Name

CWID

Homework Assignment 3

November 9th, 2022

Due on November 23th, 11:59pm (midnight)

CS425 - Database Organization

Results

Please leave this empty!

3.1 3.2 3.3

Sum

Instructions

- Try to answer all the questions using what you have learned in class
- Some questions are marked as bonus. You do not have to answer these questions to get full points for the assignment. However, you can get bonus points for these questions!

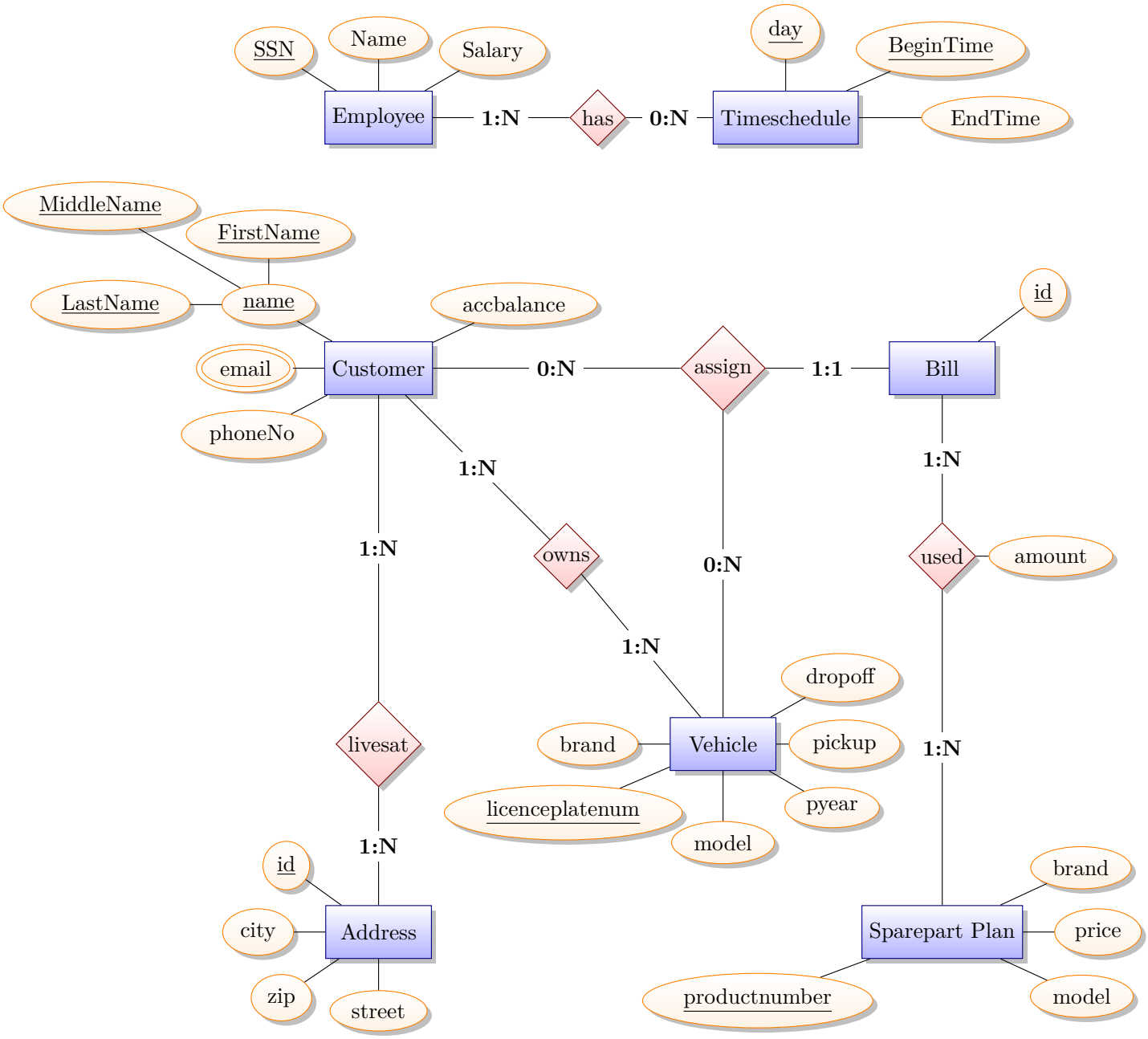
Part 3.1 Modelling (Total: 60 Points)

Question 3.1.1 (60 Points)

Build a conceptional model for a **car repair shop**. The solution should be presented as an **ER-diagram**. Base your design on the following requirements.

- The database should record information about Employees, Timeschedules, Customers, Cars (being repaired), Spare parts, Bills.
- An **Employee** is identified by their SSN. We also record their names and salary (monthly.
- A **Timeschedule entry** encodes a particular day and time interval during which an employee is at the shop. Each employee has at least one timeschedule entry, but may also have multiple entries.
- A **Customer** has a name which consists of *firstName*, *middleName* and *lastName* which are used together to identify a customer. A **Customer** has optionally an *Address*. All customers have a *phoneNumber* and *email* addresses. We also record the outstanding balance per customer.
- The repairshop keeps track of the customer's cars which are currently at the shop. A **Vehicle** is identified by the combination of their *licenseplatenum*. For each **Vehicle** we store the *brand*, *model*, and *production year*. Furthermore, we record when the vehicle was dropped off at the shop (*drop off date*) and when it was picked up (*picked up*). We also record which customer does own the vehicle.
- The shop keeps **spare parts** for repairs. For a spare part we record the *car brand* and *model* it can be used on, a *product number* (which is unique) and a *price*.
- A **Bill** is send to a particular *customer* for a particular *vehicle*. For each bills we record which *spare parts* (and how many of each type) were used in the repair. Bills are identified by a unique *id*.

Solution

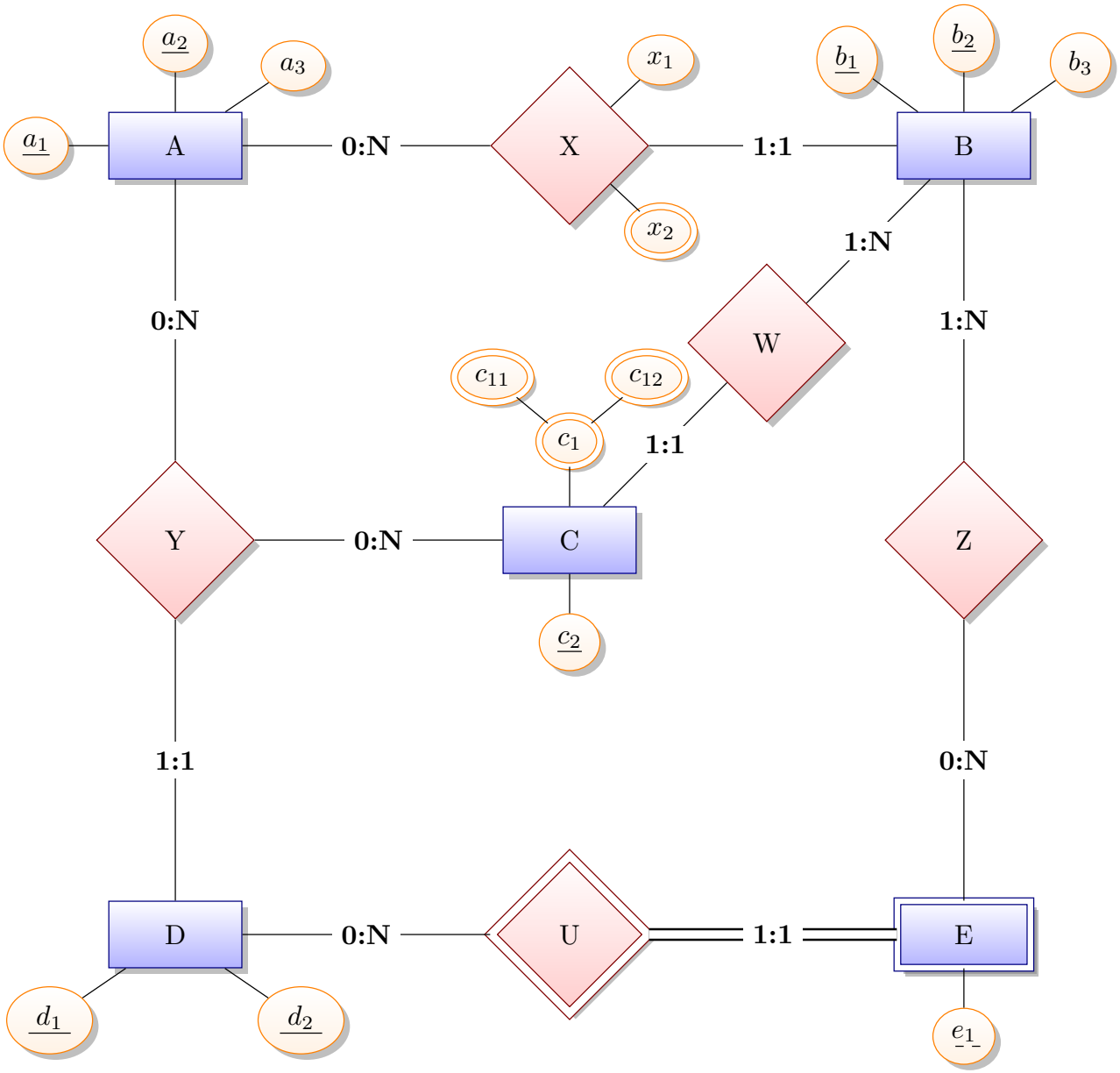

SSN
Name
Salary
Employee
1:N
has
0:N
day
BeginTime
Timeschedule
EndTime
MiddleName
FirstName
LastName
name
accbalance
email
Customer
0:N
assign
1:1
Bill
id
phoneNo
1:N
1:N
owns
0:N
used
amount
1:N
1:N
dropoff
livesat
brand
Vehicle
pickup
1:N
licenceplatenum
pyear
model
1:N
id
brand
city
Address
Sparepart Plan
price
zip
street
productnumber
model

Part 3.2 Translation of ER into Relational Model (Total: 40 Points)

Question 3.2.1 (40 Points)

Take the following ER-model and translate it into a relational schema using the rules presented in class. Present the relational schema as an SQL script (assume that all attributes are of data type `INT`). Present the results of the following intermediate steps in this order:

1. Translate strong entities + unnest composite attributes
2. Translate weak entities
3. Translated multi-valued attributes
4. Translate relationships



Solution

1st Step (strong entities)

```
CREATE TABLE A (
   a1 INT,
   a2 INT,
   a3 INT,
   PRIMARY KEY(a1, a2)
);

CREATE TABLE B (
   b1 INT,
   b2 INT,
   b3 INT
   PRIMARY KEY (b1,b2)
);

CREATE TABLE C (
   c2 INT PRIMARY KEY
);

CREATE TABLE D (
   d1 INT,
   d2 INT,
   PRIMARY KEY (d1,d2)
);
```

2nd Step (weak entities)

```
CREATE TABLE A (
    a1 INT,
    a2 INT,
    a3 INT,
    PRIMARY KEY(a1, a2)
);

CREATE TABLE B (
    b1 INT,
    b2 INT,
    b3 INT
    PRIMARY KEY (b1,b2)
);

CREATE TABLE C (
    c2 INT PRIMARY KEY
);

CREATE TABLE D (
    d1 INT,
    d2 INT,
    PRIMARY KEY (d1,d2)
    );

CREATE TABLE E (
    e1 INT,
    d1 INT,
    d2 INT,
    PRIMARY KEY (e1,d1,d2),
    FOREIGN KEY d1,d2 REFERENCES D
);
```

3rd Step (multivalued attributes)

```
CREATE TABLE A (
    a1 INT,
    a2 INT,
    a3 INT,
    PRIMARY KEY(a1, a2)
);

CREATE TABLE B (
    b1 INT,
    b2 INT,
    b3 INT
    PRIMARY KEY (b1,b2)
);

CREATE TABLE C (
    c2 INT PRIMARY KEY
);

CREATE TABLE C1 (
    c2 INT REFERENCES C,
    c11,
    c12,
    PRIMARY KEY (c2,c11,c12)
);

CREATE TABLE D (
    d1 INT,
    d2 INT,
    PRIMARY KEY (d1,d2)
    );

CREATE TABLE E (
    e1 INT,
    d1 INT,
    d2 INT,
    PRIMARY KEY (e1,d1,d2),
    FOREIGN KEY (d1,d2) REFERENCES D
);
```

4th Step (relationships)

```
CREATE TABLE A (
    a1 INT,
    a2 INT,
    a3 INT,
    PRIMARY KEY(a1, a2)
);

CREATE TABLE B (
    b1 INT,
    b2 INT,
    b3 INT,
    x1 INT,
    a1 INT,
    a2 INT,
    PRIMARY KEY (b1,b2),
    FOREIGN KEY (a1,a2) REFERENCES A
);

CREATE TABLE X2 (
    b1 INT,
    b2 INT,
    x2 INT,
    PRIMARY KEY (b1,b2,x2)
);

CREATE TABLE C (
    c2 INT PRIMARY KEY,
    b1 INT,
    b2 INT,
    FOREIGN KEY (b1,b2) REFERENCES b
);

CREATE TABLE C1 (
    c2 INT REFERENCES C,
    c11,
    c12,
    PRIMARY KEY (c2,c11,c12)
);

CREATE TABLE D (
    d1 INT,
    d2 INT,
    PRIMARY KEY (d1,d2)
    );

CREATE TABLE E (
    e1 INT,
    d1 INT,
    d2 INT,
    PRIMARY KEY (e1,d1,d2),
    FOREIGN KEY (d1,d2) REFERENCES D
);
```

```
CREATE TABLE Y (
   a1 INT,
   a2 INT,
   c2 INT,
   d1 INT,
   d2 INT,
   PRIMARY KEY (a1,a2,c2,d1,d2),
   FOREIGN KEY (a1,a2) REFERENCES A,
   FOREIGN KEY (c2) REFERENCES B,
   FOREIGN KEY (d1,d2) REFERENCES C
);

CREATE TABLE Z (
   b1 INT,
   b2 INT,
   d1 INT,
   d2 INT,
   e1 INT,
   PRIMARY KEY (b1,b2,d1,d2,e1),
   FOREIGN KEY (b1,b2) REFERENCES B,
   FOREIGN KEY (d1,d2,e1) REFERENCES E
);
```

Part 3.3 Normalization (Total: 10 (BONUS) Points)

Question 3.3.1 (10 (BONUS) Points)

Consider the following relations and for each determine in which normal form the relation is (note that a relation can be in multiple normal forms). Please consider the following normal forms: 1NF, 2NF, 3NF and BCNF.

1. $R(A, B, C, D, E)$ and the Functional Dependencies are $B \rightarrow D, BD \rightarrow AE, BE \rightarrow AC, E \rightarrow D$
2. $R(A, B, C, D, E)$ and the Functional Dependencies are $B \rightarrow A, E \rightarrow AB, D \rightarrow B$
3. $R(A, B, C, D, E)$ and the Functional Dependencies are $A \rightarrow C, E \rightarrow BD, BE \rightarrow AD$
4. $R(A, B, C, D, E)$ and the Functional Dependencies are $E \rightarrow B, DE \rightarrow A, B \rightarrow D$

Solution

1. The relation is in 1NF and 2NF.
2. The relation is in 1NF.
3. The relation is in 1NF and 2NF.
4. The relation is in 1NF.