

COL362 / COL632 Minor 1

Divyanshu Agarwal

TOTAL POINTS

26.5 / 38

QUESTION 1

4 pts

+ 0.5 pts Partially correct 2.b.ii

✓ + 0 pts Incorrect / Not attempted 2.b.ii

1.1 2 / 2

✓ + 1 pts Proof of AB being a superkey

✓ + 1 pts Proof of AB being minimal

+ 0 pts Both reasons and their proofs not provided or incorrect

QUESTION 3

4 pts

3.1 2 / 2

✓ + 2 pts Correct argument for no rows because of Genre being varchar(5)

+ 2 pts Ignored varchar(5) but correct argument for NULL handling

+ 0 pts Incorrect / Not Attempted

1.2 2 / 2

✓ + 2 pts correct with proper explanation

+ 1 pts without proper proof

+ 0 pts incorrect

3.2 0 / 1

+ 1 pts Correct, Explanation is present about NULL

+ 0.5 pts Partially correct, Length <= 120 mentioned but nothing about ignoring NULL

✓ + 0 pts Incorrect / Not Attempted

QUESTION 2

4 pts

2.1 2 / 2

✓ - 0 pts Both are Correct (2.a.i and 2.a.ii)

- 0.5 pts Partially correct 2.a.i

- 1 pts Incorrect/ Not attempted 2.a.i

- 0.5 pts Partially correct 2.a.ii

- 1 pts Incorrect/ Not attempted 2.a.ii

3.3 0 / 1

+ 1 pts Correct, all except Length=null

✓ + 0 pts Incorrect / Not Attempted

2.2 0 / 2

+ 1 pts Correct 2.b.i

+ 0.5 pts Partially correct 2.b.i

✓ + 0 pts Incorrect / Not attempted 2.b.i

+ 1 pts Correct 2.b.ii

QUESTION 4

6 pts

4.1 3 / 3

✓ + 1 pts Reflexivity

✓ + 1 pts Augmentation

✓ + 1 pts *Transitivity*

- 3 pts Incorrect/Not Attempted

4.2 1 / 3

+ 0.5 pts Closure for W+, Y+, Z+, W+

✓ + 0.5 pts Closure for WY+

✓ + 0.5 pts Closure for XY+

✓ + 0.5 pts Closure for WZ+, WX+, XZ+, YZ+

✓ + 0.25 pts Closure for WXY+

+ 0.25 pts Closure for WYZ+

+ 0.25 pts Closure of WXYZ+

+ 0.25 pts For each attribute closure A+ above

with P belongs to A+, the closure of F+ will have A->P in it.

+ 0 pts Incorrect/Not Attempted

- 0.75 Point adjustment

💬 Where is XY ->Z? No rule application

QUESTION 5

5 3 / 3

✓ + 1 pts **Customers keys Correct**

✓ + 1 pts **CinemaShow keys Correct**

✓ + 1 pts **Reservations keys Correct**

+ 0 pts **Incorrect**

QUESTION 6

6 0 / 4

+ 4 pts Correct

+ 1 pts Mentions B->D violates BCNF condition

+ 2 pts Decomposed R(A,B,C,D,E) as R1(B,D) and

R2(ABCE) with explanation

+ 1 pts Shows individual breakdowns are lossless decomposition

+ 2.5 pts Chosen a decomposition of R and

shown that it is lossless.

✓ + 0 pts *Incorrect*

- 0.5 pts Not minimal

QUESTION 7

6 pts

7.1 1 / 1

✓ + 1 pts *Correct*

+ 0 pts incorrect

7.2 1 / 1

✓ + 1 pts *Correct*

+ 0 pts incorrect

7.3 1 / 1

✓ + 1 pts *Correct*

+ 0 pts incorrect

7.4 0 / 1

+ 1 pts *Correct*

✓ + 0 pts *incorrect*

7.5 1 / 1

✓ + 1 pts *Correct*

+ 0 pts incorrect

7.6 1 / 1

✓ + 1 pts *Correct*

+ 0 pts incorrect

QUESTION 8

8 2 / 2

✓ - 0 pts *Correct*

- 1 pts Partially Correct

- 2 pts Incorrect/Not Attempted

QUESTION 9

5 pts

9.1 1.5 / 2

✓ + 1.5 pts Query return name and age of people who are having the maximum age(multiple names if multiple people are having equal age as maximum) in the city they are born in and also have an age > 60.

+ 0.5 pts If multiple people with same name and same age are present and have maximum age in the city they are born in then such row is present only ones in output, i.e only distinct rows are present

+ 0 pts Incorrect

9.2 3 / 3

✓ + 3 pts Correct with explanation

+ 0 pts Incorrect

COL 362 / COL 632 - Minor1 Examination

06th February 2023

Exam time: 08:00 IST – 09:00 IST

Duration: 1 hour

Total Points: 38

Answer all questions.

This is **NOT** an open-book exam and **NOT** a collaborative exam. You are expected not to seek help from any other person(s) directly or indirectly (through web, forums, emails, messages etc.) for answering these questions.

Honor Code

I acknowledge the IITD Honor Code and confirm that the answers I have written for this exam are entirely my own.

1. I have **not** used the help of any person, organization or discussions during the examination in answering.
2. I have **not** given or received assistance in either answering, or providing specimen answer/hint/diagram/model/code during the exam.

I am fully aware that if found to have used unfair and disallowed practices in the examination, I am liable for strict action, which could include receiving a failing grade in this course, as well as other actions as deemed fit by the institute disciplinary committee.

Name: DIVYAN SHU AGARWAL

Entry number: 2020CS10343

Signature: Divyanshu

Date: 06 - Feb - 2023

Instructions

- Please make sure you have read the honor code in the front page, and accepted it by filling all the details.
- Please make sure you have no reference material, mobile phone, laptop, or any other device that could be construed to help you to answer this exam
- Questions are made as unambiguous as possible. In case you need, make appropriate and meaningful assumptions and state them clearly (only if required).
- Answer **only within the space given below each question**. If you need correct an answer, then you must neatly cross-out the incorrect answer you have filled, and write it separately at the end (write the question number correctly).

Questions

Question 1 4 points

Consider a relation R(A,B,C,D,E) with 5 attributes. Following functional dependencies hold:
 $AB \rightarrow C$, $BC \rightarrow AD$, $CE \rightarrow B$, $CD \rightarrow AE$. Answer the following with a *complete proof* (answers *without proof* will *not* fetch *any* marks)

- (a) Can AB be a candidate key?

$AB \rightarrow C$ $BC \rightarrow AD$ $CE \rightarrow B$ $CD \rightarrow AE$	$\xrightarrow{AB^+ = \{A, B\}}$ $AB \rightarrow C \text{ & } BC \rightarrow AD, \text{ so } AB^+ = \{A, B, C\}$ $\xrightarrow{AB \rightarrow BC \text{ & } BC \rightarrow AD, \text{ so }}$ $\Rightarrow AB \rightarrow AD, AB^+ = \{A, B, C, D\}$ $\xrightarrow{AB \rightarrow CD \text{ & } CD \rightarrow AE}$ <p>Let AB^+ denote closure of AB, ie attributes determined by AB</p> <p>since $AB^+ = \{A, B, C, D, E\}$</p> <p>so, Yes AB^+ can be a candidate key, as it determines all attributes & is minimal.</p>
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- (b) Can C be a candidate key?

No, C cannot be a candidate key.

this is because ~~there is~~ there is no functional dependency of the form $C \rightarrow \beta$

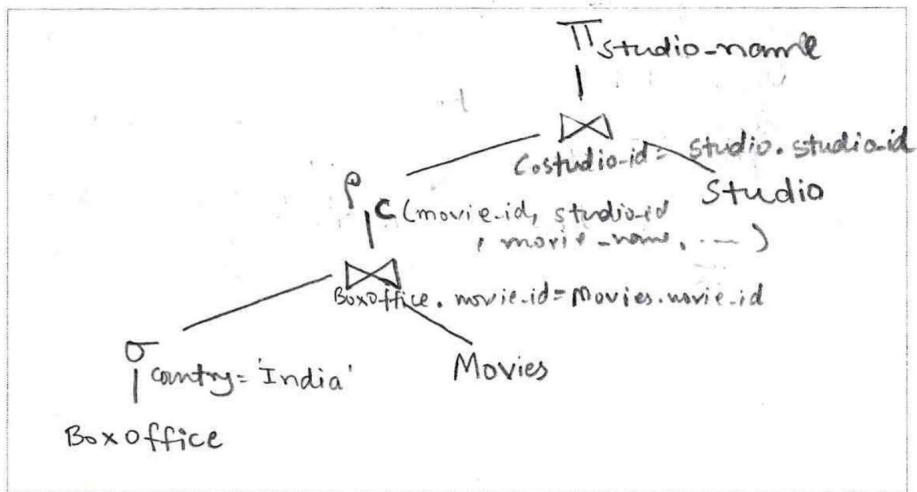
so, there is no set of ~~of~~ attributes other than C, that it uniquely determines. We are not able to expand $C^+ = \{C\}$ & in any no. of steps.

Question 2 4 points
 Consider the following schema (underline indicates key):

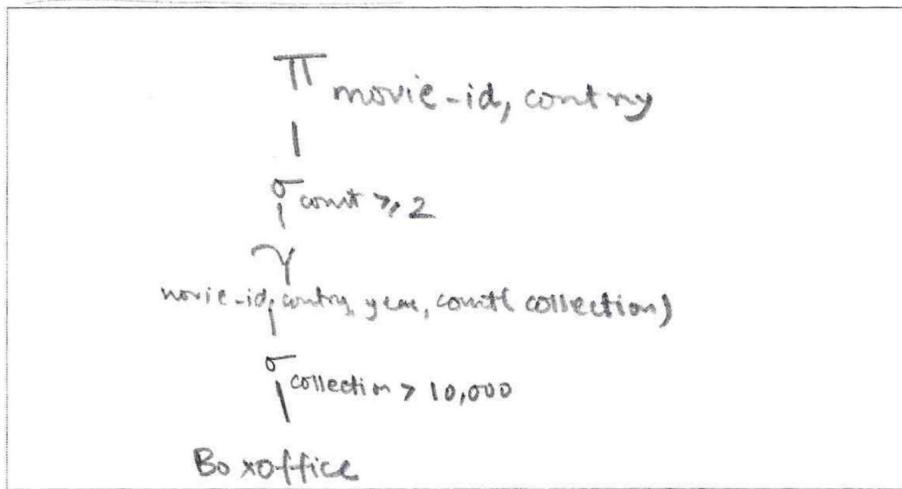
Movies (movie_id, movie_name, studio_id, year, budget)
 Studio (studio_id, studio_name, location)
 Boxoffice (movie_id, country, year, collection)

- (a) Write valid relational algebra expressions for the following queries expressed over this schema (assume there are no NULL values):

1. i. Return the names of the studios which have made movies that are released in India.

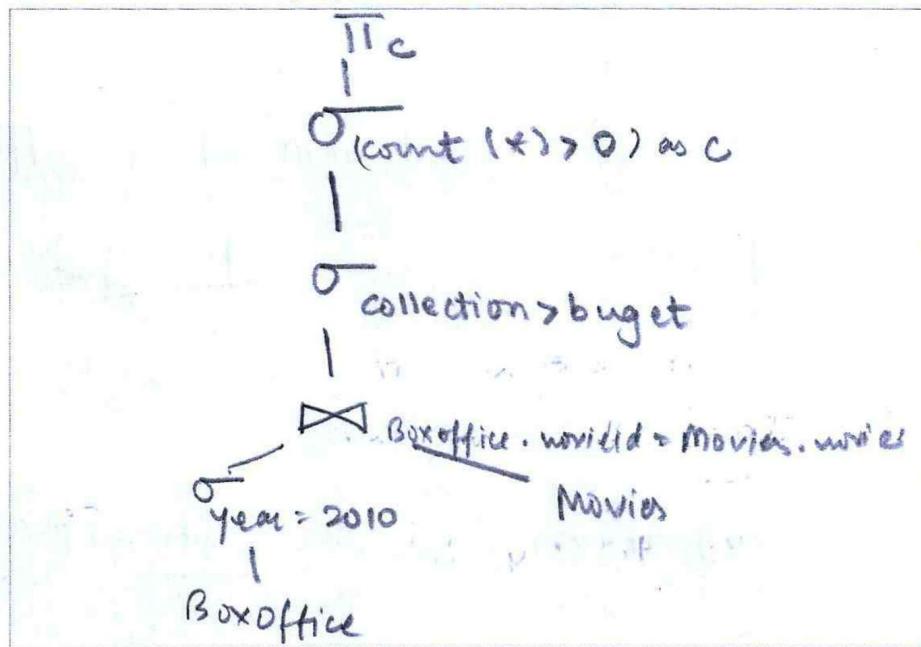


1. ii. Which are the countries and the movies that have collected more than 10,000 in at least two different years in a country.

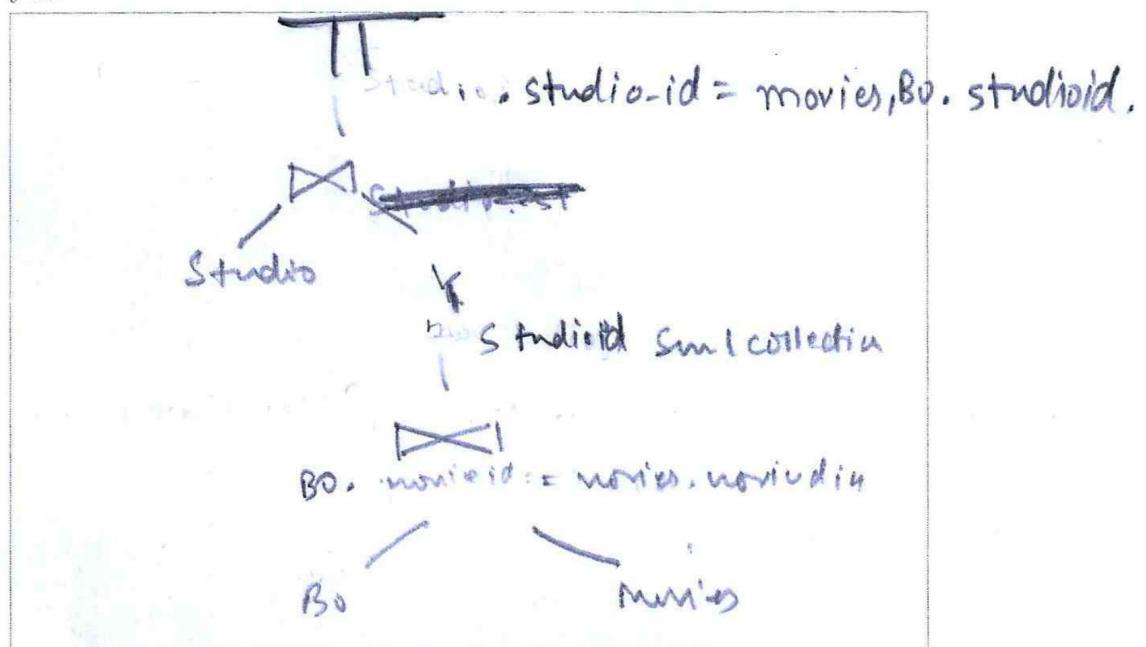


(b) Write valid SQL statements for the following queries over this schema:

- 1 i. Return **TRUE** (boolean value) if there is a movie that has made a profit (defined as (total collections - budget)) and was released in 2010.



- ii. Return the studios whose movies have collected maximum boxoffice collection in any year.



Question 3..... 4 points

Consider the relation definition in SQL and the query below:

```
CREATE TABLE Movies (
    Name varchar(30),
    Genre varchar (5) NOT NULL,
    Length numeric (3,0),
    PRIMARY KEY (Name)
);
SELECT * FROM Movies WHERE Genre='Comedy' AND Length <= 120;
```

- 2 (a) What is the output that you expect from the SQL query given above? Explain. (Hint: note that Length attribute can be NULL)

0 rows in the output.
(relational instances).

There will be no movies that satisfy the
where clause as Genre is varchar(5)
"Comedy" has 6 chars.

- 1 (b) What will be the output if we replace AND with OR in the above query? Explain.

All (Name, Genre, Length) tuples from movies
that have length ≤ 120 or null.
since Null is treated as 0 when seen as int.

- 1 (c) What will be the output if we use the following in the WHERE clause instead of what is given:
Length > 120 OR Length ≤ 120 ?

all ~~---~~ (name, Genre, Length) tuples
from movies will be in the output.

Question 4 6 points

Assume that we have a relation $R(W,X,Y,Z)$ with no null-values in any attribute. We are given the following functional dependencies that hold on this relation $Y \rightarrow Z$ and $WZ \rightarrow X$. Now answer the following:

- [3] (a) List the axioms that can be used to derive the closure of any given set of functional dependencies on a given relation.

These are the Armstrong's Axioms,

① Reflexivity: $\alpha \rightarrow \beta$ where $\beta \subseteq \alpha$
 (R)

② Augmentation if $\alpha \rightarrow \beta$ in F
 (A) then $\gamma\alpha \rightarrow \gamma\beta$ for all attribute sets γ .

③ Transitivity if $\alpha \rightarrow \beta$, $\beta \rightarrow \gamma$ in F then
 (T) $\alpha \rightarrow \gamma$

- [3] (b) Using the axioms you have listed above, derive the closure of the two functional dependencies given on the given relation. At each derivation, clearly mention the axiom that has been applied. Avoid applying multiple axioms simultaneously in a single step of your derivation.

$$Y \rightarrow Z$$

$$WZ \rightarrow X$$

Reflexivity. $\rightarrow WZ \rightarrow W$
 $WZ \rightarrow Z$.

Augmentation: $Y \rightarrow Z$

$$XY \rightarrow XZ$$

$$WY \rightarrow WZ$$

$$ZY \rightarrow Z$$

$$XWY \rightarrow XWZ$$

$$\begin{aligned} XZY &\rightarrow XZ \\ WZY &\rightarrow WZ \end{aligned}$$

So, for we have

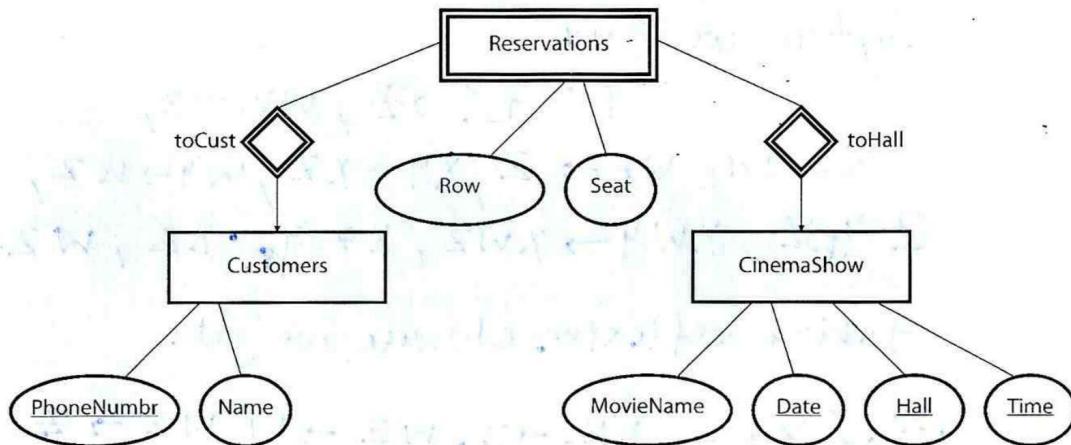
$$F^+ = \{ Y \rightarrow Z, WZ \rightarrow X, \\ WZ \rightarrow W, WZ \rightarrow Z, XY \rightarrow XZ, WY \rightarrow WZ, \\ ZY \rightarrow Z, XWY \rightarrow XWZ, XZ \rightarrow XZ, WZY \rightarrow WZ \}$$

taking reflexive closure we get:

$$\begin{aligned} F^+ = \{ &Y \rightarrow Z, WZ \rightarrow X, WZ \rightarrow W, WZ \rightarrow Z \\ &XY \rightarrow XZ, \underline{XY \rightarrow X}, \underline{XY \rightarrow Y}, WY \rightarrow WZ, \\ &WY \rightarrow Y, \underline{WY \rightarrow W}, ZY \rightarrow Z, \\ &XWY \rightarrow XWZ, XWY \rightarrow XW, XWY \rightarrow XY, \\ &XWY \rightarrow WY, XWY \rightarrow X, XWY \rightarrow W, XWY \rightarrow X \\ &(XWY \rightarrow XWY, XZY \rightarrow XZ, XZY \rightarrow XZY) \} \\ &XYZ \rightarrow Z, XYZ \rightarrow YZ, XYZ \end{aligned}$$

Question 5 3 points

Consider the toy ER diagram for a movie bookings scenario given below. Convert this into a relational schema and identify the keys that can be used for each relation clearly.



CinemaShow (MovieName, Date, Hall, Time)

Reservations

Customer (Phone Numbr, Name)

Reservation (Phone Numbr, Date, Hall, Time)

(Row, Seat)

— underlined represents keys for each relation.

Question 6 4 points

Consider a schema $R(A, B, C, D, E)$ where (only) the following functional dependencies known to hold:

$$A \rightarrow BC$$

$$CD \rightarrow E$$

$$B \rightarrow D$$

$$E \rightarrow A$$

Derive the lossless decomposition of this schema. Explain each step clearly.

Question 7 6 points

Define the following terms in plain, clear and technically correct English (do not "explain" by just giving an example):

- [1] (a) Functional dependency

for a relation $\tau(R)$
 $\alpha \rightarrow \beta$ $\alpha, \beta \subseteq R$

is a functional dependency if for every legal instance of a relation of τ , if 2 tuples agree on attributes α , then they also agree on attributes β

- [1] (b) BCNF

A relation is in BCNF if any non-trivial functional dependency $X \rightarrow Y$ has X as a superkey.

- [1] (c) Weak entity sets

entity sets whose attributes do not uniquely determine the entity.
You cannot come up with a primary key for a weak entity set.

[1] (d) Fixpoint computation

This is computation till you reach a fixpoint, ie. a point after which further computation yields no more results.

[1] (e) Materialized View

This is a view ~~for~~ for which we actually ~~not~~ store the result returned by the query. If you have a material view of a relation, you can only access data in the view and not the whole relation.

[1] (f) Logical query plan

Logical schema of the relational algebra queries that you apply to your relations to obtain the desired result from your query.

Question 8 2 points

Antisemijoin operator $R \bar{\bowtie} S$ between two relations R and S produces as output a bag of tuples in R that do not agree with any tuple in S in the attributes (whose names are) common to R and S. Give an equivalent relational algebra expression for antisemijoin.

$$R - \text{TT}_R(R \bowtie S)$$

Question 9 5 points

Given the table: bornIn (name, age, city) which describes which city a person was born in and the person's current age, the following query was formulated. Answer the following questions.

```

SELECT name, age FROM bornIn AS b
WHERE age =
  (SELECT MAX(age) FROM bornIn
   WHERE b.city = city)
GROUP BY name, age HAVING (age > 60)
  
```

- (a) State in English, what the query returns

This query returns all the eldest people's name, age from bornIn, whose city of birth was 'city', they must have this eldest age > 60 .

- (b) Rewrite the query without any subqueries. If it cannot be done, explain why not.

It cannot be done, since you need to select people that have the max(age) and at the same time this age must be more than 60. You also have to output this max(age).

If grouping by name then you can't output all the people with max(age).

End of the paper

