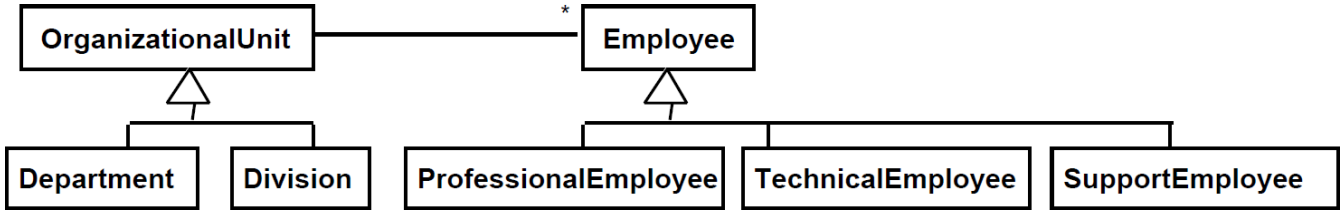
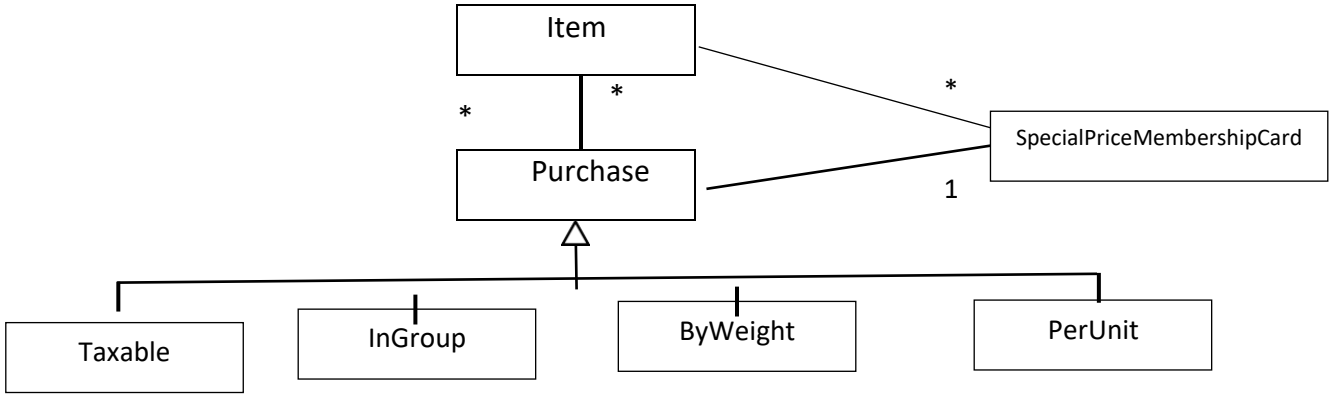
Practical exercises: Class diagrams

Draw a class diagram corresponding to the following situations.

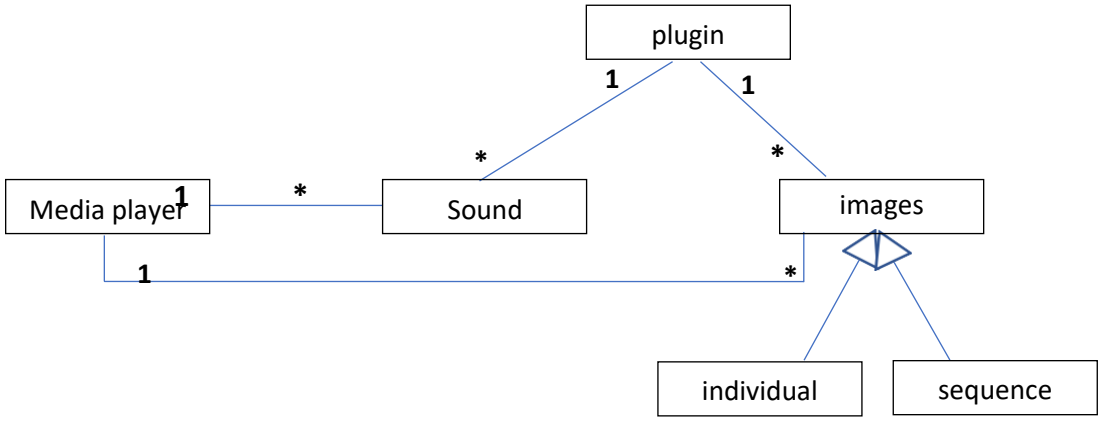
1. An organization has three categories of employees: professional staff, technical staff and support staff. The organization also has departments and divisions. Each employee belongs to either a department or a division Assume that people will never need to change from one category to another.



2. A grocery store has some items sold by weight, and some per unit. Some items are taxable, while others are not. Some items have special prices when sold in groups (e.g. 3 for $2). Finally, some items have special prices if you have certain ‘membership cards’. There could be several different membership prices on the same item, but you can only use one membership card per purchase.



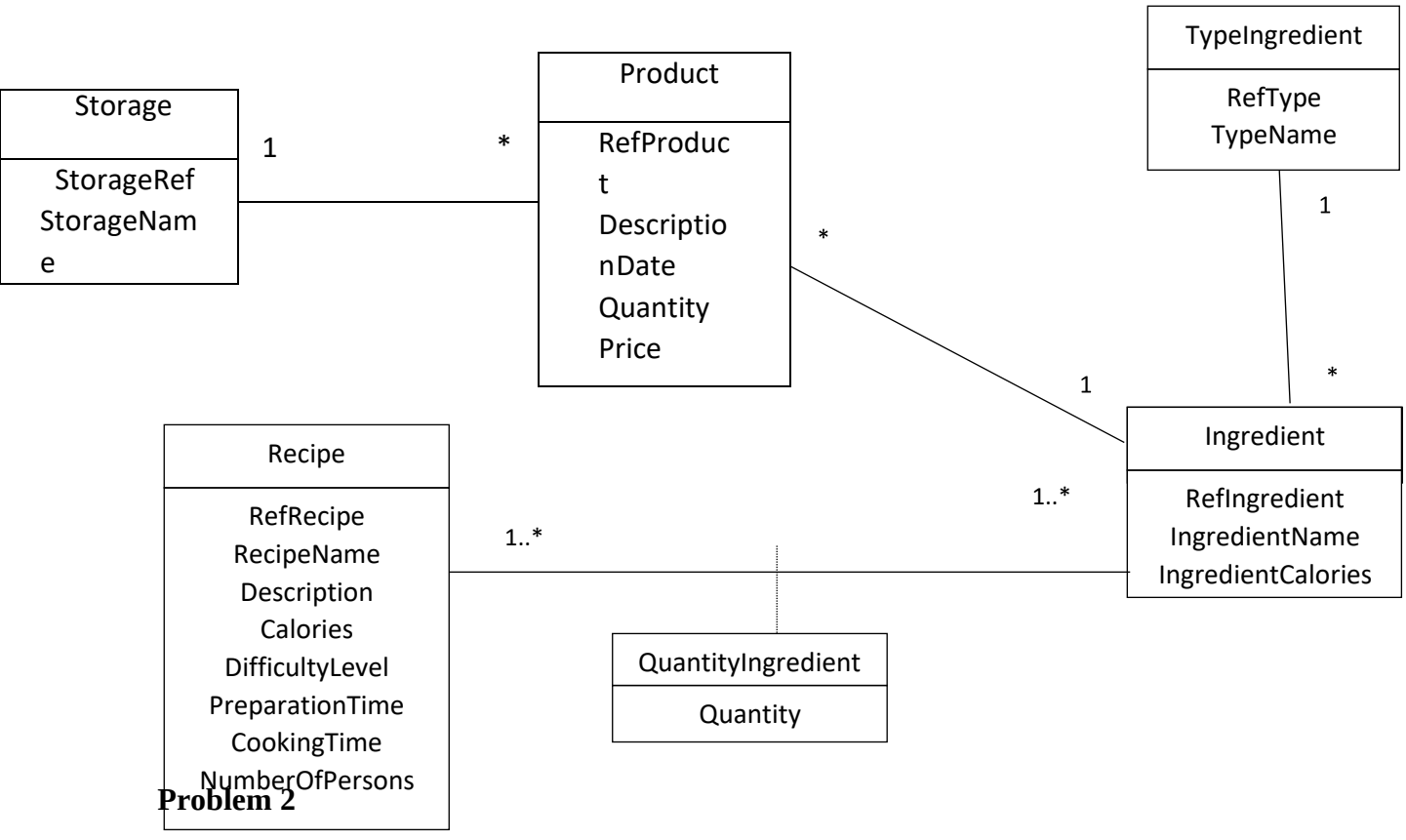
3. A media player that can handle sound, images and sequences of images. Each type of media requires a ‘plugin’, although some plugins can handle more than one type of media.



Draw a class diagram corresponding to the following problems.

Problem 1

You are asked to create a database for storing cooking recipes and managing the stocks of the ingredients you have. Each cooking recipe has a name, a description, the preparation time and the cooking time, the number of calories per person, the number of portions and the level of difficulty: difficult, medium or easy. For each recipe you want to know what ingredients are needed and the amount associated with each ingredient. For each ingredient you have its name and the number of calories per 100 grams of that ingredient. Each ingredient has a type, for example starchy for the potato ingredient. The same ingredient can have several packages, for example, the flour ingredient can be stored in the form of a 1 kg or 500 g package. These two packaging will be considered as different products. To manage the stocks of the ingredients, the place of storage of the products in the accommodation is memorized. Each storage unit is named and for each storage unit you know which products are stored there. The same ingredient can be stored in several storage spaces



Problem 2

We're interested in a company that manufactures engine components. In terms of production means, the company has 6 factories, one of which is dedicated to assembly. Manufacturing includes a machining phase, a heat and surface treatment phase, then assembly of the sub-assemblies that will be integrated into the engines. The sales department receives customer orders every day. Given the manufacturing deadlines (cycles of 8 to 15 months), customers in a hurry can place priority orders but at the price of an overcharging of 20% of the order. The factories then treat them as a priority. Large customers (more than 10 orders per year) are also given priority. After a technical check of the items ordered, the sales department enters the order into a computer and obtains, as an output, the breakdown of the assemblies composed of elementary components which belong to two distinct categories:

- Parts manufactured by the company
- Sub-contracted parts

It then prints a list of "in-house" components intended for the factories and a list of subcontracted components intended for the company's inventory management service for supply. This service also manages the bi-monthly supply of raw materials. The global order is sent to the assembly plant, which can only finalize the order after receipt of all the required components.

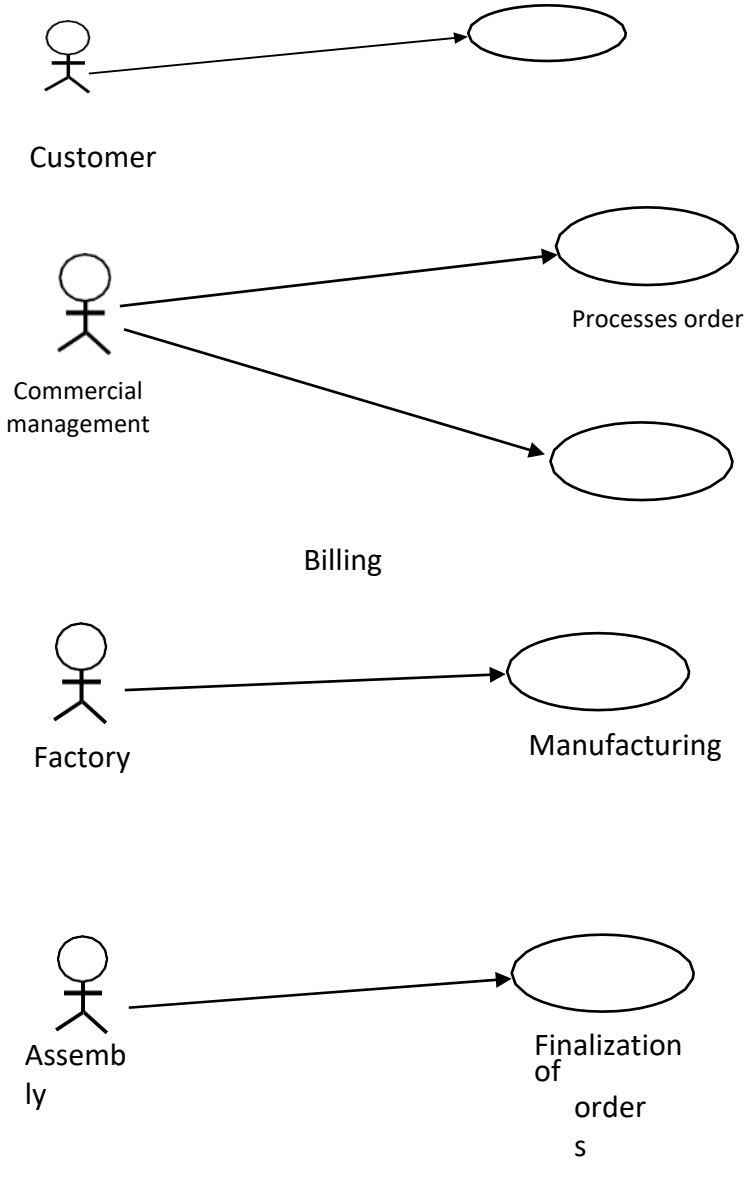
Changes (endorsements) to customer orders can be made after the order has been placed, in order to amend: the article codes (in the case of a technical evolution of the article), or the other characteristics of the item (deadline, quantity ordered, etc.).

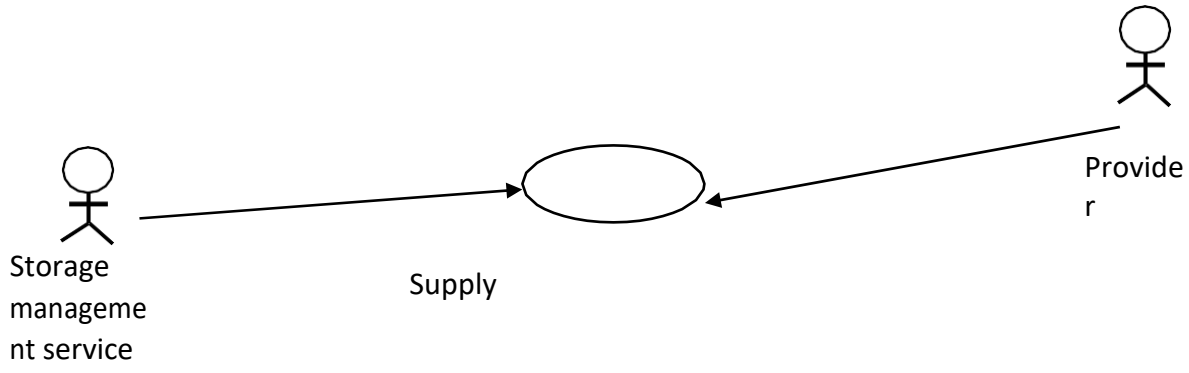
The sales department is also responsible for monitoring invoicing. Actual costs are recorded per order received, with management of the number of hours spent (productive hours transmitted by factories) and the value (purchase price) of raw materials or semi-finished parts from various suppliers (supplied by the stock management service). The invoice is then sent to the assembly plant, which also manages the delivery of the order.

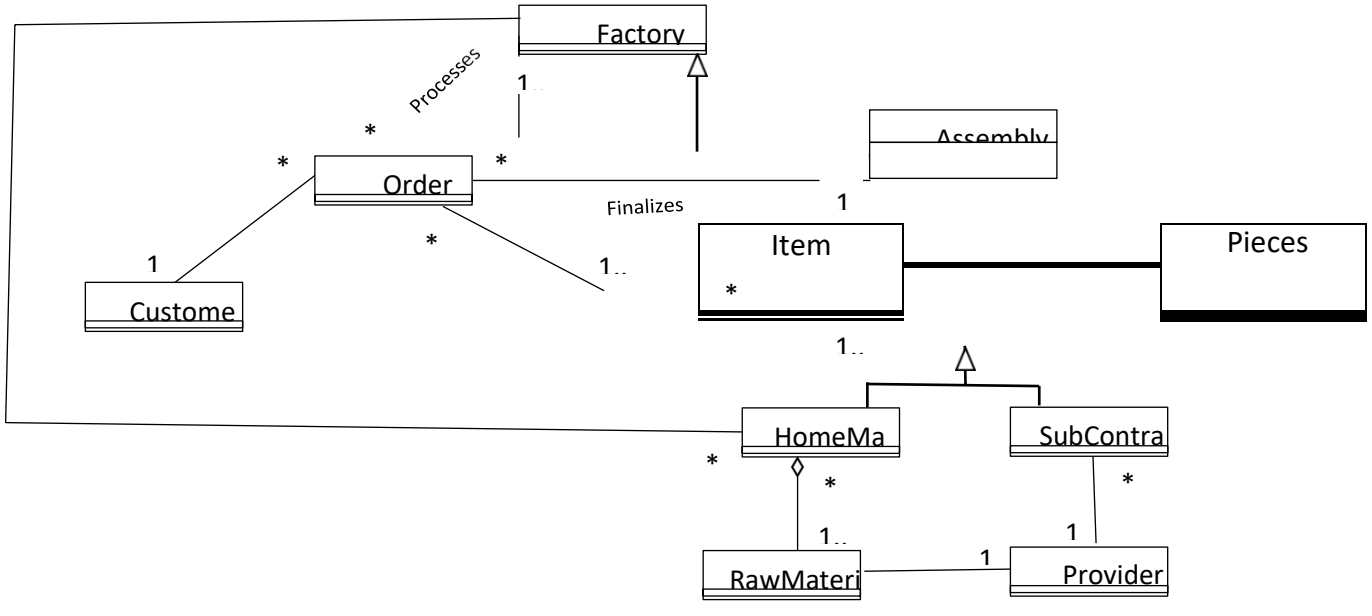
Work to do:

1. Give the diagram of the use cases of this system
2. Give a class diagram of this system.
3. Describe the scenario "Processing an order" using a sequence diagram.

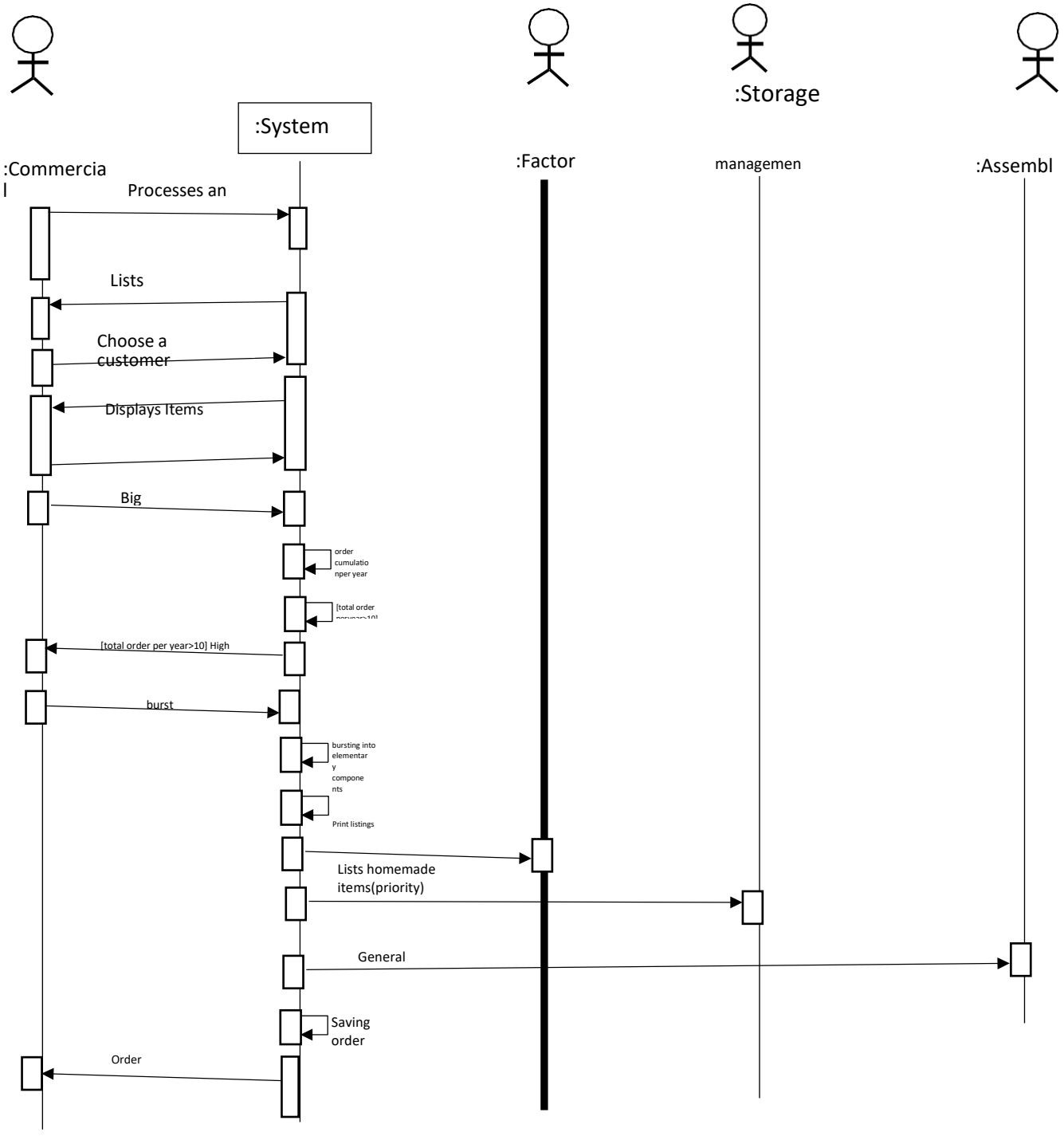
1. Use cases




Provide
r
Storage
manageme
nt service
Supply


Factory
Processes
1
*
*
*
Order
Finalizes
1
Assembly
1
*
1
Custome
Item
*
Pieces
1
HomeMa
SubContra
*
*
*
1
1
RawMateri
1
Provider

2. Sequence diagram for the scenario “Processing order”



Problem 3

We are interested in an express home delivery company. Customer service receives customers every daywho want delivery in France or abroad. This service manages two categories of packages:
Light packages or letters whose weight is at 2 kg,

Heavy packages or packages weighing> 2 kg.

The price is calculated according to the weight of the package and its destination with a flat rate of 10Euros if the customer chooses a shipment with acknowledgment of receipt. The Customer Service records the references of the customer packages (sender + recipient contact details, weight, etc.) on a computer and prints out a receipt for the customer. The invoicing of light packets destined for France isalso managed by this service. Once the payment has been made, the service forwards the package to the Logistics Department for delivery.

Heavy packages, for international destinations, must comply with customs regulations and must thereforebe subject to heavier procedures which extend their delivery time by at least 48 hours and are over-invoicedby 10%. In particular, the customer must complete and sign a transport package that specifies the natureand the value of the content of the package (s) to be transported. The package, accompanied by this document, is sent to the company's Export department.

Packages weighing more than 20 kg or, the content of which is listed in a list of goods well defined by customs regulations, must undergo formalities with French customs, in conjunction with the Export service.The package cannot be forwarded before the customs agreement which is materialized by a slip with the references of the package to be forwarded and the amount of the tax charged to the customer. The export department of the company then transmits the information to the billing department. The latter then, issues the final invoice to the customer. After payment, the Export department is informed and transmits the package with the customs slip to the Logistics service which takes care of the delivery.

WORK TO DO:
Give the use case diagram that describes how this company works.

Describe the static structure of this system using a class diagram.

Describe the main scenario triggered by Customer Service using a sequence diagram.

Analysis and design of Minesweeper game

The goal of this case study is to design a minesweeper game like the one that ships with the Microsoft Windows © operating system. The aim of the game is to find all the squares on the board containing mines as quickly as possible without touching them.

The game consists of a rectangular board, a stopwatch and a mine counter. The board is a grid of boxes. At the start of the game, all the squares on the board are covered, the mine counter indicating the number of mines remaining to be located. The stopwatch counts the number of seconds since the start of the game. The game begins when the first box is discovered. When a box is discovered, its content is displayed. The content of a box can be nothing or a mine or a number indicating the number of mines present in the neighboring boxes. The following scenarios can occur when a box is discovered, depending on its content:

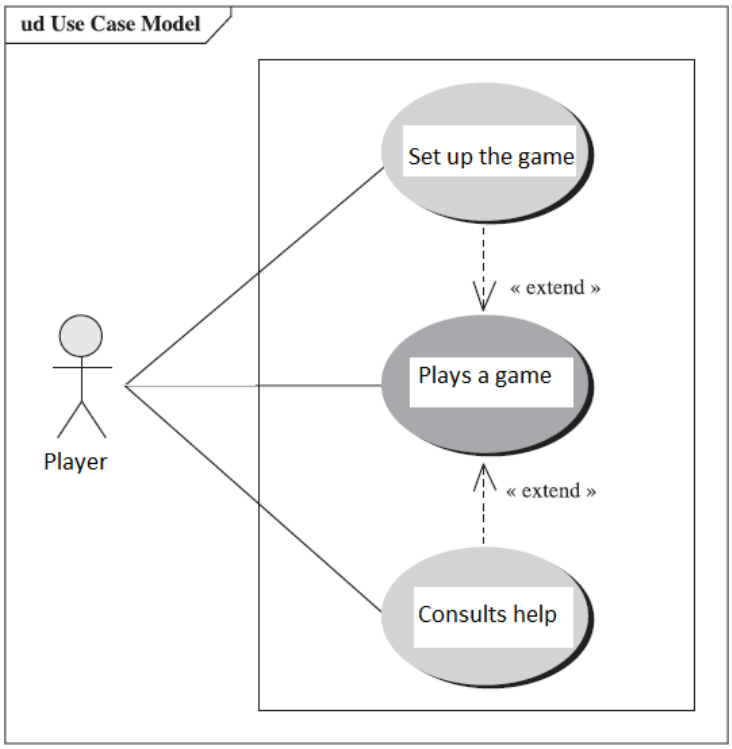
1. A number - Nothing happens.
2. A blank - All neighboring boxes are exposed, in condition that were not reported by a flag. If one of these neighboring boxes contains nothing, the discovery process automatically continues from this box.
3. A mine - The game is over, and the player has lost.

If it is still covered, a box can be marked according to the following rules:

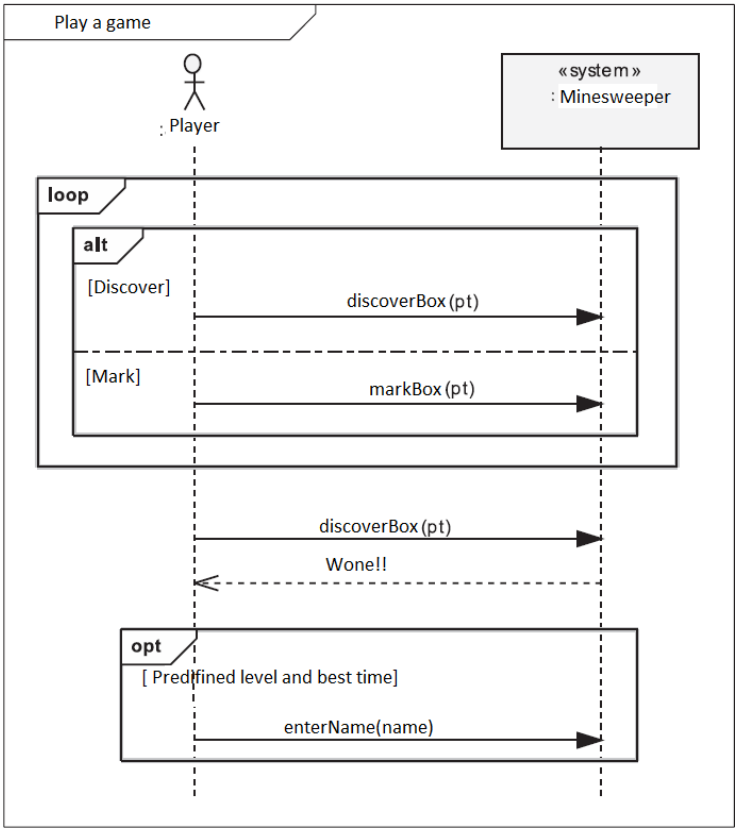
Marking a box that is neither discovered nor marked decrements the remaining mine counter and a flag appears on the box. He indicates that this box potentially contains a mine. A square marked with a flag cannot be discovered.

- Marking an already flagged box with a flag will restore it to its original state, i.e. covered and unmarked. The mine counter is then incremented by 1.

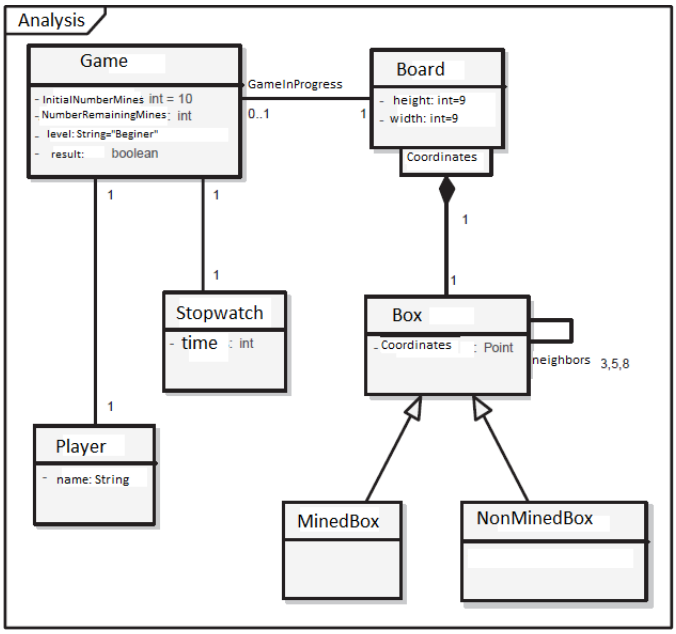
a. Develop a use case diagram for the Minesweeper game.



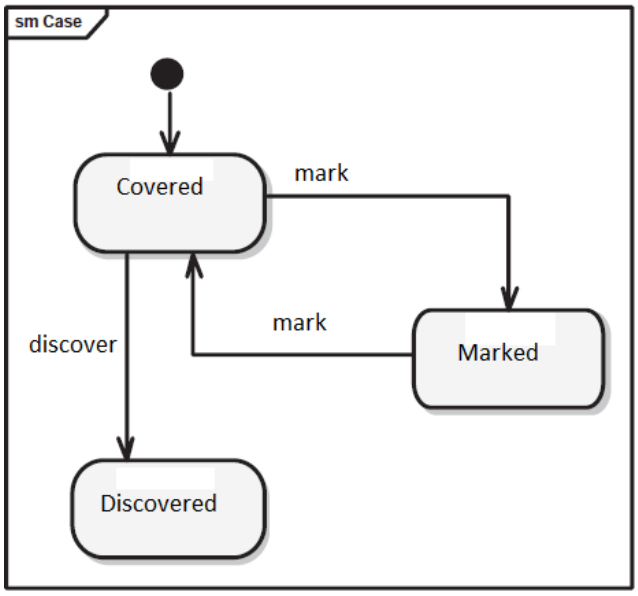
b. Develop a sequence diagram for the "Play Minesweeper" use case.



c. Propose a class diagram for this system.



d. Draw a state diagram for this system.

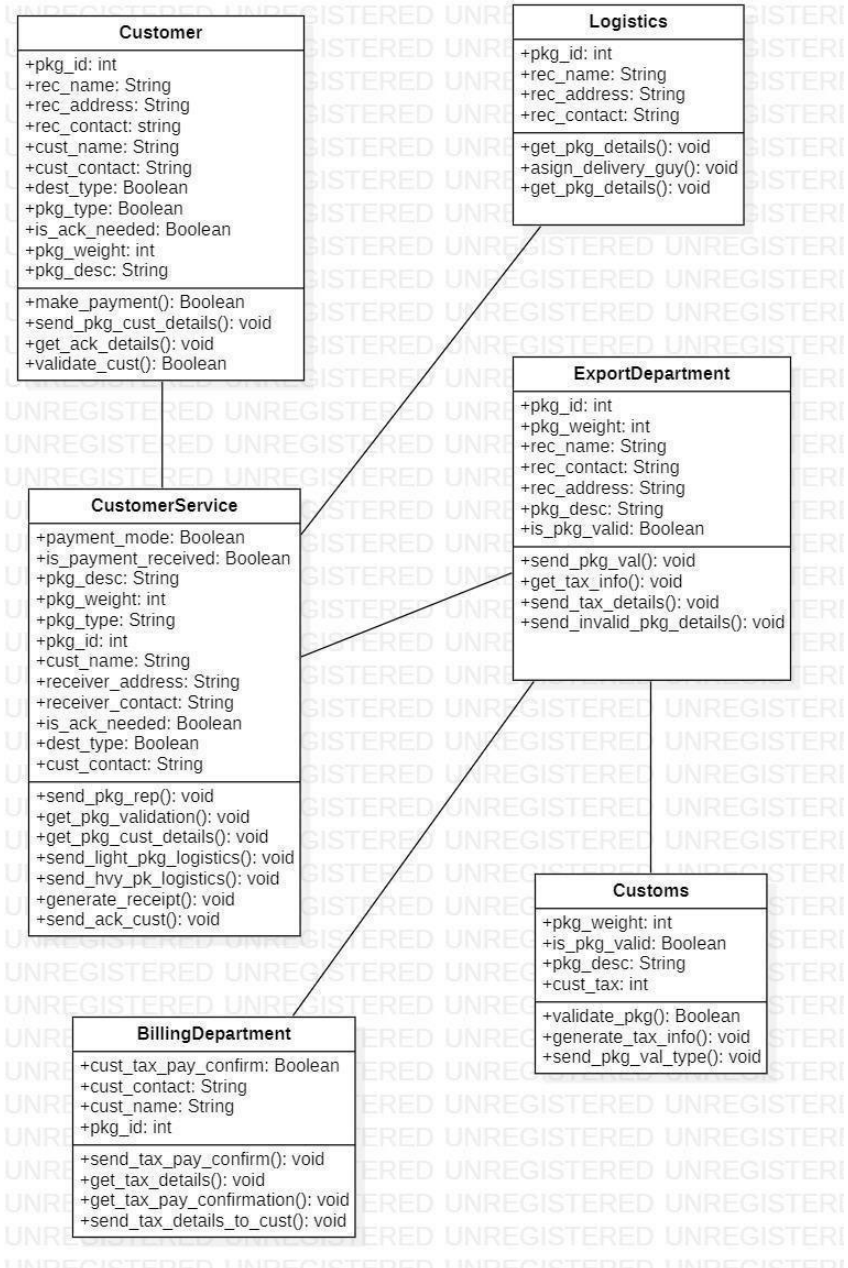


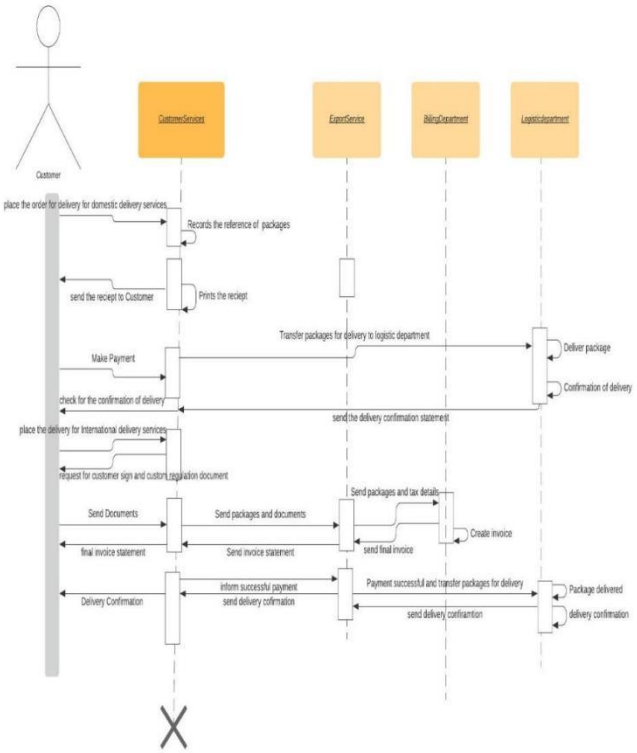
Problem: We are interested in an express home delivery company. Customer service receives customers every day who want delivery in France or abroad. This servicemanages two categories of packages: Light packages or letters whose weight is? at 2 kg,Heavy
packages or packages weighing> 2 kg.
The price is calculated according to the weight of the package and its destinationwith a flat rate of 10 Euros if the customer chooses a shipment with acknowledgment of receipt. The Customer Service then records the references ofthe customer packages (sender + recipient contact details, weight, etc.) on a computer and prints out a receipt for the customer. The invoicing of light packetsor destined for France is also managed by this service. Once the payment has been made, the service forwards the package to the logistics department for delivery.

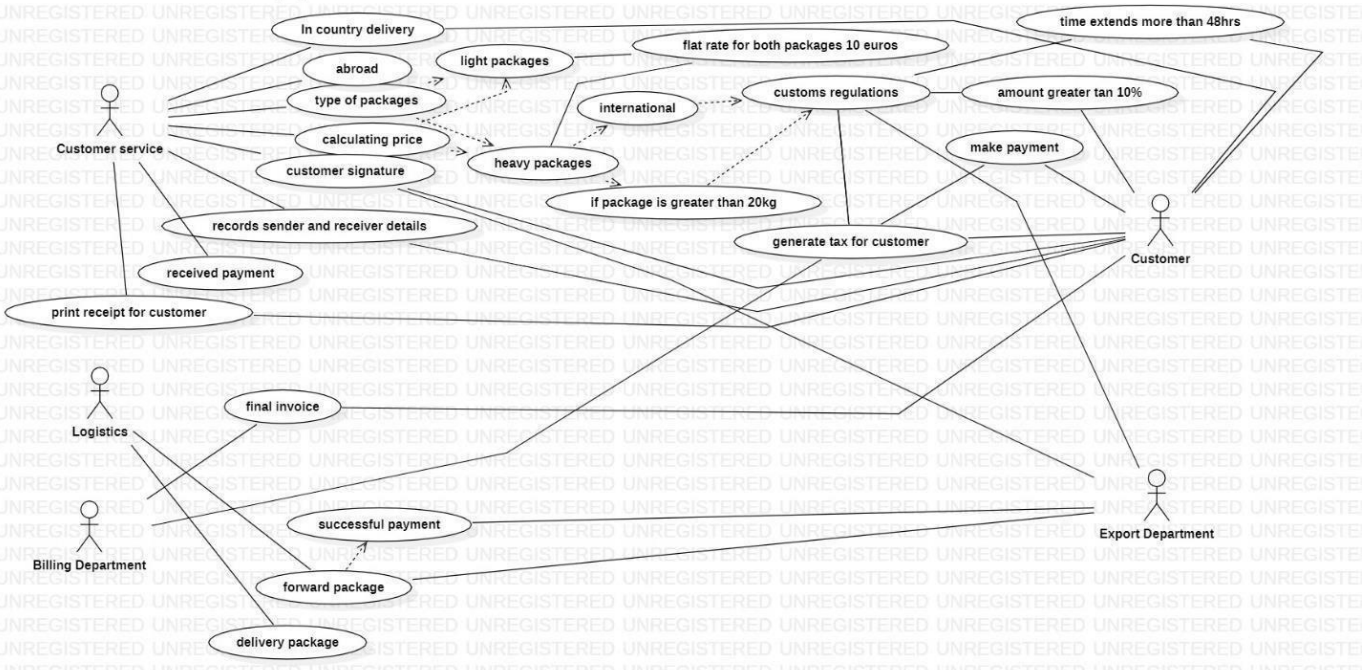
Heavy packages, for international destinations, must comply with customs regulations and must therefore be subject to heavier procedures which extendtheir delivery time by at least 48 hours and are over-invoiced by 10%. In particular, the customer must complete and sign a transport package which specifies the nature and the value of the content of the package (s) to be transported. The package, accompanied by this document, is sent to the company's Export department.
Packages weighing more than 20 kg or, the content of which is listed in a list of goods well defined by customs regulations, must undergo formalities with Frenchcustoms, in conjunction with the Export service. The package cannot be forwarded before customs agreement which is materialized by a slip with the references of the package to be forwarded and the amount of the tax charged to the customer. The export department of the company then transmits the information to the billing department. The latter then issues the final invoice to the customer. After payment, the Export department is informed and transmits the package with the customs slip to the logistics service which takes care of the delivery.

WORK TO DO:

1. **Give the use case diagram that describes how this company works.**
2. **Describe the static structure of this system using a class diagram.**
3. **Describe the main scenario triggered by Customer Service using a sequencediagram.**


Customer
+pkg_id: int
+rec_name: String
+rec_address: String
+rec_contact: string
+cust_name: String
+cust_contact: String
+dest_type: Boolean
+pkg_type: Boolean
+is_ack_needed: Boolean
+pkg_weight: int
+pkg_desc: String
+make_payment(): Boolean
+send_pkg_cust_details(): void
+get_ack_details(): void
+validate_cust(): Boolean
Logistics
+pkg_id: int
+rec_name: String
+rec_address: String
+rec_contact: String
+get_pkg_details(): void
+asign_delivery_guy(): void
+get_pkg_details(): void
ExportDepartment
+pkg_id: int
+pkg_weight: int
+rec_name: String
+rec_contact: String
+rec_address: String
+pkg_desc: String
+is_pkg_valid: Boolean
+send_pkg_val(): void
+get_tax_info(): void
+send_tax_details(): void
+send_invalid_pkg_details(): void
CustomerService
+payment_mode: Boolean
+is_payment_received: Boolean
+pkg_desc: String
+pkg_weight: int
+pkg_type: String
+pkg_id: int
+cust_name: String
+receiver_address: String
+receiver_contact: String
+is_ack_needed: Boolean
+dest_type: Boolean
+cust_contact: String
+send_pkg_rep(): void
+get_pkg_validation(): void
+get_pkg_cust_details(): void
+send_light_pkg_logistics(): void
+send_hvy_pk_logistics(): void
+generate_receipt(): void
+send_ack_cust(): void
Customs
+pkg_weight: int
+is_pkg_valid: Boolean
+pkg_desc: String
+cust_tax: int
+validate_pkg(): Boolean
+generate_tax_info(): void
+send_pkg_val_type(): void
BillingDepartment
+cust_tax_pay_confirm: Boolean
+cust_contact: String
+cust_name: String
+pkg_id: int
+send_tax_pay_confirm(): void
+get_tax_details(): void
+get_tax_pay_confirmation(): void
+send_tax_details_to_cust(): void


Customer
CustomerServices
ExportService
BillingDepartment
LogisticsDepartment
place the order for delivery for domestic delivery services
Records the reference of packages
send the receipt to Customer
Prints the reciept
Transfer packages for delivery to logistic department
Deliver package
Make Payment
Confirmation of delivery
check for the confirmation of delivery
send the delivery confirmation statement
place the delivery for International delivery services
request for customer sign and custom regulation document
Send packages and tax details
Send Documents
Send packages and documents
Create invoice
final invoice statement
Send invoice statement
send final invoice
inform successful payment
Payment successful and transfer packages for delivery
Package delivered
Delivery Confirmation
send delivery confirmation
send delivery confiramtion
delivery confirmation


In country delivery
abroad
type of packages
calculating price
customer signature
light packages
heavy packages
international
customs regulations
flat rate for both packages 10 euros
time extends more than 48hrs
amount greater tan 10%
make payment
if package is greater than 20kg
generate tax for customer
Customer service
records sender and receiver details
received payment
print receipt for customer
Customer
Logistics
final invoice
Billing Department
successful payment
forward package
delivery package
Export Department

Problem: UML

This exercise is for a simplified supermarket cash register system. Thenormal procedure for using the cash register is as follows:

- **A customer arrives at the checkout with items to pay.**
- **The cashier records the identification number of each item, as well asthe quantity if it is greater than one.**
- **The checkout displays the price of each item and its description.**
- **When all purchases are recorded, the cashier signals the end of the sale.**
- **The cash register displays the total purchases.**
- **The customer chooses his method of payment:**

✓ **cash: the cashier collects the money received; the cashier indicates thecurrency to be returned to the customer;**

✓ **check: the cashier checks the creditworthiness of the customer by transmitting a request to an authorization center via the cashier;**

✓ **credit card: a bank terminal is part of the cash register. It transmits an authorization request to an authorization center according to the typeof card.**

- **The cash register registers the sale and prints a receipt.**
- **The cashier gives the customer the receipt.**

After the items have been entered, the customer can present discount coupons for certain items to the cashier. When payment is completed, the checkout transmits information on the number of items sold to theinventory management system.

Every morning, the store manager initializes the cashes register for theday.

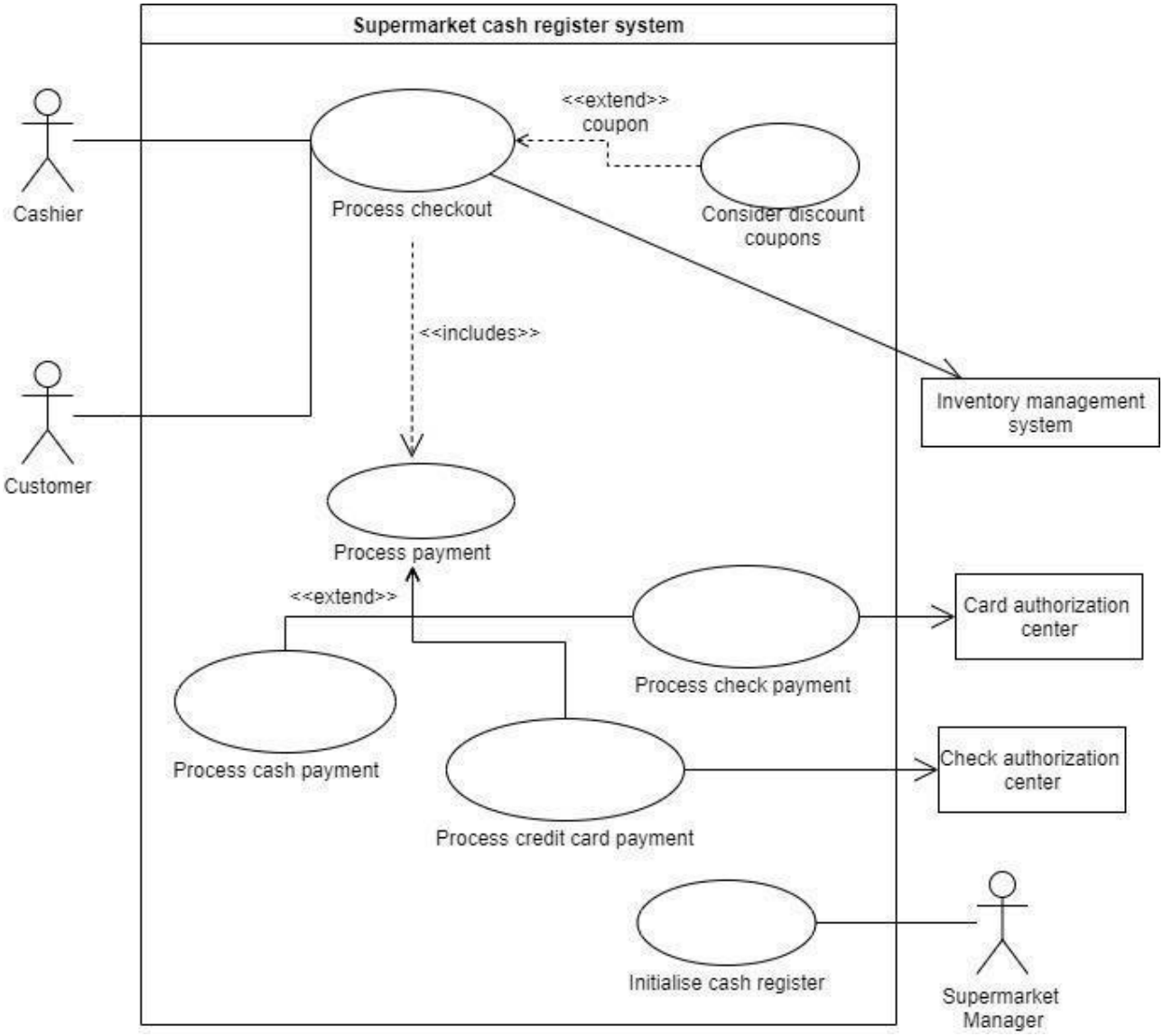
1. **Write a detailed use case diagram for the cash register. Feel free to usethe use case relationships to make your diagram more precise.**

2. **Write an essential detailed description of the main use case: PROCESS CHECKOUT. (See Textual Use Case Description Example in 7. Modelingwith UML Part 2, slide 10).**

3. **Write a system sequence diagram that describes the nominal scenario ofthe essential use case PROCESS CHECKOUT, considering only cash payment.**

4. **Show by a state diagram the forced succession of the system operations forthe case of PROCESS CHECKOUT use, always considering only cash payment.**

5. **Expand the diagram in 4) by considering the different types of payment, aswell as the other actions of the cashier.**

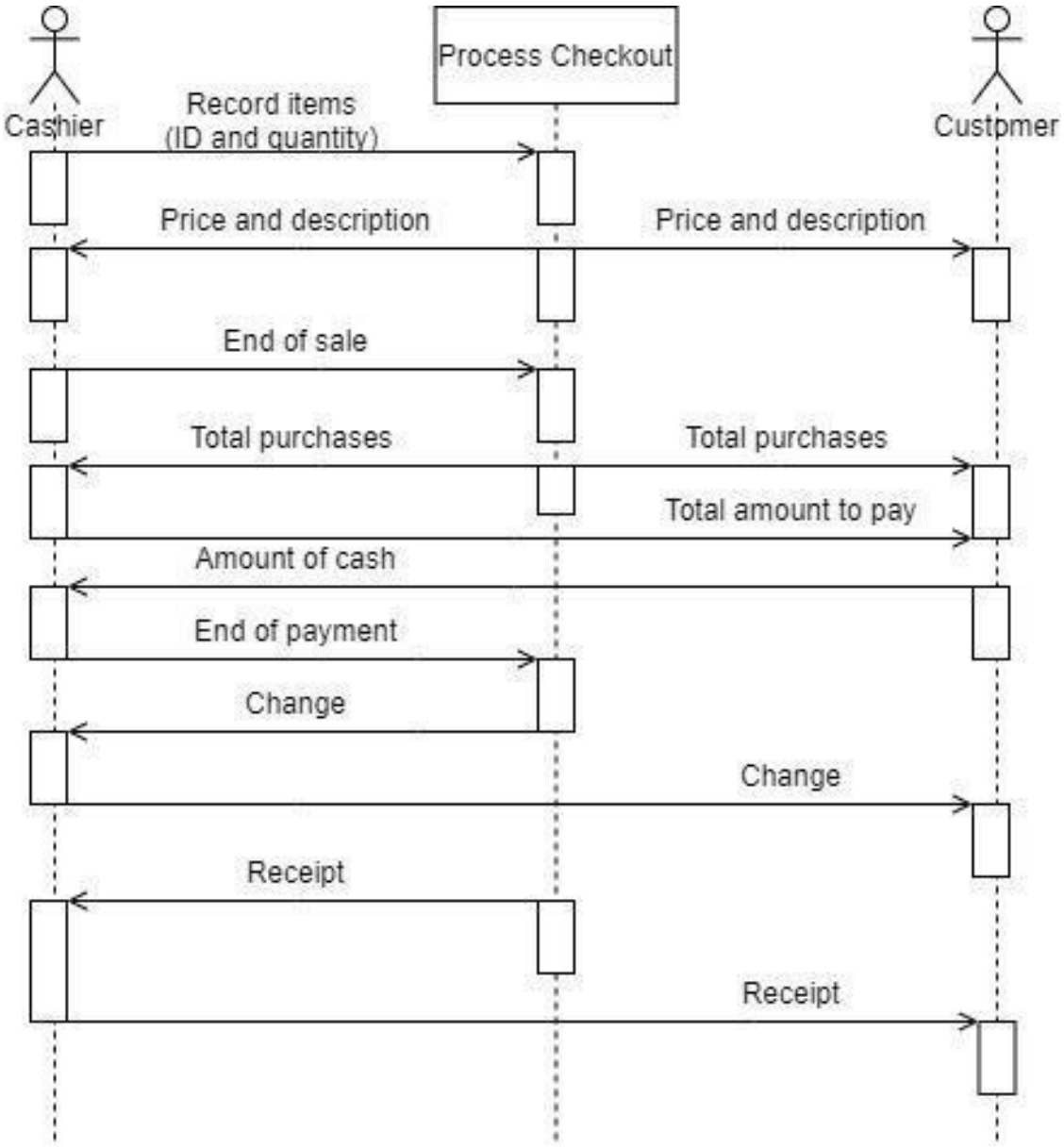

Supermarket cash register system
Cashier
Customer
Process checkout
<<extend>>
coupon
Consider discount coupons
<<includes>>
Inventory management system
Process payment
<<extend>>
Process check payment
Card authorization center
Process cash payment
Process credit card payment
Check authorization center
Initialise cash register
Supermarket Manager

2. Write an essential detailed description of the main use case: PROCESS CHECKOUT. (SeeTextual Use Case Description Example in 7. Modeling with UML Part 2, slide 10).

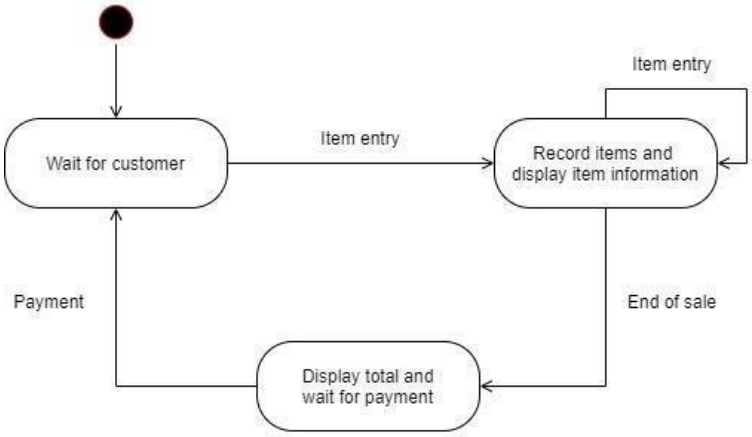
   Detailed Description:

   Name: Process Checkout
   Participating actors: Cashier (primary), Customer (secondary)
   Entry conditions:
   Cash register is open and cashier present
   Exit condition:
   Payment has been completed and receipt given
   Flow of events:
   1. The customer arrives at the checkout with items to purchase
   2. The cashier records all items' ID and quantity
   3. The cash register displays the price and description of each item
   4. Once all items are recorded, the cashier signals the end of the sale
   5. The cash register displays the total purchases and the cashier informsthe customer about the total amount to pay
      The customer chooses their method of payment
      a. If cash: the cashier collects the money and returns the change
      b. If check: the cashier checks the creditworthiness with a request toan authorization center
      c. If credit: the cash register sends an authorization request to a authorization center
      The cash register records the purchase and prints a receipt
      The cashier gives the receipt to the customer
      The customer leaves with purchased items
   Special requirements: Customer must be able to pay, otherwise an errorwill occur
   Exceptional cases:
   C1: The customer has a discount coupon C1 starts after step 3
      The customer gives discount coupon to the cahier
      The cashier processes the discount an adjusts the priceThe flow continues with step 4

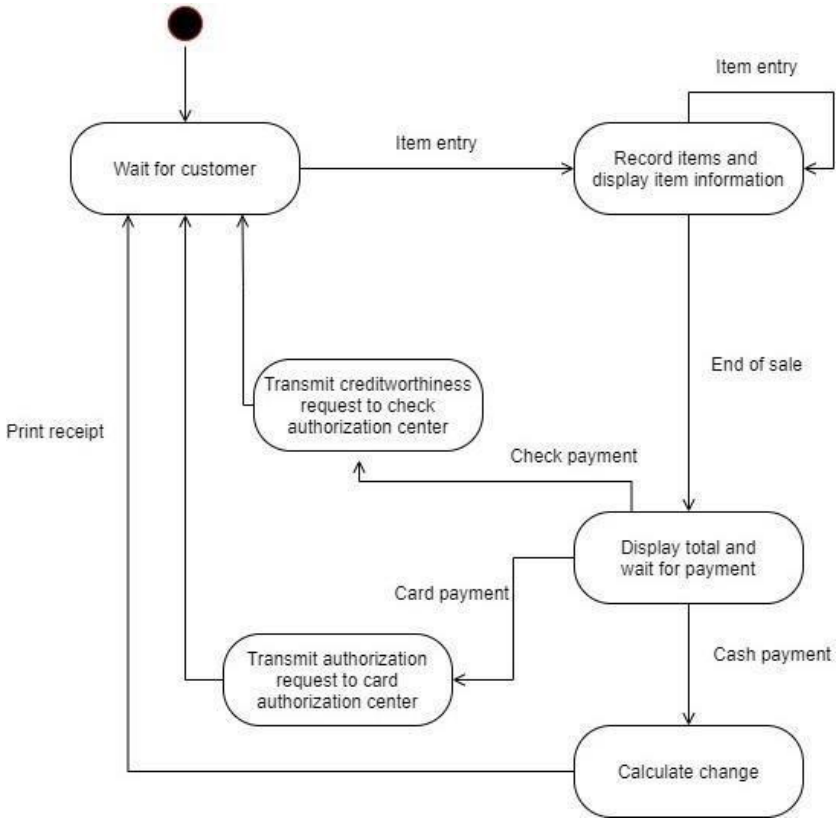
3. Write a system sequence diagram that describes the nominal scenario of the essential use casePROCESS CHECKOUT, considering only cash payment



4. Show by a state diagram the forced succession of the system operations for the case of PROCESSCHECKOUT use, always considering only cash payment.



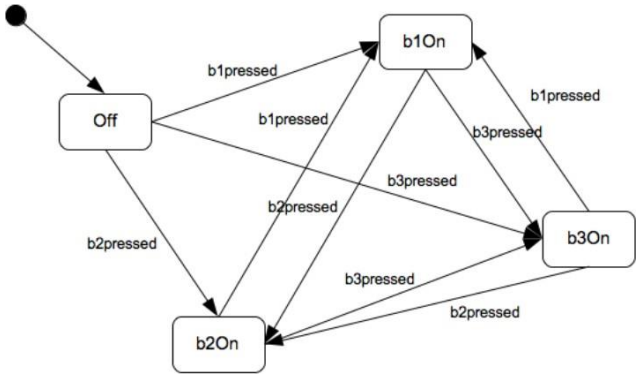
5. Expand the diagram in 4) by considering the different types of payment, as well as the otheractions of the cashier.



Practical exercises: Behavior modelling

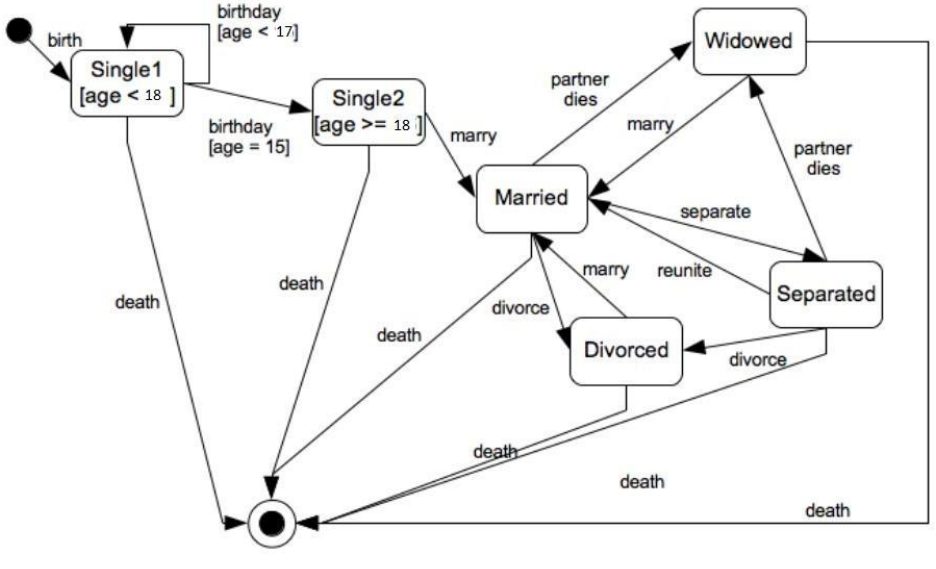
Exercise 1

Draw a state chart for a set of three radio buttons, b1, b2, and b3. The buttons are all initially off (unpressed). Subsequently, if one button is pressed, it goes on and all the others go off.



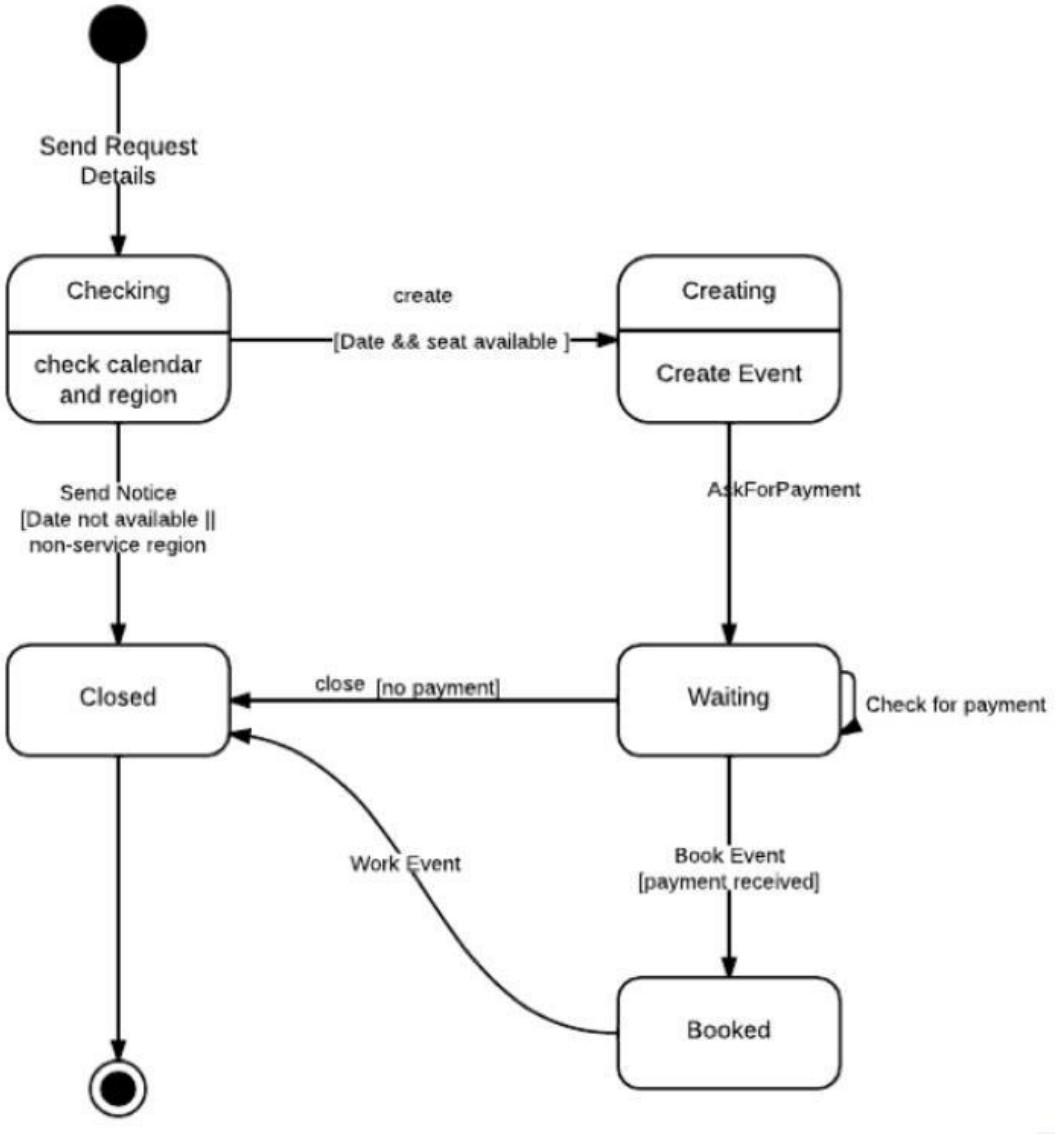
Exercise 2

Draw a state chart to describe one's marital status.



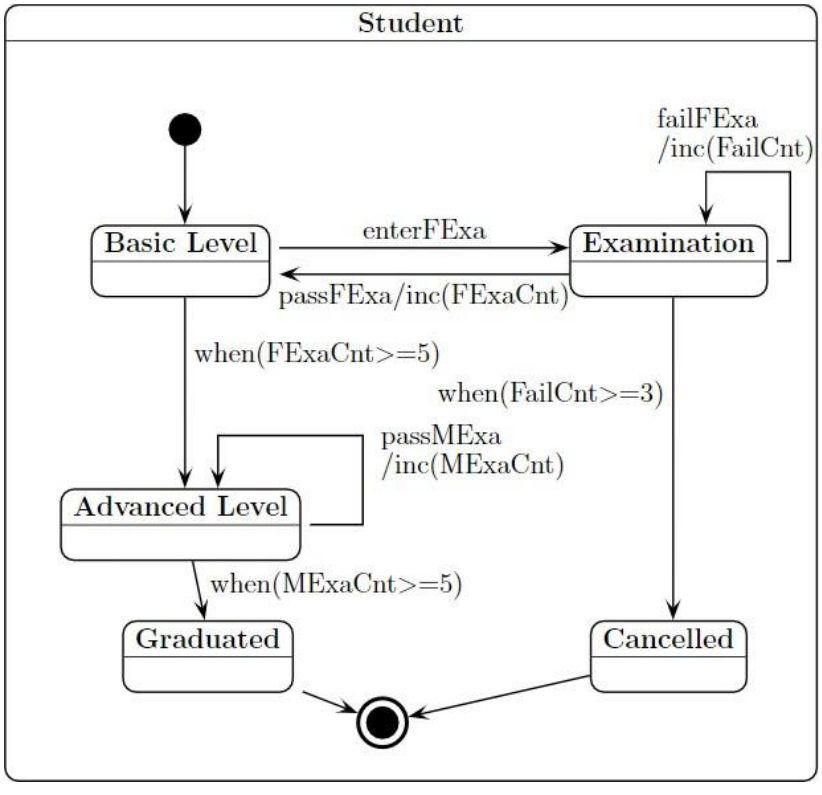
Exercise 3

Draw a state chart to describe the process of booking a set for some special event.



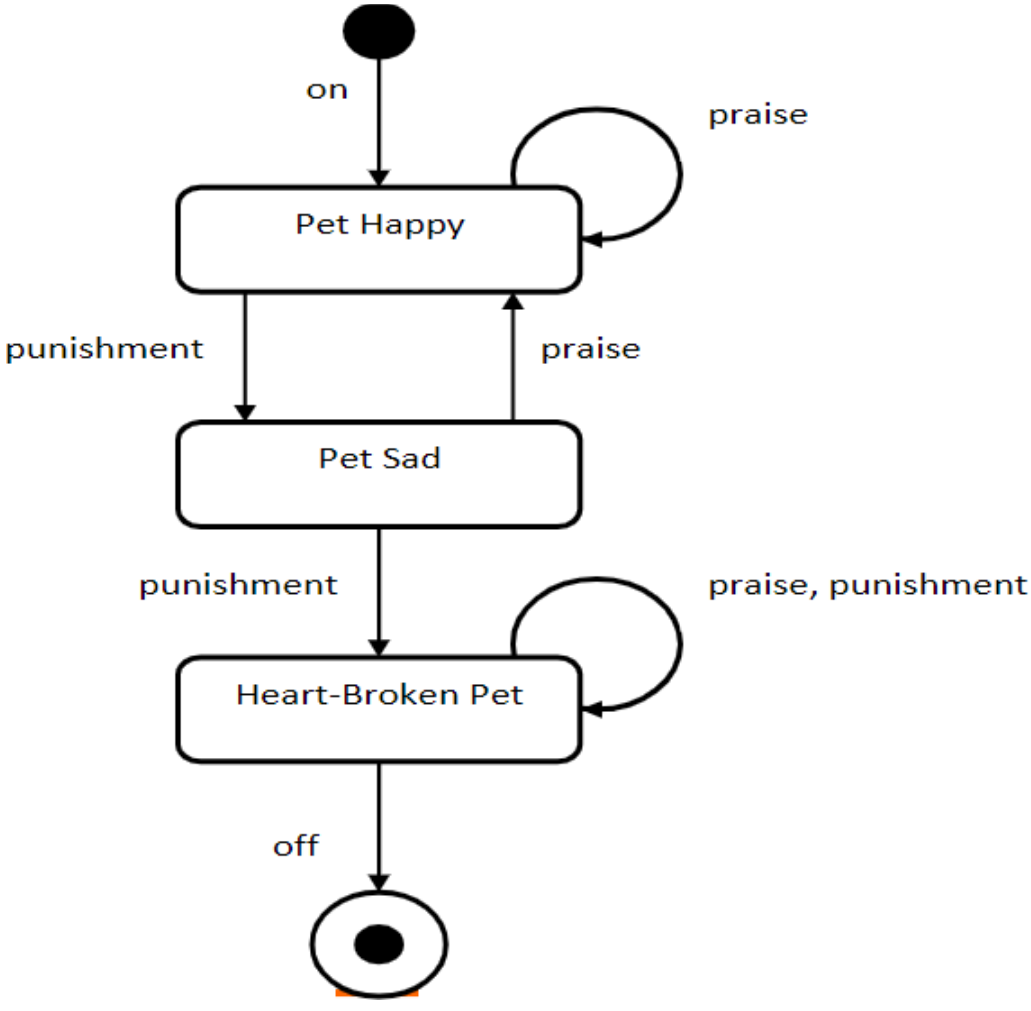
Exercise 4

A student must complete the basic level before entering the advanced level. After both levels, the student has to pass five examinations. An examination can be retaken at most twice. After the third failed attempt, the student's registration is cancelled. Draw the corresponding state chart diagram.



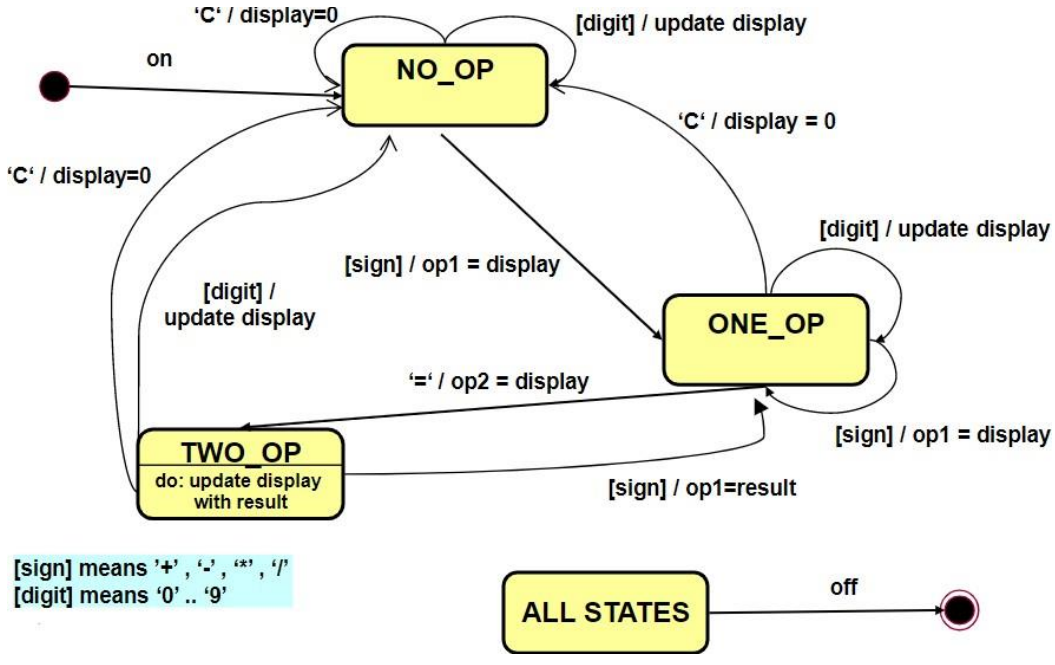
Exercise 5

You are creating a digital pet program. What happens to the pet when he receives different stimuli is determined by the state he is in, so you decide to model the digital pet with a state diagram. The behavior of the digital pet program is as follows: When the pet is turned on, it starts out happy. If the pet is happy and receives punishment, then he becomes sad. If the pet is sad and receives praise, it becomes happy. If the pet is sad and receives punishment, it is heart broken. Identify the states and transitions of the digital pet and draw a state diagram.



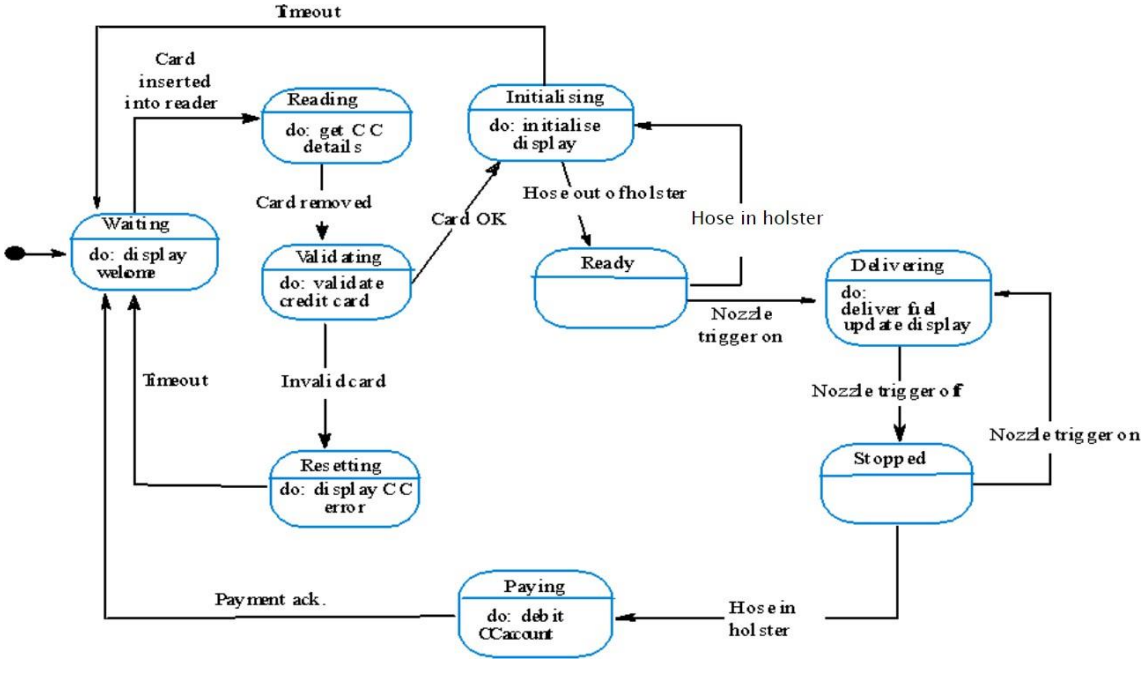
Exercise 6

Draw a state chart of a simple calculator. The interface of the calculator is composed of ten buttons with digits, and four buttons with the basic operations (+, -, *, /). The button “C” resets the display. The button “=” displays the result. This simple calculator contains the buttons “On” and “OFF”.



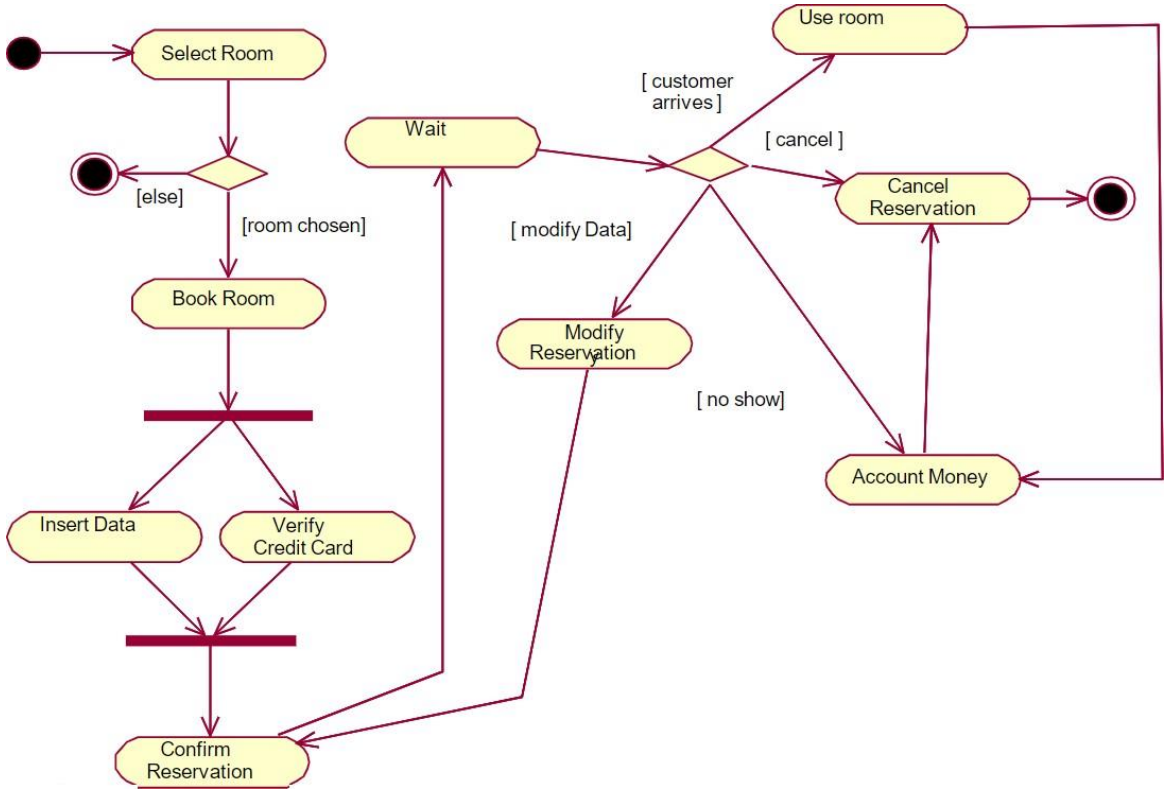
Exercise 7

Model the behavior of a fuel pump controller. User can buy fuel after inserting a credit card, which is read and validated by the controller. Then the user takes the hose out of the holster, and pushes the nozzle trigger, to fuel his car. When the nozzle is off, the fuel flow is stopped and the price is charged on the credit card. If invalid card or timeout the system returns to the initial waiting state.



Exercise 8: Booking a Room in a hotel

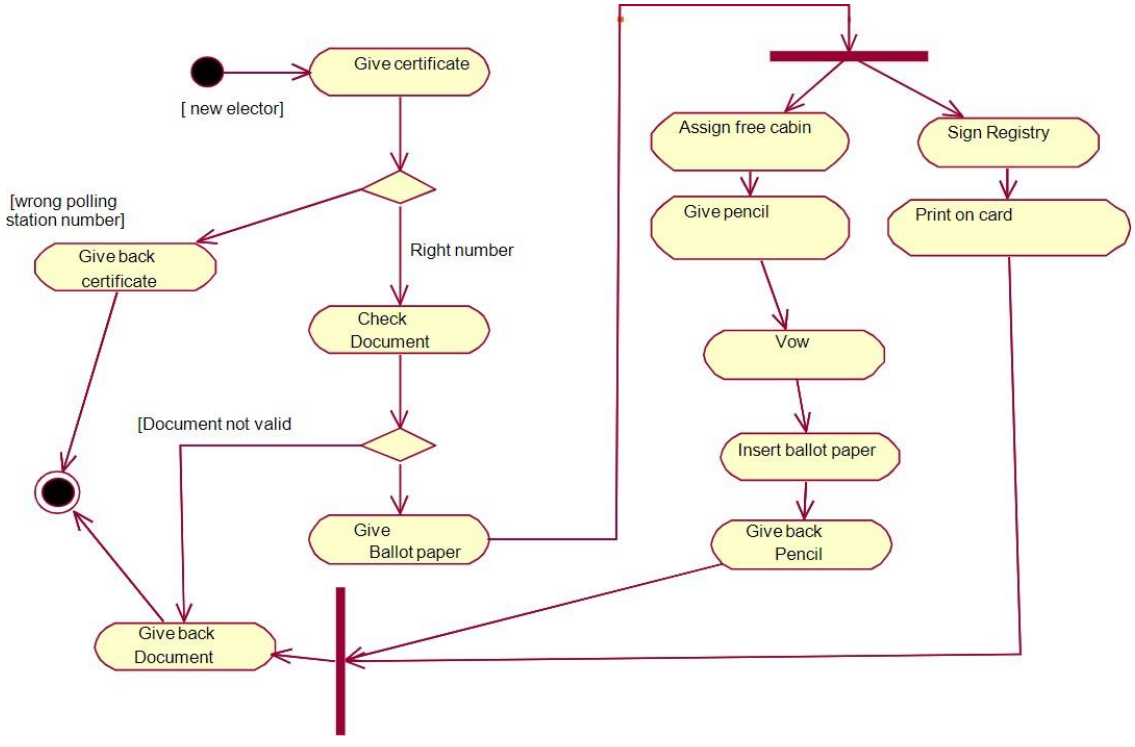
When customer requests a room, the hotel employee looks for room availability, then he insert customer's data and verifies if the provided credit card number has enough credit to pay the room: in this case the booking is confirmed and we wait customer arrival. The Hotel information system allows customer to modify or cancel his/her reservation. If the customer arrives, he uses the room and then he pays, in case of no-show a penalty is accounted on his credit card and the booking is canceled. Model the process with an activity diagram.



Exercise 9: Voting

Once arrived at the polling station, elector gives the own electoral card to station president who checks if the polling station number is right. Then he checks the identity document and if ok he gives the ballot paper to the elector. Then the president waits for a cabin to get free, and he gives the pencil to the elector and a secretary who signs the registry and put a print on the elector certificate. Once an elector has voted, he/she

inserts the ballot paper in the urn, giving back the pencil and taking back the own ID document. Modelthe process with an activity diagram.



The class diagram for shopping cart.