- Database 1

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Department of Computer Science
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COMP.3090 Midterm

Closed Book, 75 Minutes
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Problem	Score	
1	(40%)	24
2	(26%)	13
3	(34%)	20
EC	(10%)	0
Total	(100%)	57

NOTE: Write clearly — if your handwriting can not be read easily, your exam will not be graded.

Problem 1

(8 points each question)

Given the following schema:

movies (title, year, length, genre, studioName)
stars (name, address, gender, birthdate)
starsIn (title, year, name)

Write the following queries in Relational Algebra.

A Find the title of movies made by studio MGM.

8

$\Pi_{(title)}\left(\sigma_{(studioName = 'MGM')} Movies\right)$

$\pi_{title}\left(\sigma_{(studioName = 'MGM')} Movies\right)$

B Find the name and address of stars who have starred in "Star Wars".

6

$R_1 := \left(\Pi_{(name\ AND\ Address)} Stars\right) \bowtie_{(title = 'Star\ Wars')} StarsIn$

$\Pi_{(R_1)}$

$\pi_{name, address}\left(\sigma_{title = 'Star\ War'}\right)(Stars \bowtie StarsIn)$

StarsIn

C Find the name of stars who have starred in both action movie and sci-fi movie.

4

① $R_1 := (\Pi_{(name)}\ StarsIn \bowtie_{(genre = 'action')} movies)$

② $R_2 := (\Pi_{(name)}\ StarsIn \bowtie_{(genre = 'sci-fi')} Movies)$

③ $R_3 = R_1 \cap R_2$

④ ~~$\Pi_{(name)}\ R_3$~~

$R_1(\Pi_{name}(genre = 'action')\ (StarsIn \bowtie movie))$

$R_2(\Pi_{name}\ (genre = 'sci-fi')\ (StarsIn \bowtie movie))$

$R_3 = R_1 \cap R_2.$

D Find the name of stars who have starred in at least two movies.

6

$\Pi_{(name)}\ (\rho_{S1}(title, year, name) \bowtie_{(S1.title = StarsIn.title\ StarsIn)}$

$S1.year = StarsIn.year$

$S1.name = StarsIn.name$

$S1.title = StarsIn.title$

~~$S1.year = StarsIn.year$~~

~~$S1.name = StarsIn.name$~~)

~~$\Pi_{(name)}$~~

$\Pi_{(name)}((\rho_{S1}(StarsIn) \bowtie StarsIn)$ ~~$S1.title$~~

$S1.name = StarsIn.name$

$S1.year != StarsIn.year$

$S1.tittle != StarsIn.title)$

E Find the name of stars who have starred in exactly one movie.

0.

$$\Pi_{(name)} \left(\rho_{S1(Title, year, name)} \bowtie_{(S1.title = StarsIn.title \; \wedge \; S1.year = StarsIn.year \; \wedge \; S1.name = StarsIn.name)} StarsIn \right)$$

~~$\Pi_{(name)}$~~

$R_1 : \Pi_{name}(\rho_{Si}(starIn))$

$R_2 = D.$

$R_3 = R_1 - R_2.$

Problem 2

(26 points)

Consider a relation with schema R(A,B,C,D) and Functional Dependency rules $AB \rightarrow C$, $AD \rightarrow B$, $BC \rightarrow D$, $BC \rightarrow A$

A (6 points)

Find all keys of R.

L	M	R
A	B	C
A	D	B
B	C	D
B	C	A

AD {B}

BC {D, A}

AB: {C}

Keys: A, B, ABCD ×

A → A
B → B
C → C
D → D

AB → C
AD → B
BC → D
BC → A

AB → ABC
AD → ADB
BC → BCD
BC

A+ = A
B+ = B
C+ = C
D+ = D

L	M	R
	ABCD	

A^+

AB += ABCD
AC += AC
AD += ADBC
BC += BCDA
BD += BD
CD += CDAB.

AB = ABC
AC = AC
AD = ABCD * all AD in card
BC = ABCD * all BC in card
BD = BD
CD = CD

B (10 points)

What is BCNF? Is R in BCNF? Why?

①

Boyce-Codd Normal form, BCNF: A condition for normalizing anomalies in databases

If there is a functional dependancy $X \rightarrow Y$ that satisfies R, then X must be a superkey for R.

②

R is ~~not~~ in BCNF, because we have violations

$BC \rightarrow D$

$BC \rightarrow A$

BC is ~~Not~~ a superkey

C (10 points)

What is 3NF? Is R in 3NF? Why?

/ 10

①

Third normal form: A condition less strict than BCNF used for normalizing a database. If there is a functional dependancy $X \rightarrow Y$ that satisfies R, then one of the following must be true:

- X is a superkey for R ✓
- OR. Y is a primary attribute of R ✓

②

R is in 3NF because for all FD's $AB \rightarrow C$, $AD \rightarrow B$, $BC \rightarrow D$, $BC \rightarrow A$

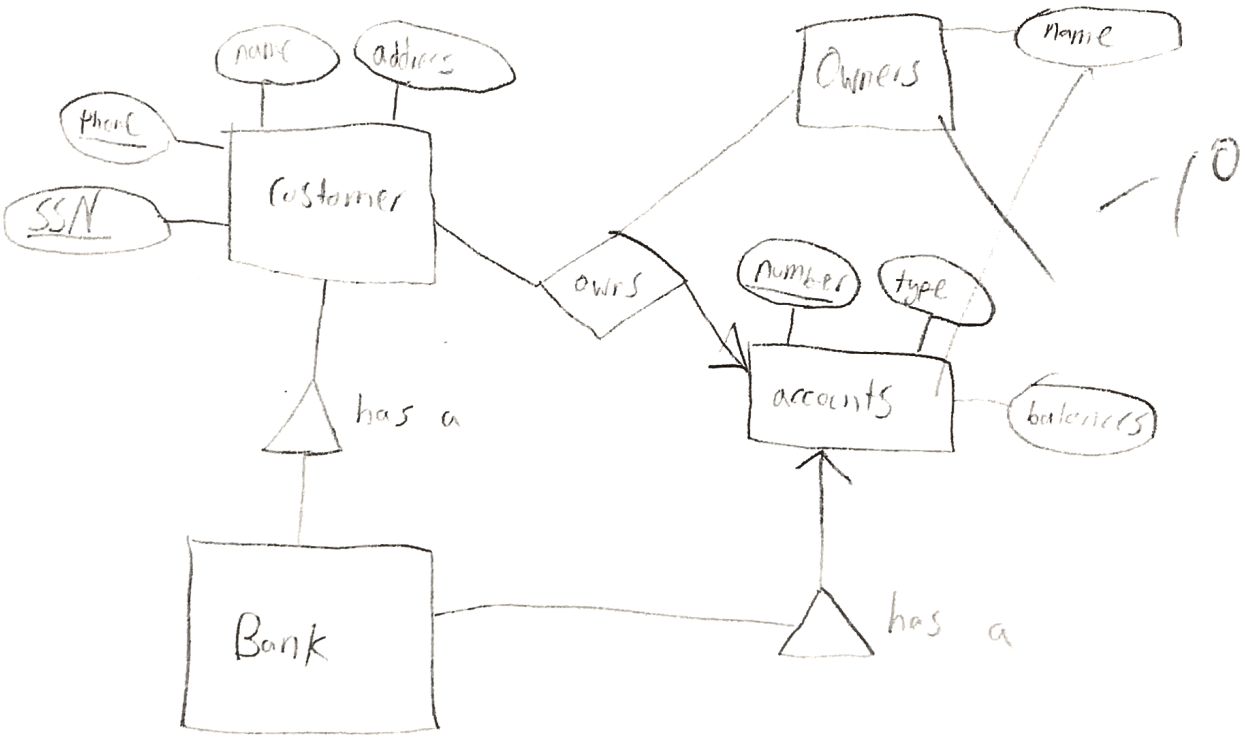
A, B, C, and D are primary attributes.

Problem 3

(34 points) 10

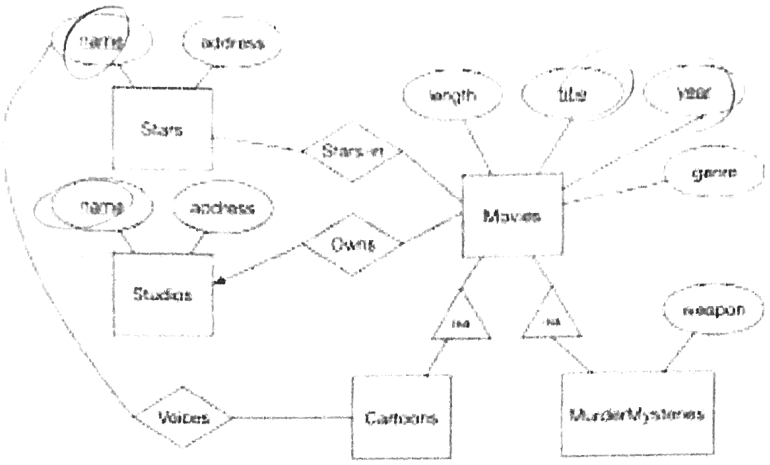
A (20 points)

Design a database for a bank, including information about customers and their accounts. Information about a customer includes their name, address, phone, and Social Security number. Accounts have numbers, types (e.g., saving, checking) and balances. Also record the customer(s) who own an account. Draw the E/R diagram for this database. Be sure to include arrows where appropriate, to indicate the cardinality of a relationship.



B (14 points) 10

Convert the following E/R diagram to relational database schemas.



Movies (length, title, year, genre, starName, StudioName)

Cartoons (length, title, year, genre, voices StarName)

MurderMysteries (length, title, year, genre, weapon)

Studios (name, address)

Stars (name, address, movieTitle, MovieYear)

-04

Problem Extra Credit

(10 points) 0

Using the same schema as in Problem 1, write the following query in Relational Algebra:
Find the name of stars who have starred in every movie made by studio MGM.

// title of every MGM movie

① $R_1 := \Pi_{title}(\sigma_{(studioname = 'MGM')} Movies)$

② $R_2 := R_1 \bowtie_{(R_1.title = StarsIn.title)} StarsIn$ // StarsIn of every MGM movie

③ $R_3 := R_2 \bowtie_{(R_2.title = R_{2a}.title \text{ AND } R_2.name = R_{2a}.name)} \rho_{R_{2a}}(R_2)$ renaming

$R_1 \leftarrow \Pi_{title}(\sigma_{studioname = 'MGM'} Movies \bowtie StarIn)$

$R_2 \leftarrow \Pi_{name}(R_1)$

$S \leftarrow \Pi_{title, year}(\sigma_{studioname = 'MGM'} Movies)$

$T \leftarrow \Pi_{title, name, year}(starIn)$

$temp1 \leftarrow \Pi_{name}(T)$

$temp2 \leftarrow \Pi_{name}(S \times temp1 - T)$

$result \leftarrow \Pi_{name}(stars \bowtie (temp1 - temp2))$