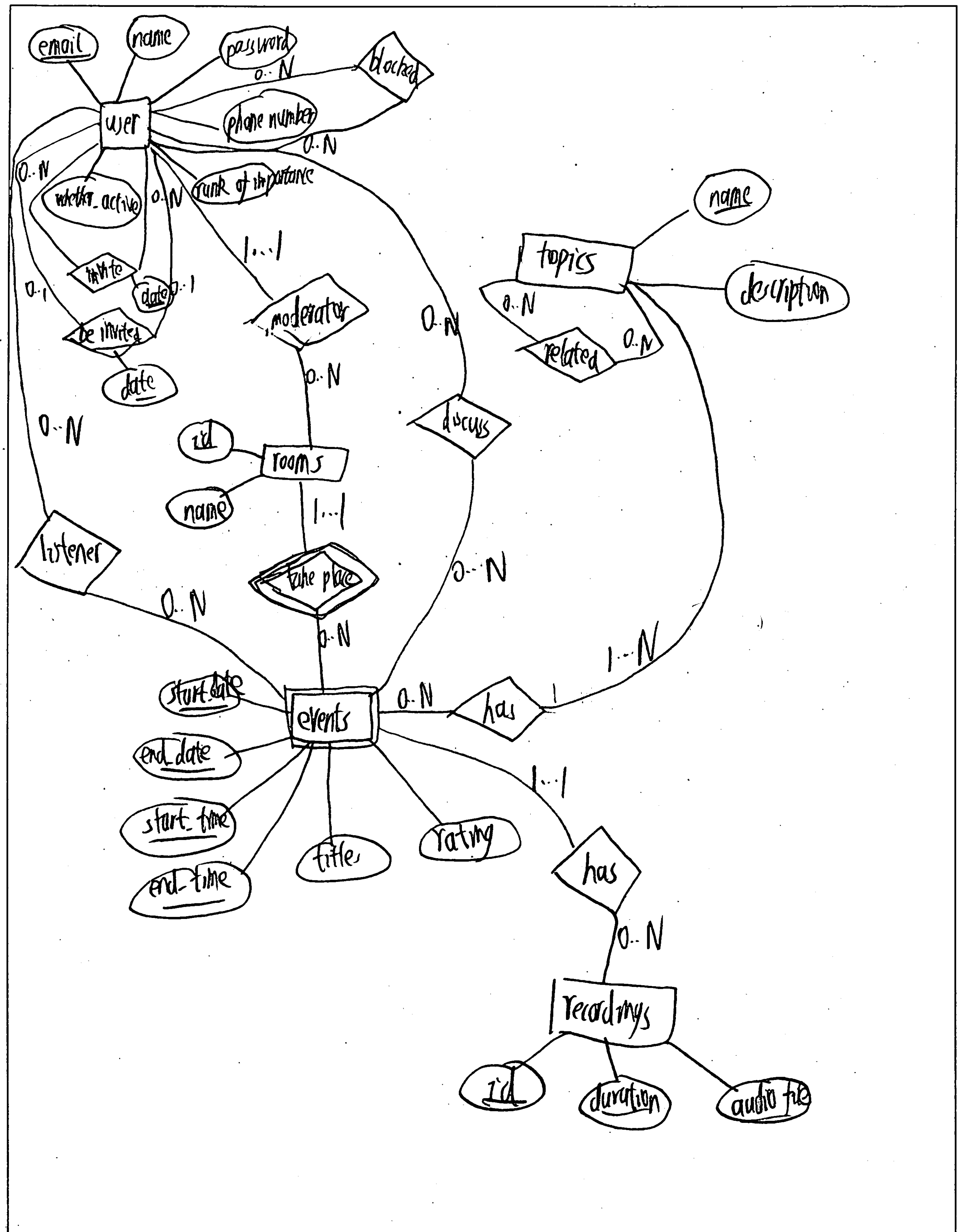
There are topics. For each topic, there is a unique name. Topics also have a description. Topics can be related to zero or more topics.

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.


email
name
password
blocked
user
phone number
whether_active
rank of importance
invite
date
be invited
date
moderator
rooms
id
name
topics
name
description
related
discuss
listener
take place
events
start_date
end_date
start_time
end_time
title
rating
has
has
recordings
id
duration
audio file
0..N
0..1
1...1
1..N
1..1