

Fundamentals of Database Systems - Assignment 3

2024

Note: Collaboration on assignments is encouraged, but you must write up your work individually and in your own words.

1. (Entity-Relationship Modelling)

Consider the relational database schema $\{\text{CUSTOMER}, \text{ORDER}, \text{DRIVER}\}$ with the relation schemata:

- $\text{CUSTOMER} = \{\text{name}, \text{dob}, \text{email}\}$ with key $\{\text{name}, \text{dob}\}$
- $\text{DRIVER} = \{\text{date}, \text{driver_name}, \text{vehicle}\}$ with key $\{\text{date}\}$
- $\text{ORDERS} = \{\text{order_id}, \text{name}, \text{dob}, \text{address}, \text{payment_method}, \text{date}\}$ with key $\{\text{order_id}, \text{name}, \text{dob}\}$ and with foreign keys

$[\text{name}, \text{dob}] \subseteq \text{CUSTOMER}[\text{name}, \text{dob}]$

$[\text{date}] \subseteq \text{DRIVER}[\text{date}]$

- (a) Specify the ER schema that corresponds to the database schema above.

[4 marks]

- (b) Specify the ER diagram that corresponds to the database schema above.

[2 marks]

- (c) Define an instance over the ER schema that contains at least three objects for each object type.

i) Use foreign key semantics to specify your instances.

ii) In addition, use identifier semantics to write down the same instances.

[3 marks]

2. (Functional Dependencies)

Consider the following relation over the relation schema **ADDRESS**:

number	street	zip	city
88	The Strand	1010	Auckland
38	Liverpool Street	1026	Auckland
38	Princes Street	1010	Auckland
42	Princes Street	6021	Wellington
38	Cuba Street	6021	Wellington

- (a) Find a non-trivial functional dependency that holds on the relation, and perform a lossless decomposition of the relation using the functional dependency.

[2 marks]

- (b) In the decomposition from a) we managed to eliminate redundancy. Give an example of the problems that redundancy in relational databases can cause.

[1 marks]

3. (Database Normalization)

Consider the relation schema **FACULTY** = {*lecturer*, *department_head*, *department*} which keeps information on a university faculty along with the lecturers, the different departments and the head of department. In addition, we have the set of functional dependencies that hold on **FACULTY** which is $\Sigma = \{lecturer \rightarrow department, department_head \rightarrow department\}$.

- (a) Determine all keys for **FACULTY** with respect to Σ and explain why there cannot be any further keys.

[2 marks]

- (b) Is the schema **FACULTY** in 3NF (with respect to Σ)? Please explain why or why not. If not, determine a faithful, lossless 3NF decomposition of **FACULTY**.

[3 marks]

- (c) Is the schema **FACULTY** in BCNF (with respect to Σ)? Please explain why or why not. If not, determine a lossless BCNF decomposition of **FACULTY** and explain whether or not this is also faithful.

[3 marks]

Possible Marks: 20
