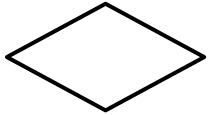
POLITECNICO
MILANO 1863

ER Exercise Session

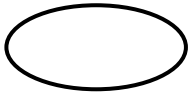
Andrea Tocchetti
andrea.tocchetti@polimi.it

ER Basic Elements

Entity

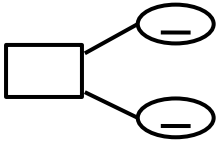


Relationship



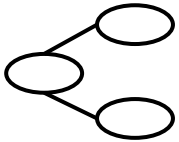
Attribute

Primary Key

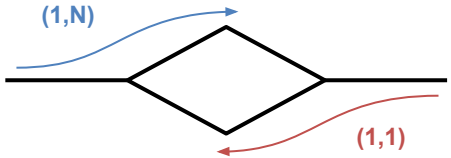


Composite Primary Key

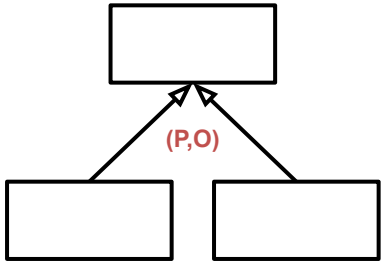
ISA Relationship



Composite Attribute



Cardinalities



ISA Hierarchy

Exercise 1 - Text

Design an ER Model for a car rental system that manages the customers, the cars and their related elements. If a customer wants to rent a car, they should provide their personal ID card (9-digit ID, name, surname, birth date, address, release date, expiration date), driving license (10-digit drive license number, name, surname, birthdate, release date, expiration date and the list of vehicles they are allowed to drive, e.g. truck, car, motorcycle, bus, etc.) and credit card (16 digit number and expiration date). Then, the list of cars is shown to the customer. Each car is described by its brand, the price per day, the maximum speed, and the fuel consumption per km. Before proposing the car, the system checks whether a car inspection has been performed in the last 3 months. Such data includes all the inspections (described by date and the name of the company who took care of it), alongside the list of all the operations the car underwent in each inspection. As soon as the customer picks the car they want, the keys are provided to the customer and the system stores the rental invoice (described by rental date, the period for which the car has been rented, and the final price). When the car is returned, the customer is charged. As soon as the payment is completed, the system marks the rental invoice as “closed” and the customer is provided with his invoice.

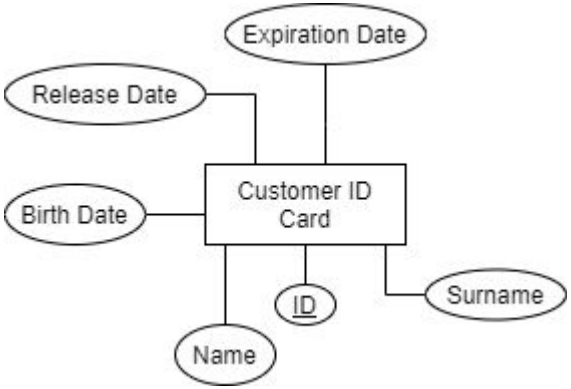
Exercise 1 - Text

Design an ER Model for a car rental system that manages the **CUSTOMERS**, the **CARS** and their related elements. If a customer wants to rent a car, they should provide their **PERSONAL ID CARD** (9-digit ID, name, surname, birth date, address, release date, expiration date), **DRIVING LICENSE** (10-digit drive license number, name, surname, birthdate, release date, expiration date and the list of vehicles they are allowed to drive, e.g. truck, car, motorcycle, bus, etc.) and **CREDIT CARD** (16 digit number, CVC and expiration date). Then, the list of cars is shown to the customer. Each **CAR** is described by its brand, the price per day, the maximum speed, and the fuel consumption per km. Before proposing the car, the system checks whether a **CAR INSPECTION** has been performed in the last 3 months. An inspection is described by a date and the name of the company who took care of it, alongside the list of all the **OPERATIONS** the car underwent in each inspection. As soon as the customer picks the car they want, the keys are provided to the customer and the system stores the **RENTAL INVOICE** (described by rental date, the period for which the car has been rented, and the final price). When the car is returned, the customer is charged. As soon as the payment is completed, the system marks the rental invoice as “closed” and the customer is provided with his invoice.

Exercise 1 - Solution

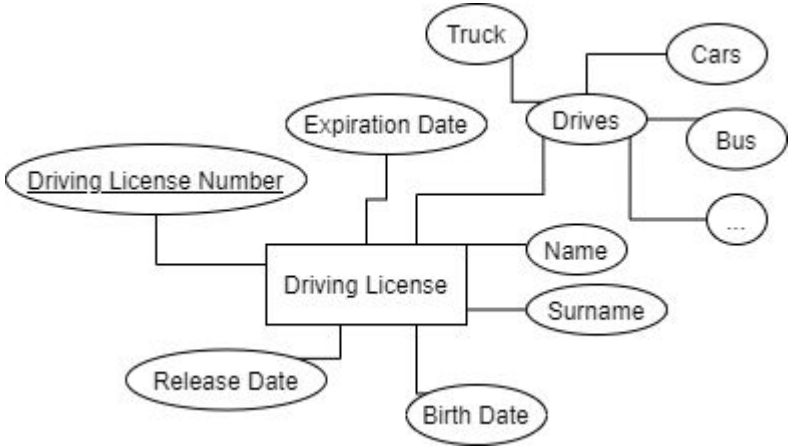
CUSTOMER ID CARD

- ID
- Name
- Surname
- Birth Date
- Address
- Release Date
- Expiration Date



DRIVING LICENSE

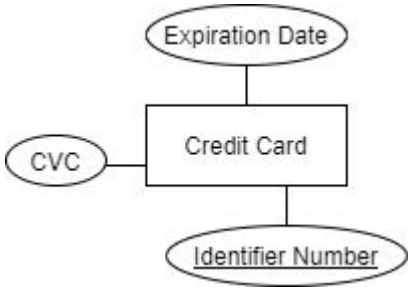
- Drive License Number
- Name
- Surname
- Birth Date
- Release Date
- Expiration Date
- Drive Cars
- Drive Bus



Exercise 1 - Solution

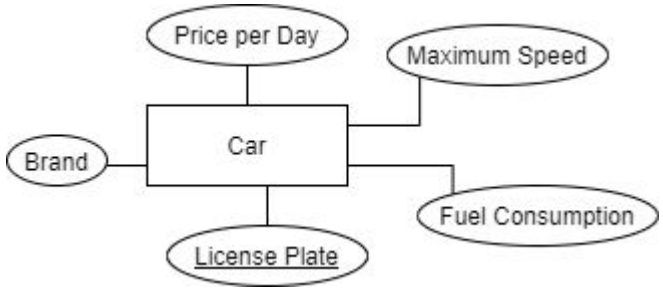
CREDIT CARD

- Identifier Number
- CVC
- Expiration Date



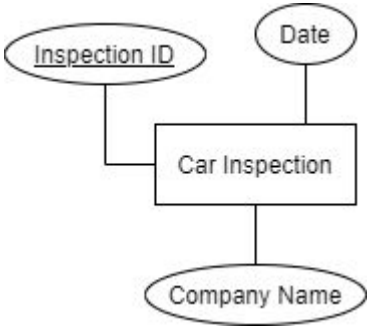
CAR

- Brand
- Price per Day
- Maximum Speed
- Fuel Consumption
- License Plate



CAR INSPECTION

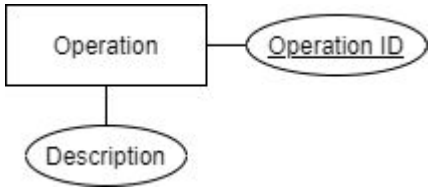
- Date
- Company Name
- Inspection ID



Exercise 1 - Solution

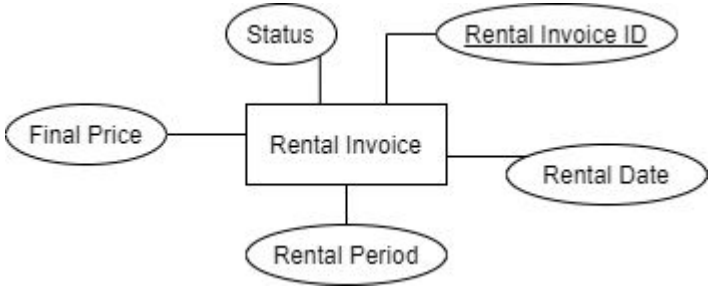
OPERATIONS

- Operation ID
- Description



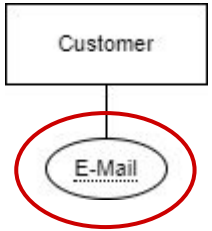
RENTAL INVOICE

- Rental Invoice ID
- Rental Date
- Rental Period
- Final Price
- Status



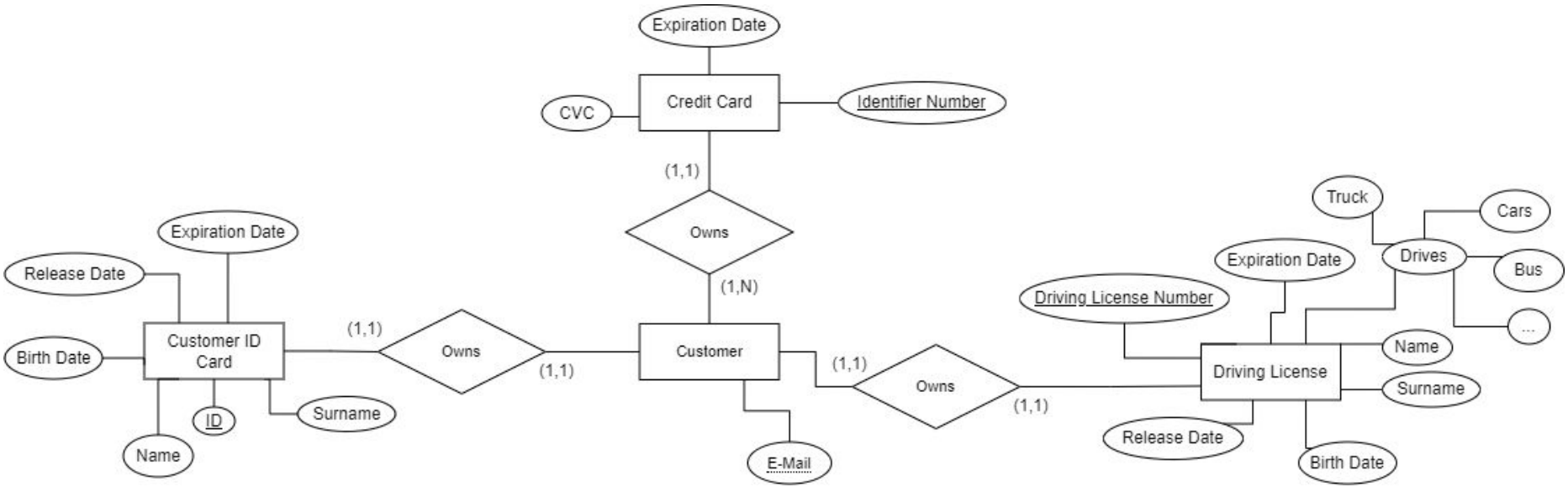
CUSTOMER

- E-mail

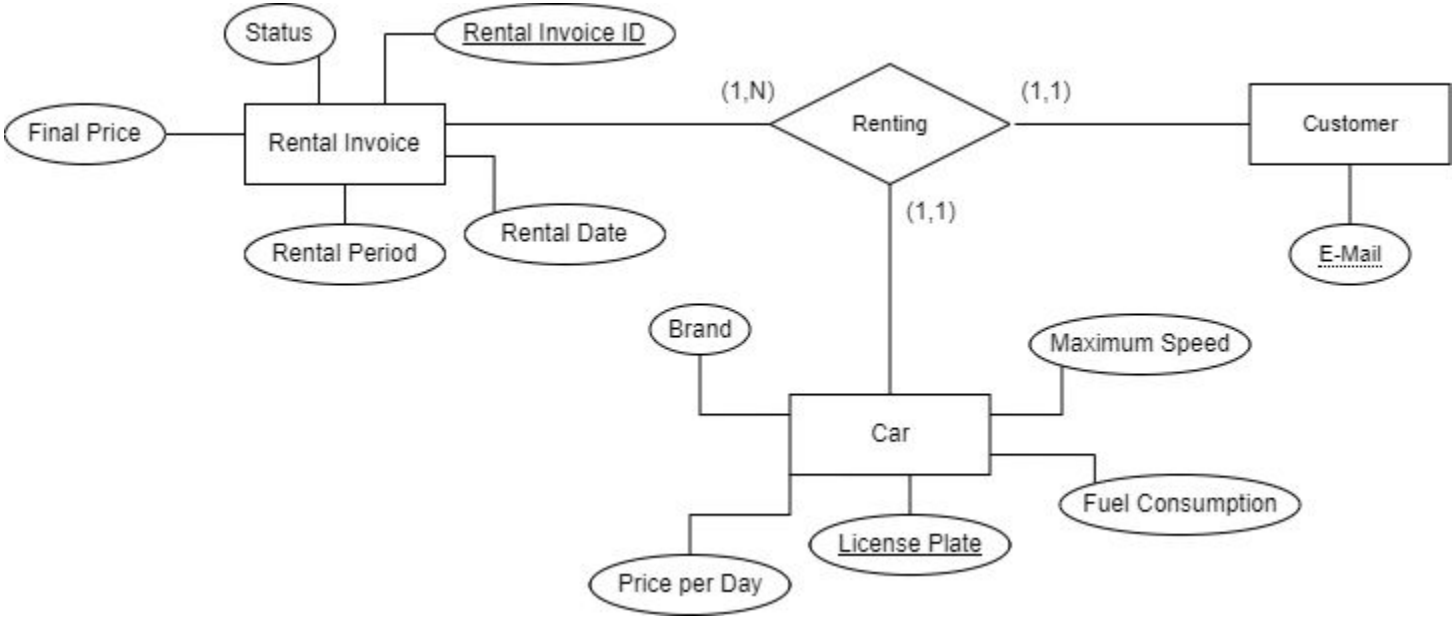


Assumption: Customer is identified through an E-Mail

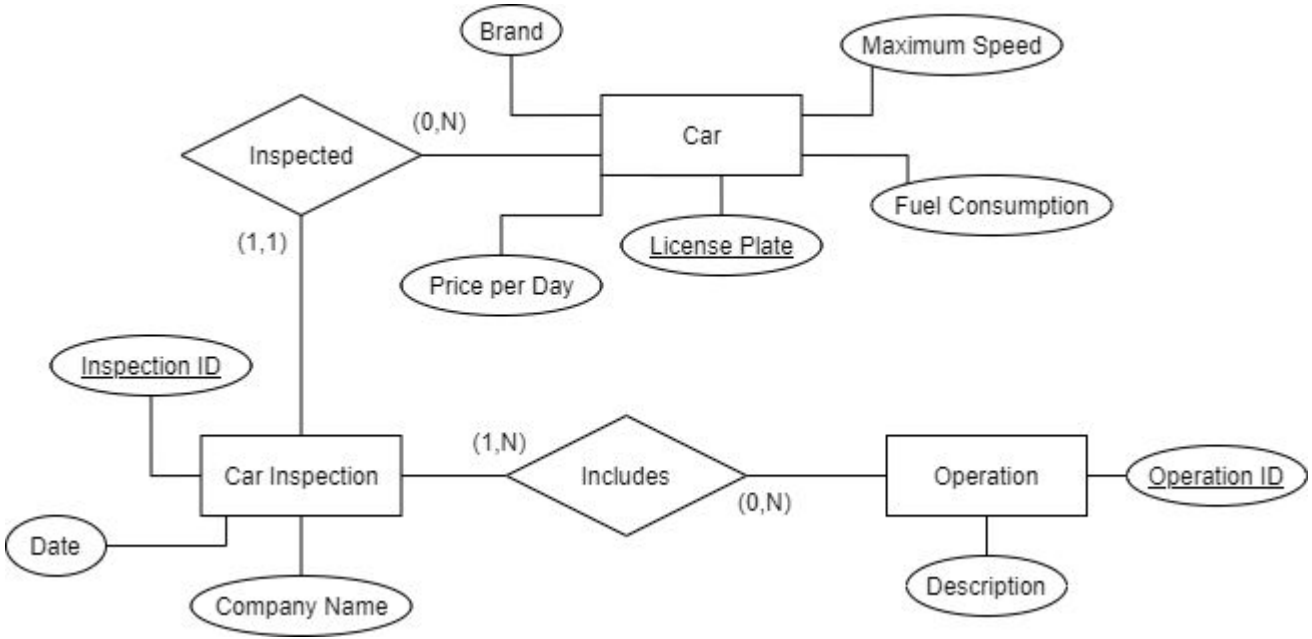
Exercise 1 - Solution



Exercise 1 - Solution



Exercise 1 - Solution



Exercise 1 - Tables

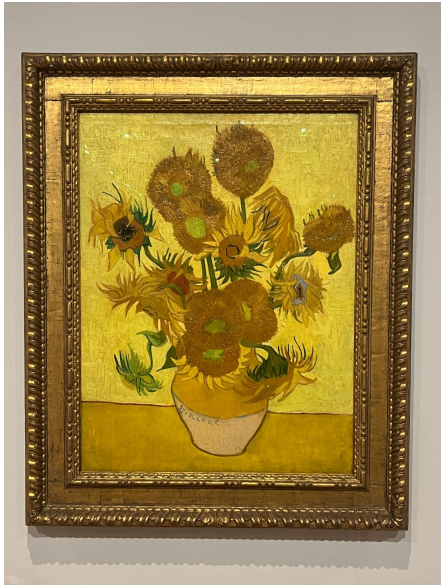
N.B. ER models will be then mapped on tables that will contain data.

License Plate	Fuel Consumption	Max Speed	Price Per Day	Brand
AF012CG	20 Km/l	135 Km/h	50€	Citroen
DG186HF	10 Km/l	320 Km/h	2’000€	Ferrari

Inspection ID	Date	Company Name	License Plate
1	01/05/2021	Tires & Co.	AF012CG
2	01/08/2021	Ferrari	DG186HF


ANY
Questions?

Exercise 2 - Introduction



Exercise 2 - Text

The Dutch Museum Association wants to keep records of all the Dutch museums and their artworks, as well as keep track of daily visitors and sales.

Each museum is described by a unique name, location (further described by address and city), opening time, closing time, and the average time it takes to visit the whole museum. Opening and closing times are the same every day of the week. Every museum is divided into halls, and every hall contains one or more artworks. Each hall is described by a unique three-character identifier, title, and one or more types (e.g., sculpture, paintings, etc.). Artworks are defined by a unique title, description, and type (same as the hall types). Each artwork is produced by only one artist. Artists are described by name, surname, date of birth, town of birth, and their life description. Visitors buy tickets to visit the museum. Each ticket is described by a unique barcode, the number of visitors, and the total price. Visitors state the time when they would visit the museum when they buy tickets to allow the museum to keep track of the crowd. Museums also include a shop that sells gadgets. Each gadget is described by a unique barcode, product name, and price. Visitors buy gadgets at shops.

Exercise 2 - Text

The Dutch Museum Association wants to keep records of all the Dutch museums and their artworks, as well as keep track of daily visitors and sales.

Each **MUSEUM** is described by a unique name, location (further described by address and city), opening time, closing time, and the average time it takes to visit the whole museum. Opening and closing times are the same every day of the week. Every museum is divided into **HALL**s, and every hall contains one or more **ARTWORK**s. Each hall is described by a unique three-character identifier, title, and one or more types (e.g., sculpture, paintings, etc.). Artworks are defined by a unique title, description, and type (same as the hall types). Each artwork is produced by only one **ARTIST**. Artists are described by name, surname, date of birth, town of birth, and their life description. **VISITOR**s buy **TICKET**s to visit the museum. Each ticket is described by a unique barcode, the number of visitors, and the total price. Visitors state the time when they would visit the museum when they buy tickets to allow the museum to keep track of the crowd. Museums also include a **SHOP** that sells **GADGET**s. Each gadget is described by a unique barcode, product name, and price. Visitors buy gadgets at shops.

Exercise 2 - Solution

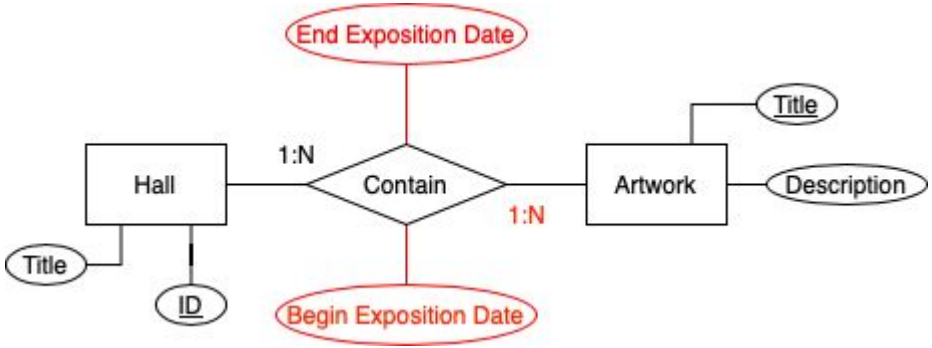
Link

Exercise 2 - Extra I

The Dutch Museum Association now wants to allow museums to borrow and lend artworks from other museums. They want to keep track of the period each artwork spends in each museum. The latter is agreed on before moving the artwork from one museum to another.

Exercise 2 - Extra I

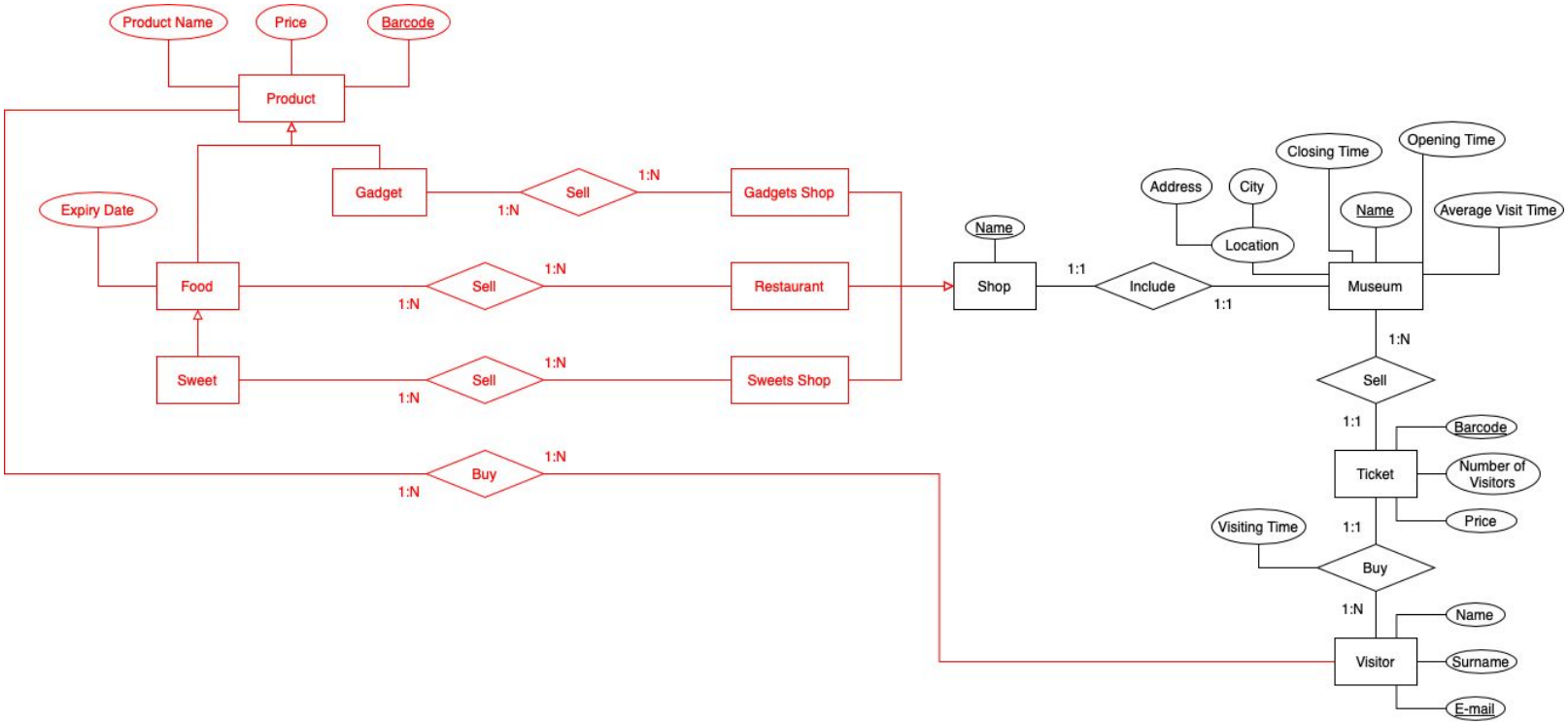
The Dutch Museum Association now wants to allow museums to borrow and lend artworks from other museums. They want to keep track of the period each artwork spends in each museum. The latter is agreed on before moving the artwork from one museum to another.



Exercise 2 - Extra II

The Dutch Museum Association now wants museums to expand their shops. In particular, now museums will include three different kinds of shops: restaurant, sweets shop, and gadgets shop. While the first two shops sell food, the latter sells gadgets. Sweet shops only sell sweets. Food is described by the same attributes as gadgets, plus an expiry date.

Exercise 2 - Extra II

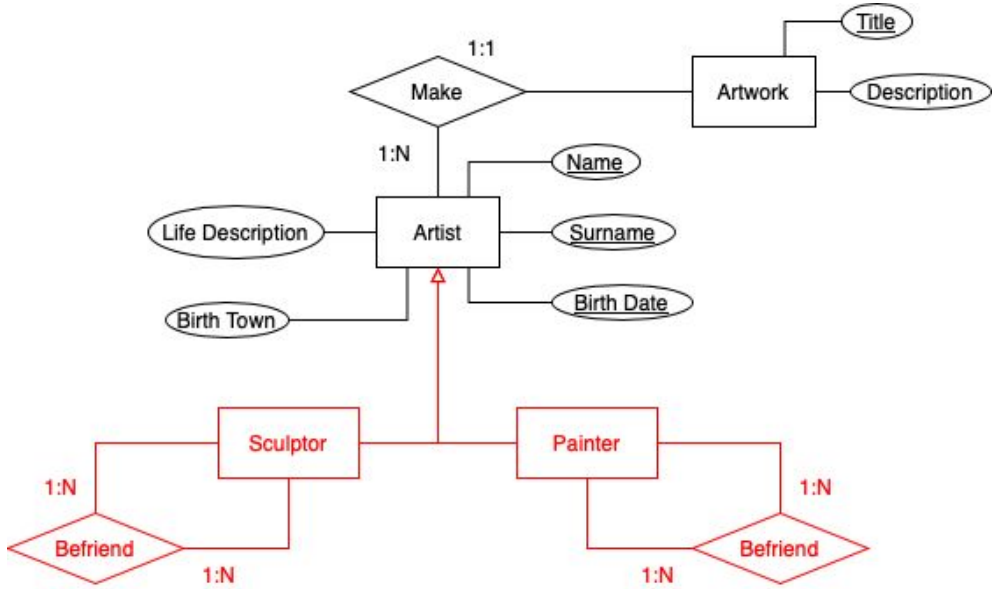


Exercise 2 - Extra III

The Dutch Museum Association wants to model the friendship relationship between the various artists whose artwork are exposed in their museum, considering sculptors and painters only. Furthermore, they made an astounding discovery: painters only befriend other painters and sculptors only befriend other sculptors.

Exercise 2 - Extra III

The Dutch Museum Association wants to model the friendship relationship between the various artists whose artwork are exposed in their museum, considering sculptors and painters only. Furthermore, they made an astounding discovery: painters only befriend other painters and sculptors only befriend other sculptors.




ANY
Questions?

Materials

ER Diagrams Tool
https://app.diagrams.net/

Exercise 1 Full ER Diagram - Link

Exercise 2 Full ER Diagram - Link
Exercise 2 Extra I - Link
Exercise 2 Extra II - Link
Exercise 2 Extra III - Link
Exercise 2 Extra IV - Link

Exercise 2 - Text

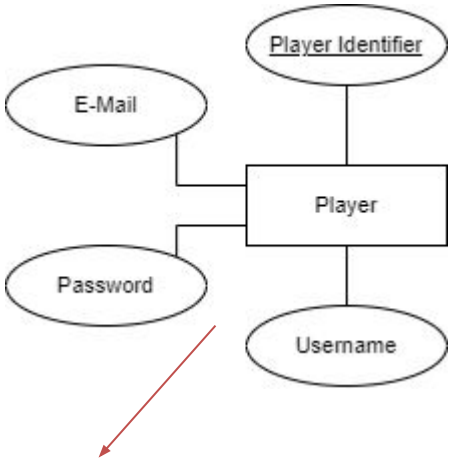
Design an ER Diagram for “Dungeons & Dragons RPG”. During the registration, a player is asked for username, password, password confirmation, e-mail, e-mail confirmation and when the registration is complete, they are assigned a unique 10-digits identifier To play the game, each player creates one or more characters and explores the world, defeating monsters and acquiring items. Each character is defined by a class (warrior, ranger, mage or cleric), experience points, name and strength score (derived from the strength of the items equipped). When a monster is defeated, a random amount of items and gold is provided to the player. Items can be of two types: generic items or weapons. Weapons can be equipped to improve the strength score of the character, although warriors can wield one or more (maximum 2) melee weapons, rangers can only wield one ranged weapon, mages and clerics can only wield one magical weapon. Each item also has a name, a price, a rarity and a unique identifier. monsters are defined by the amount of experience points they provide the player, their difficulty score (ranging between 1 and 20), a gold score (amount of gold dropped when defeated), an item score (amount of items dropped when defeated), a name and a unique identifier. Some monsters can be boss monsters, yelding to more loot and experience points. A monster can be defeated by one or more players. Players can add other players to their friend list.

Exercise 2 - Text

Design an ER Diagram for “Dungeons & Dragons RPG”. During the registration, a **PLAYER** is asked for username, password, password confirmation, e-mail, e-mail confirmation and when the registration is complete, they are assigned a unique 10-digits identifier To play the game, each player creates one or more **CHARACTERS** and explores the world, defeating monsters and acquiring items. Each character is defined by a **CLASS** (warrior, ranger, mage or cleric), experience points, name and strength score (derived from the strength of the items equipped). When a monster is defeated, a random amount of items and gold is provided to the player. **ITEMS** can be of two types: generic items or **WEAPONS**. Weapons can be equipped to improve the strength score of the character. Warriors can wield one or more (maximum 2) melee weapons, rangers can only wield one ranged weapon, mages and clerics can only wield one magical weapon. Each item also has a name, a price, and a rarity. **MONSTERS** are defined by the amount of experience points they provide the player, their difficulty score (ranging between 1 and 20), a gold score (amount of gold dropped when defeated), an item score (amount of items dropped when defeated), and name. Some monsters can be **BOSS MONSTERS**, yelding to more loot and experience points. A monster can be defeated by one or more players. Players can add other players to their friend list.

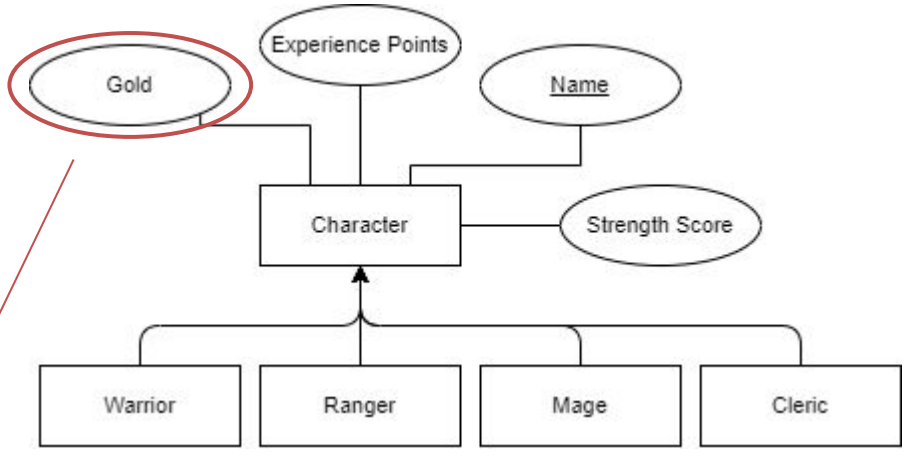
Exercise 2 - Solution

PLAYER



Not all the data is useful

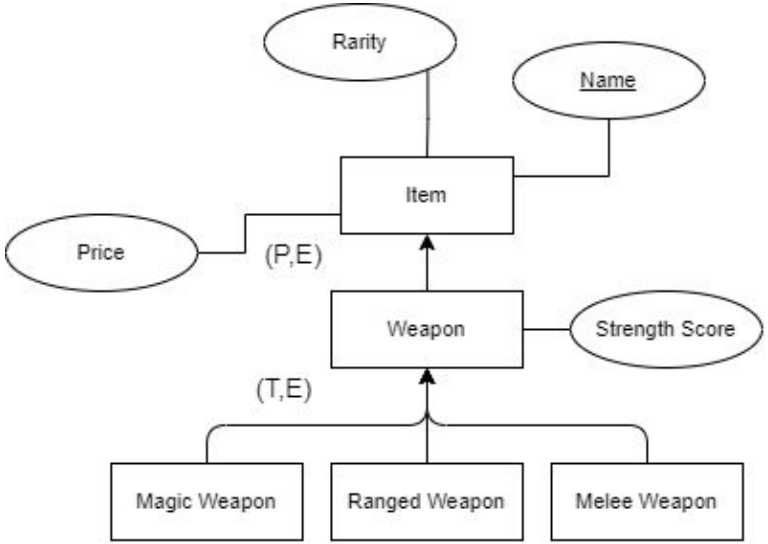
CHARACTER



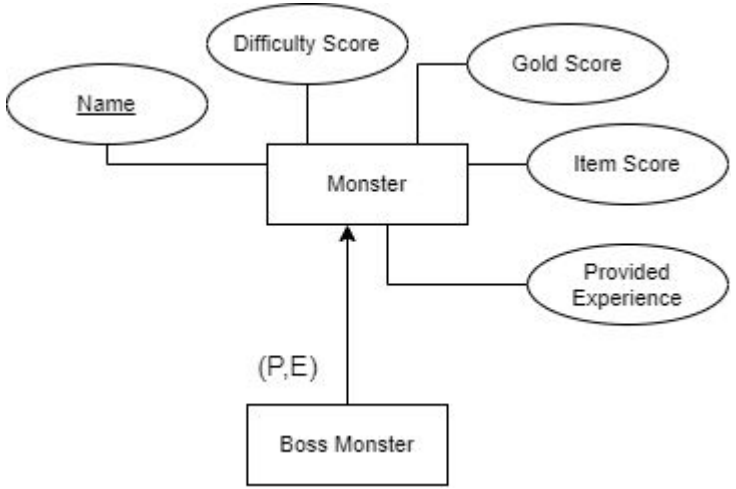
Do not forget the “Gold” attribute

Exercise 2 - Solution

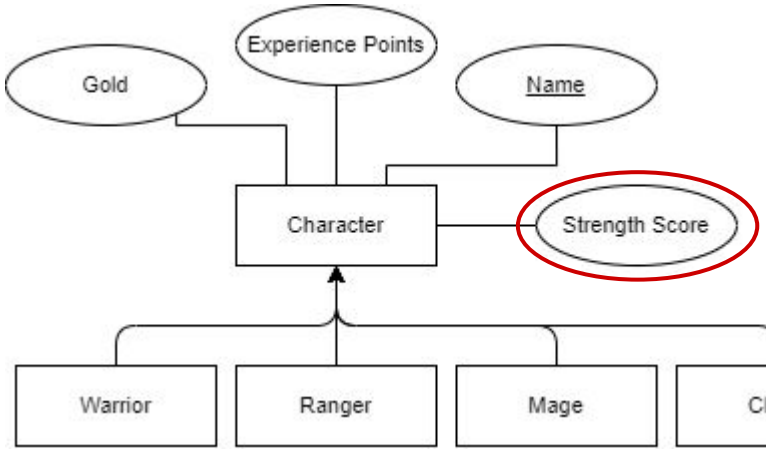
ITEM - WEAPON



MONSTER - BOSS MONSTER



Exercise 2 - Thinking



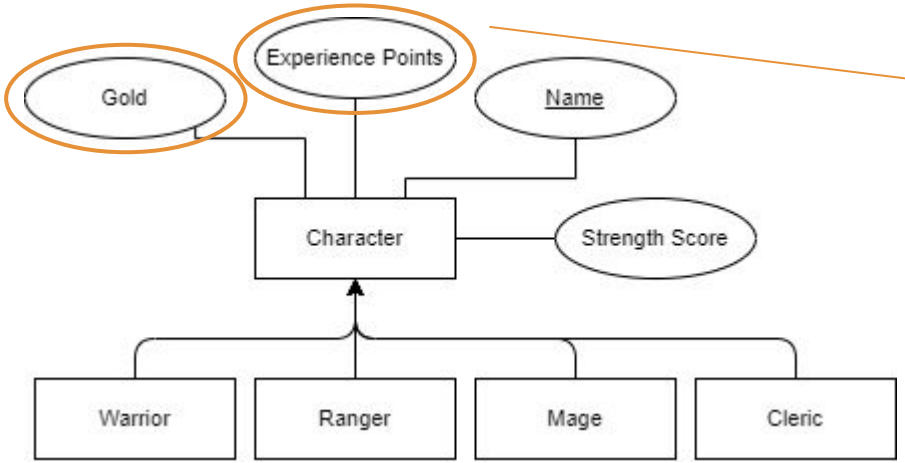
Is it really that important?

It can be derived from “Weapons”

Redundancy

What if the “Strength Score” would depend also on the “Experience Points”?

Exercise 2 - Thinking



Can we remove “Gold” and “Experience Points” based on the same statement we made before?

Yes, they can be derived.

No, they should be kept.

Assumption: “Experience Points” are only earned.

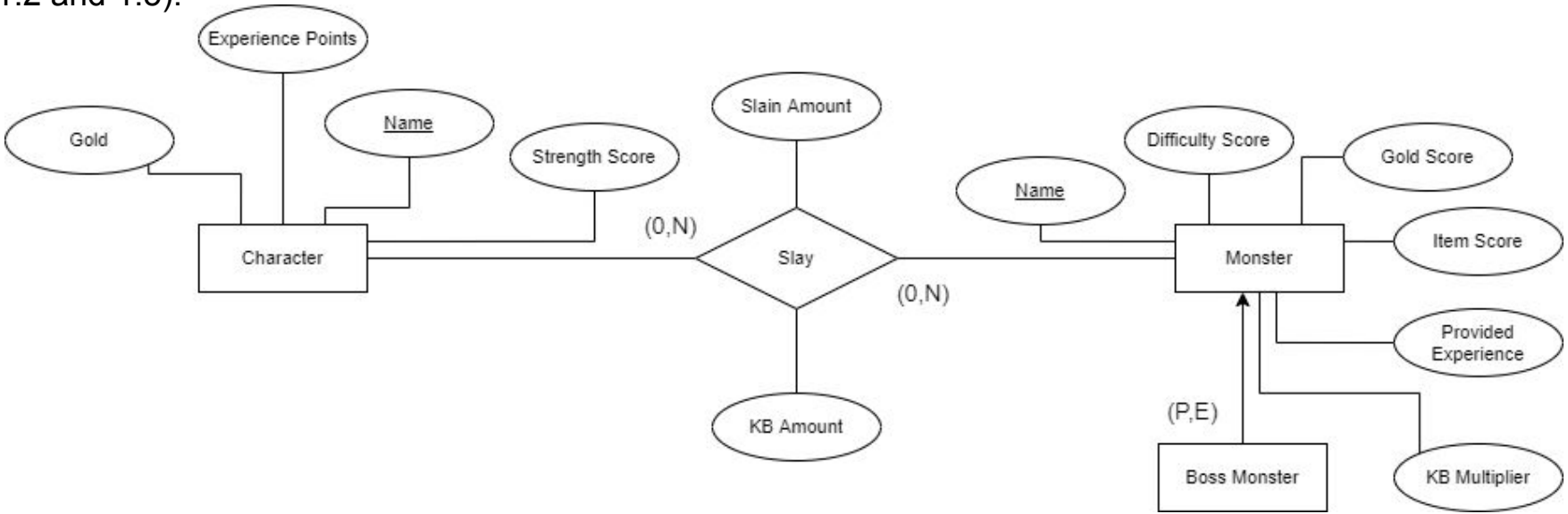
Assumption: “Gold” can be spent.

Exercise 2 - Solution

Link

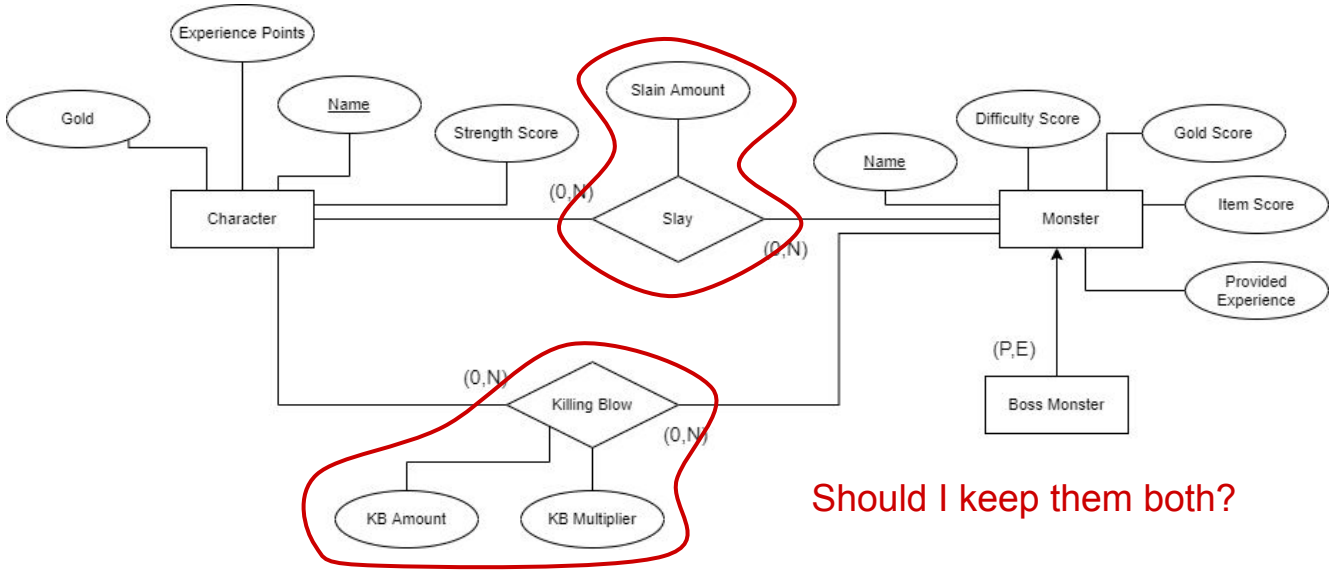
Exercise 2 - Extra I

A new update introduces a new mechanic in the game, named “Killing Blow”, that awards the player that kills the monster with extra experience points, based on a “Monster Killing Blow Multiplier” score (between 1.2 and 1.5).



Exercise 2 - Extra II

A new update balances the “Killing Blow” mechanics. It now awards the player that kills the monster with extra experience points, based on a “Killing Blow Multiplier” score (between 0.5 and 1.5) that is assigned depending on how well the player fought the monster.



Exercise 2 - Extra II

Character Name	Monster Name	KB Amount	KB Multiplier
Axel	Goblin	15	1.2
Axel	Goblin	10	1.5
Axel	Goblin	8	1.0

Standard Kill

Yes - From a data perspective, we can only keep “Killing Blow” even though the name of the relationship would change drastically. Therefore, we could assume we keep slay and add a simple “Slay Modifier”.

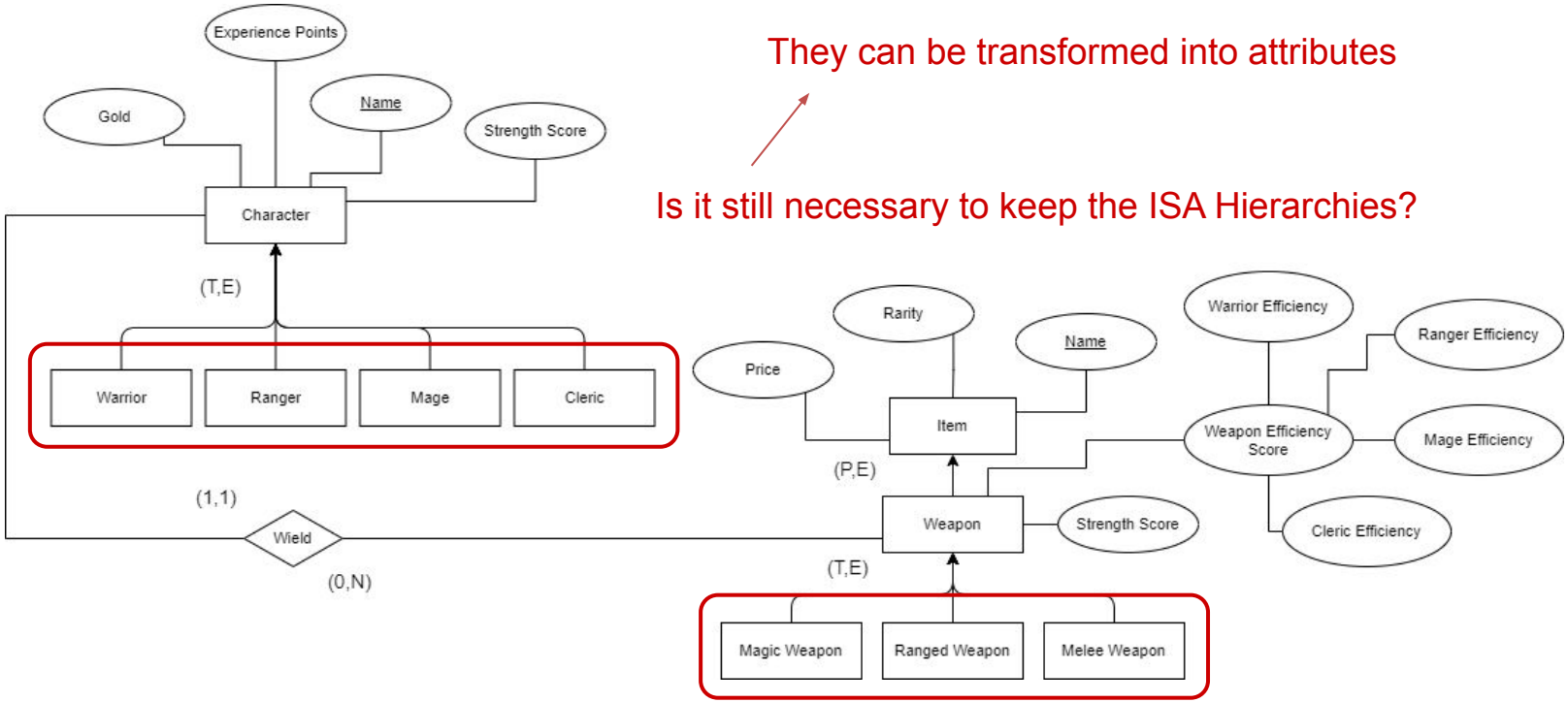
No - We should keep them both for clarity of their meaning and for text coherence.

Exercise 2 - Extra III

While balancing the “Killing Blow” mechanics, the developers unintentionally introduce a bug. In particular, players can now equip weapons regardless of the class of their character, but they can only equip one weapon.

As the developers investigate such a bug, they introduce a temporary solution. They implemented a “Weapon Efficiency Score” that defines a multiplier for each weapon to reduce the effectiveness of weapons incorrectly equipped. Different weapons have different multipliers.

Exercise 2 - Extra III

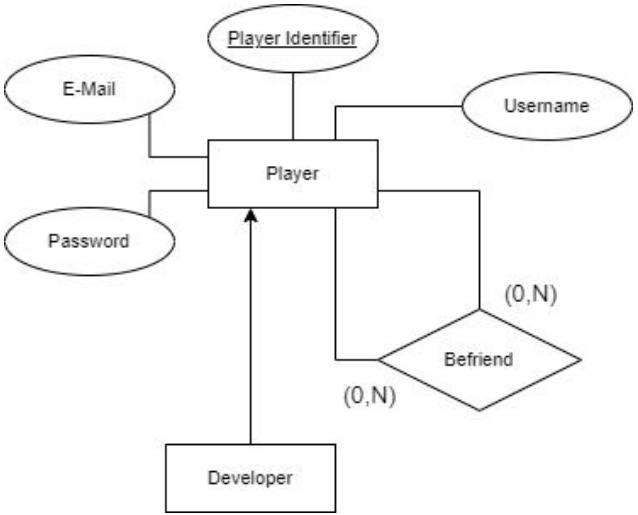


They can be transformed into attributes

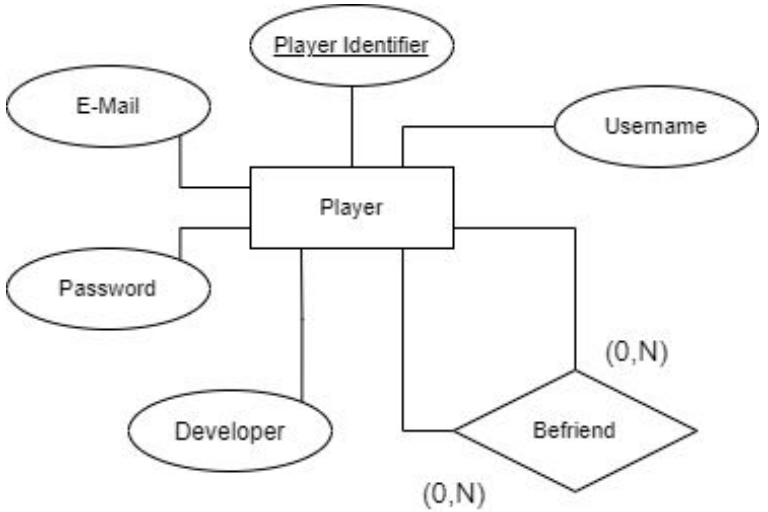
Is it still necessary to keep the ISA Hierarchies?

Exercise 2 - Extra IV

The developers noticed that moderating the game as the players are playing is needed. Therefore, they decided to start playing the game as players. Developers have the same attributes of players, although they have a special tag named “DEV” associated with their account.



OR



Exercise 2 - Extra IV

The developers have decided that allowing players to add developers to their friends is not a good practice. They therefore introduce an update to prevent such an action.