CSC 370
Spring 2024 (A01: CRN 20791; A02: CRN 20792)
Midterm #2: Thursday, 14 March 2024

Exam duration: 50 minutes
Instructor: Michael Zastre

Students must check the number of pages in this examination paper before beginning to write, and report any discrepancy immediately.

- **All answers are to be written on this exam paper.**
- The exam is closed book
- When answering questions, please do not detach any exam pages!
- No electronic devices are permitted. Phones must be turned off.
- There are twelve (12) printed pages in this document, including this cover page.
- The exam is out of a total of 90 marks.
- We strongly recommend you read the entire exam through from beginning to end before starting on your answers. Manage your time accordingly.
- **Please have your UVic ID card available for inspection by an exam invigilator.**

For each of the following ten questions, you must place an X beside all answers that apply. Partially-correct answers receive no credit. **All multiple-choice questions are worth three (3) marks.**

Question 1: As discussed in lectures, an *ER diagram* may include symbols for:

_____ relations.

__X__ relationships.

_____ classes.

__X__ entity attributes.

_____ None of the above.

Question 2: Every entity in an ER diagram:

_(X)_ may or may not have a key attribute.

_____ must be involved in at least one many-to-many relationship.

__X__ is either uniquely identifiable, or may be identified via a supporting relationship.

_____ must indicate its parent class.

_____ None of the above.

Question 3: When considering the ER diagramming notation taught in this course, we can say that the notation supports the following kinds of multiplicities for binary relationships:

_____ one to at-least-one.

__X__ many to one-or-zero

_____ at-least-one to many.

__X__ many to many.

_____ None of the above.

Question 4: As described in lectures, converting an *isa* collection of entities from an ER diagram into relations may:

__X__ use the object-oriented approach.

__X__ use the nulls approach.

____ use the SQL approach.

____ use the normalization approach.

____ None of the above.

Question 5: When examining the ER diagram on page 11 of this exam paper, we can state that the entity (or entities) needed to uniquely identify an instance of `RepairJob` is (or are):

____ `Mechanic`.

____ `Car` and `Mechanic`.

__X__ `Car`.

____ `Repairs`.

____ None of the above.

Question 6: When examining the ER diagram on page 11 of this exam paper, we can state that:

____ An `Employee` may be either a `Mechanic` or a `Salesperson` but not both at the same time.

____ There are several one-to-one relationships shown.

____ Every `Car` entity must participate in one of the `Does`, `Buys`, or `Sells` relationships.

____ Only one `Salesperson` can be associated with a `Client` (through either `Buys` or `Sells`).

__X__ None of the above.

Question 7: When applying the synthesis algorithm for 3NF, the algorithm steps include:

__X__ determining which functional dependencies have prime attributes on their right-hand sides.

_____ converting the schema first into BCNF.

_____ turning all keys into superkeys.

_____ determining which functional dependencies have prime attributes on their left-hand sides.

_____ None of the above.

Question 8: As shown in lectures, a schema decomposition guided by BCNF can lead to:

_____ elimination of *renaming* anomalies.

_____ elimination of *tuple* anomalies.

_____ elimination of *projection* anomalies.

__X__ elimination of *update* anomalies.

_____ None of the above.

Question 9: In the Object-Description Language (ODL):

_(X)_ relations are modelled as separate classes in the same manner as for entities.

_____ modelling multi-way relationships is easy and straightforward.

__X__ we can construct a data model in a way that is not specific to any particular programming language but which is well-suited to object-oriented languages.

__X__ supports the concept of an *attribute* as an element.

_____ None of the above.

Question 10: In the context of 3NF, a *minimal basis*:

_____ is the smallest set of relational-algebra operators needed to query the schema.

_____ proves that the resulting decomposition is also in BCNF.

_____ is another name for the set of trivial functional dependencies in the schema.

_____ is the set of relation schemas with the minimal number of attributes.

__X__ None of the above.

Question 11 (30 marks)

Consider the relation R consisting of attributes $ABCDE$. Further assume we have a decomposition of the schema into three sets of attributes:

$$ABC \quad BCD \quad ACE$$

a) Use the chase test to determine whether or not the decomposition of R is lossless assuming the FDs shown below. And given these FDs, would the decomposition be valid BCNF? Explain your answer.

$$B \rightarrow E \quad CE \rightarrow A$$

Solution:

Initial tableau:

A	B	C	D	E
a	b	c	d_1	e_1
a_2	b	c	d	e_2
a	b_3	c	d_3	e

After $B \rightarrow E$:

A	B	C	D	E
a	b	c	d_1	$\mathbf{e_1}$
a_2	b	c	d	$\mathbf{e_1}$
a	b_3	c	d_3	e

After $CE \rightarrow A$:

A	B	C	D	E
$\mathbf{a}$	b	c	d_1	e_1
$\mathbf{a}$	b	c	d	e_1
a	b_3	c	d_3	e

We have now applied all of the functional dependencies. However, the last and final tableau **does not have an unsubscripted row**. Therefore the chase test indicates that **there would not be** a lossless join.

With respect to BCNF, the FD $B \rightarrow E$ does not apply to any of the three relations (i.e. there is not relation that contains B and E), therfore this FD **does not** violate BCNF. The FD $CE \rightarrow A$ has a LHS which is a key for one relation (ACE), and so this FD **does not** violate BCNF. Therefore the FDs and relations **are in BCNF**.

b) Use the chase test to determine whether or not the decomposition of R (given on the previous page) is lossless assuming the FDs shown below. And given these FDs, would the decomposition be valid BCNF? Explain your answer.

$$AC \rightarrow E \quad BC \rightarrow D$$

Solution:

Initial tableau:

A	B	C	D	E
a	b	c	d_1	e_1
a_2	b	c	d	e_2
a	b_3	c	d_3	e

After $AC \rightarrow E$:

A	B	C	D	E
a	b	c	d_1	**e**
a_2	b	c	d	e_2
a	b_3	c	d_3	**e**

After $BC \rightarrow D$:

A	B	C	D	E
a	b	c	**d**	e
a_2	b	c	**d**	e_2
a	b_3	c	d_3	e

We have now applied all of the functional dependencies. If we look at the first row, all of the attributes are unscripted. Therefore the chase indicates that **there would be** a lossless join.

With respect to BCNF, the FD $AC \rightarrow E$ has a LHS that is a key for ACE. Also the FD $BC \rightarrow D$ has a LHS that is a key for BCD. Therefore both FDs **do not** violate BCNF, and so the relations and FDs are in BCNF.

Question 12 (20 marks)

Prepare an ER diagram for a database into which will be recorded information about sports teams, team players, and the fans of the teams, including:

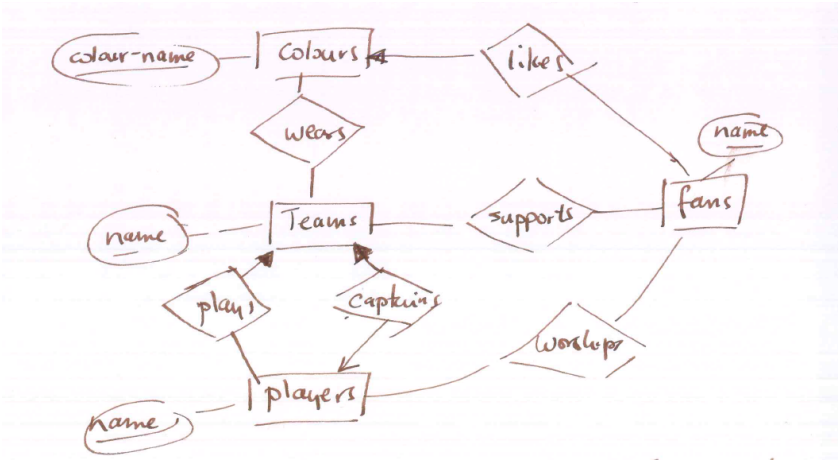
a) For each team, its name, its players, its team captain (one of its players) and the colours of its uniform.

b) For each player, their name.

c) For each fan, their name, favorite teams, favorite players, and favorite color.

Your diagram must indicate keys and multiplicities, and you must explain your assumptions and reasoning for these keys and multiplicities.

There are, of course, many possible solutions. Here is one:



Here we assume fans may or may not have a favorite colour; that fans may support many teams; that players here is a regular entity (but answers on midterm papers would be permitted to treat players as weak, given this was how weak entities were introduced).

Some other things I was looking for:

- Was "being a captain" modelled as a relationship between a Player and a Team, and separate from simply "playing"?
- Were constraints on relationships correctly modelled (such as exactly one, along with use of notation)?
- Was the relationship fans have with teams and with players flexible enough such that they could support teams separately from players?

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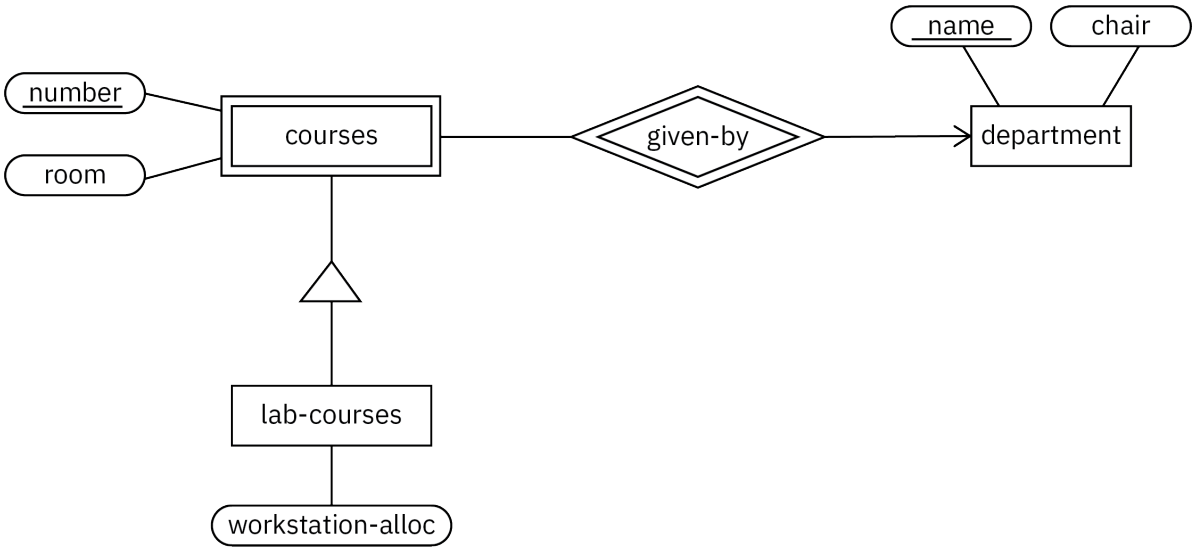
Question 13 (10 marks)

Given the ER diagram immediately below, convert the entities into relations using each of the three possible approaches described in lectures and in the text. Explain your choice of attribute names.

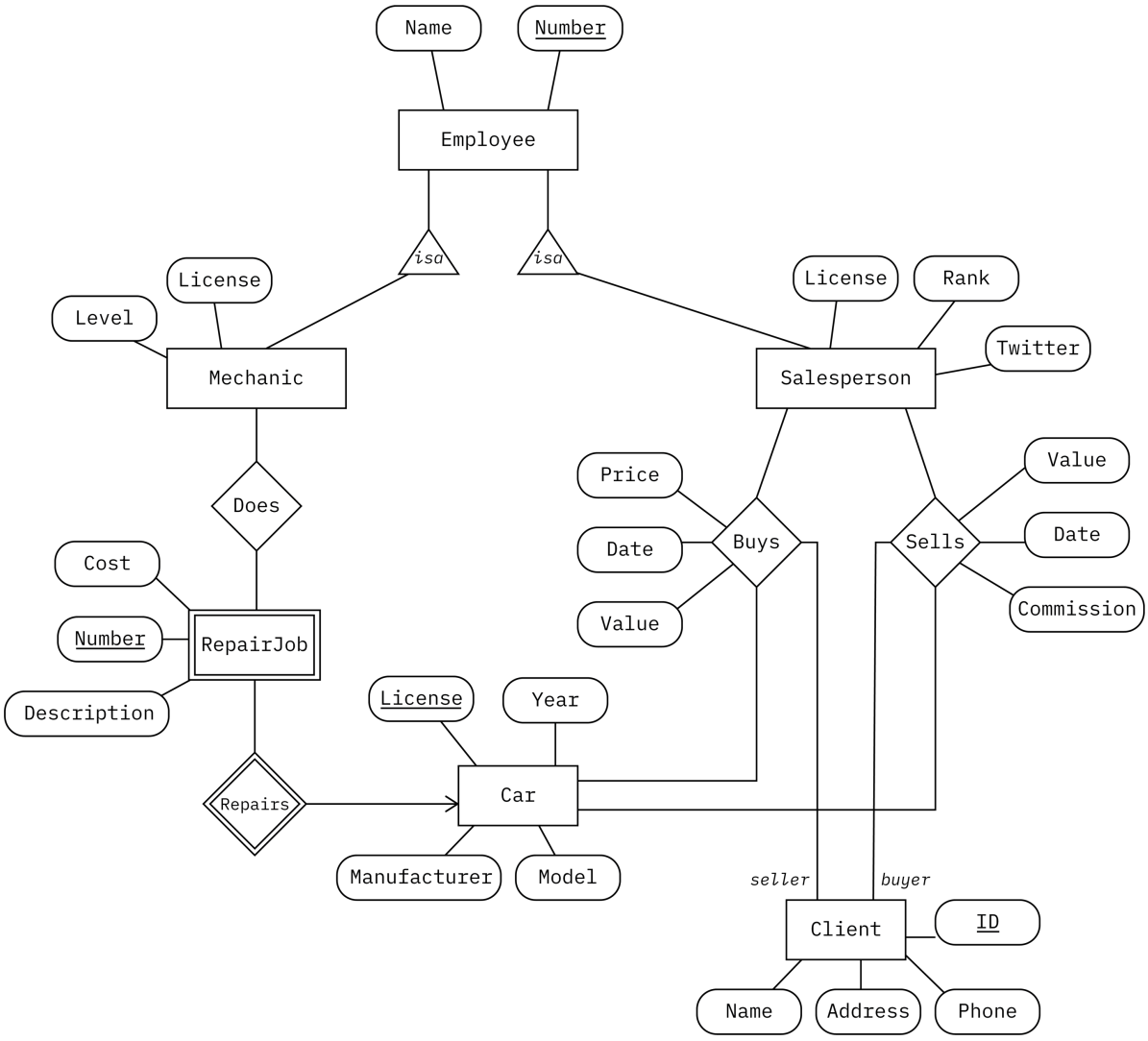


E-R approach
Department(name, chair)
Courses (number, room, name)
Lab-courses(workstation-alloc, number, name)

OO approach:
Department(name, chair)
Courses(number, name, room)
Lab-courses(workstation-alloc, name, number, room)

Nulls approach:
Department(name, chair)
Courses(number, room, name, workstation-alloc)

(Note: When grading, I did not look at keys in the answer, as it appears that simply coming up with the three different schemas was tough enough.)


Name
Number
Employee
isa
isa
License
Level
Mechanic
License
Rank
Twitter
Salesperson
Does
Price
Date
Value
Buys
Sells
Value
Date
Commission
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Description
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Car
Manufacturer
Model
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buyer
Client
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Name
Address
Phone

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