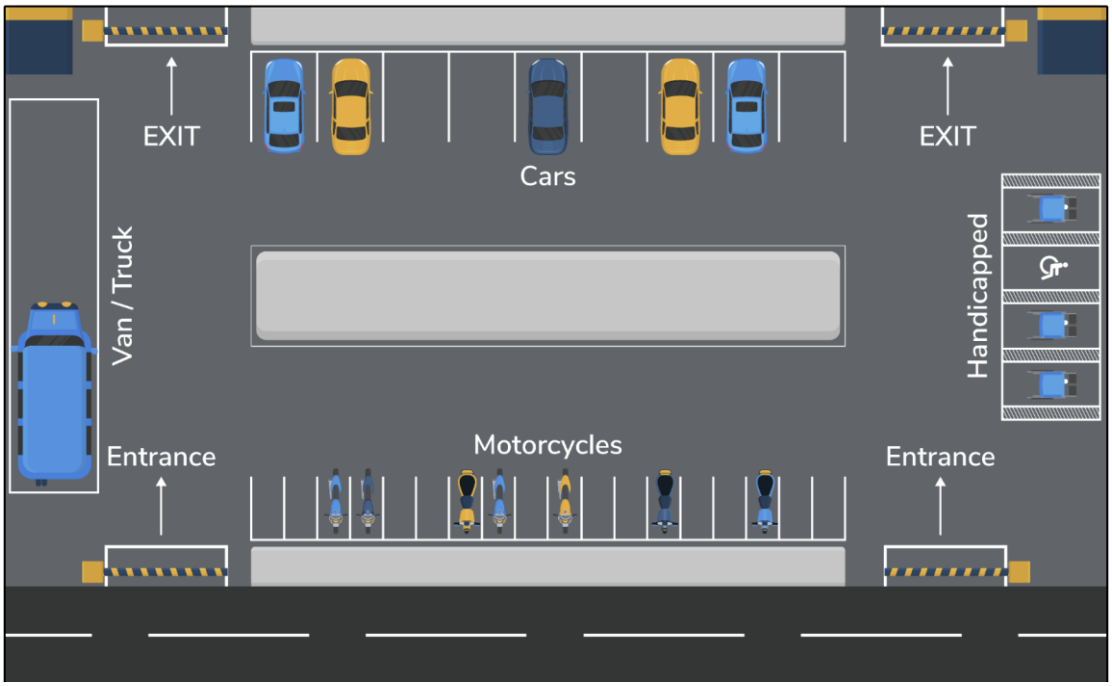
Parking Lot

Problem definition

A **parking lot** is a designated area for parking vehicles and is a feature found in almost all popular venues such as shopping malls, sports stadiums, offices, etc. In a parking lot, there are a fixed number of parking spots available for different types of vehicles. Each of these spots is charged according to the time the vehicle has been parked in the parking lot. The parking time is tracked with a parking ticket issued to the vehicle at the entrance of the parking lot. Once the vehicle is ready to exit, it can either pay at the automated exit panel or to the parking agent at the exit using a card or cash payment method.



Expectations from the interviewee

In a typical parking lot system, there are several components each with specific constraints and requirements. The following section provides an overview of some major expectations the interviewer will want an interviewee to discuss in more detail during the interview.

Payment flexibility

One of the most significant attributes of the parking lot system is the payment structure that it provides to its customers. An interviewer would expect you to ask questions like these:

- How are customers able to pay at different exit points (i.e., either at the automated exit panel or to the parking agent) and by different methods (cash, credit, coupon)?
- If there are multiple floors in the parking lot, how will the system keep track of the customer having already paid on a particular floor rather than at the exit?

Parking spot type

Another topic of discussion that an interviewer would expect you to be aware of is the different parking spot types—handicapped, compact, large, and motorcycle—regarding which you can ask the following questions:

- How will the parking capacity of each lot be considered?

- What happens when a lot becomes full?
- How can one keep track of the free parking spots on each floor if there are multiple floors in the parking lot?
- How will the division of the parking spots be carried out among the four different parking spot types in the lot?

Vehicle types

Similar to the parking spot, an interviewer would also expect you to discuss the different vehicle types—car, truck, van, motorcycle—which can have the following set of questions:

- How will capacity be allocated for different vehicle types?
- If the parking spot of any vehicle type is booked, can a vehicle of another type park in the designated parking spot?

Pricing

We touched upon the payment structure offered by the parking lot system. Now, the pricing model needs to be clarified from the interviewer, and therefore you may ask questions like these:

- How will pricing be handled? Should we accommodate having different rates for each hour? For example, customers will have to pay $4$4 for the first hour, $3.5$3.5 for the second and third hours, and $2.5$2.5 for all the subsequent hours.
- Will the pricing be the same for the different vehicle types?

Design approach

We are going to design this parking lot system using the bottom-up design approach. For this purpose, we will follow the steps below:

- Identify and design the smallest components first, like, the vehicle and parking spot types.
- Use these small components to design bigger components, for example, the payment system at the exit.
- Repeat the steps above until we design the whole system like the parking lot.

Requirements for the Parking Lot Design

This is a very crucial step since requirements define the scope of a problem, so getting them right from the interviewer and understanding them well will make the design of the rest of the system smooth and easy.

Requirements collection

Let’s define the requirements for the parking lot problem:

R1: The parking lot should have the capacity to park 40,000 vehicles.

R2: The four different types of parking spots are handicapped, compact, large, and motorcycle.

R3: The parking lot should have multiple entrance and exit points.

R4: Four types of vehicles should be allowed to park in the parking lot, which are as follows:

- Car
- Truck

- Van
- Motorcycle

R5: The parking lot should have a display board that shows free parking spots for each parking spot type.

R6: The system should not allow more vehicles in the parking lot if the maximum capacity (40,000) is reached.

R7: If the parking lot is completely occupied, the system should show a message on the entrance and on the parking lot display board.

R8: Customers should be able to collect a parking ticket from the entrance and pay at the exit.

R9: The customer can pay for the ticket either with an automated exit panel or pay the parking agent at the exit.

R10: The payment should be calculated at an hourly rate.

R11: Payment can be made using either a credit/debit card or cash.

We've identified our requirements for the problem. Next, we will define different use cases of our parking lot system.

Use Case Diagram for the Parking Lot

Let's build the use case diagram of the parking lot system and understand the relationship between its different components.

First, let's define the different elements of our parking lot, followed by the complete use case diagram of the system.

System

Our system is a "parking lot."

Actors

Here are the main actors of our parking lot system.

Primary actors

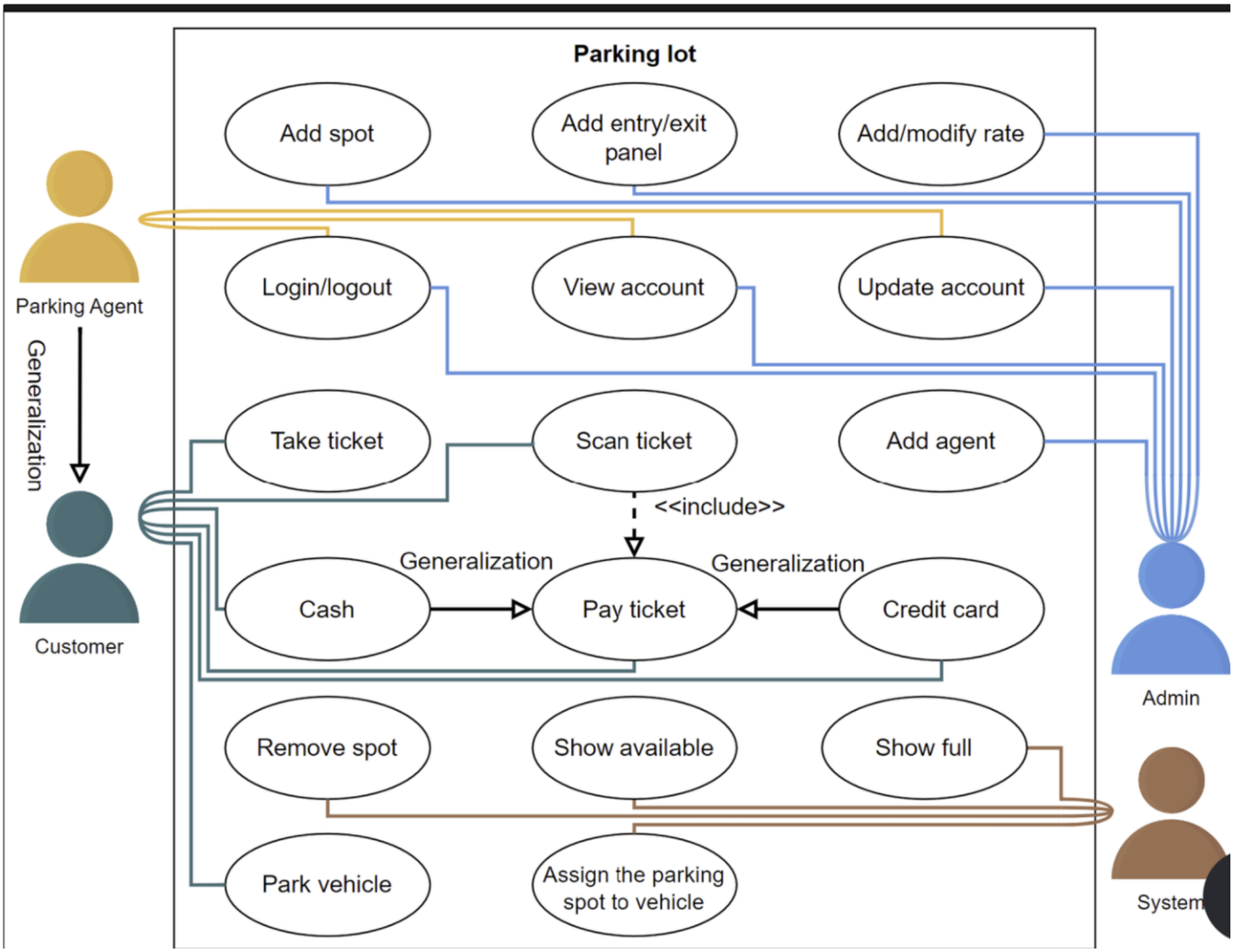
- **Customer:** This actor can park the vehicle in the allocated parking space according to the vehicle type and pay for the parking before exit.
- **Parking agent:** The parking agent will assist the customer and perform all the tasks that a customer can do, such as paying the parking ticket on behalf of the customer.

Secondary actors

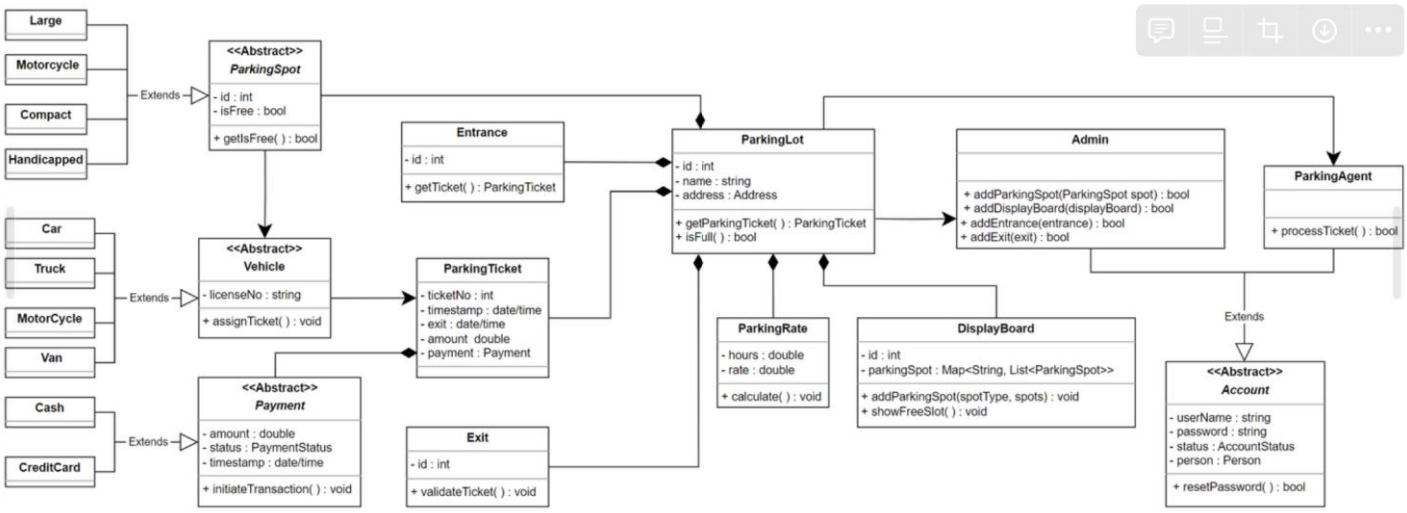
- **Admin:** This can add, remove, or update a spot, agent, entry/exit panels, and view/update accounts.
- **System:** This is responsible for giving details of parking spot availability and assigning a parking spot to a vehicle.

Use case diagram

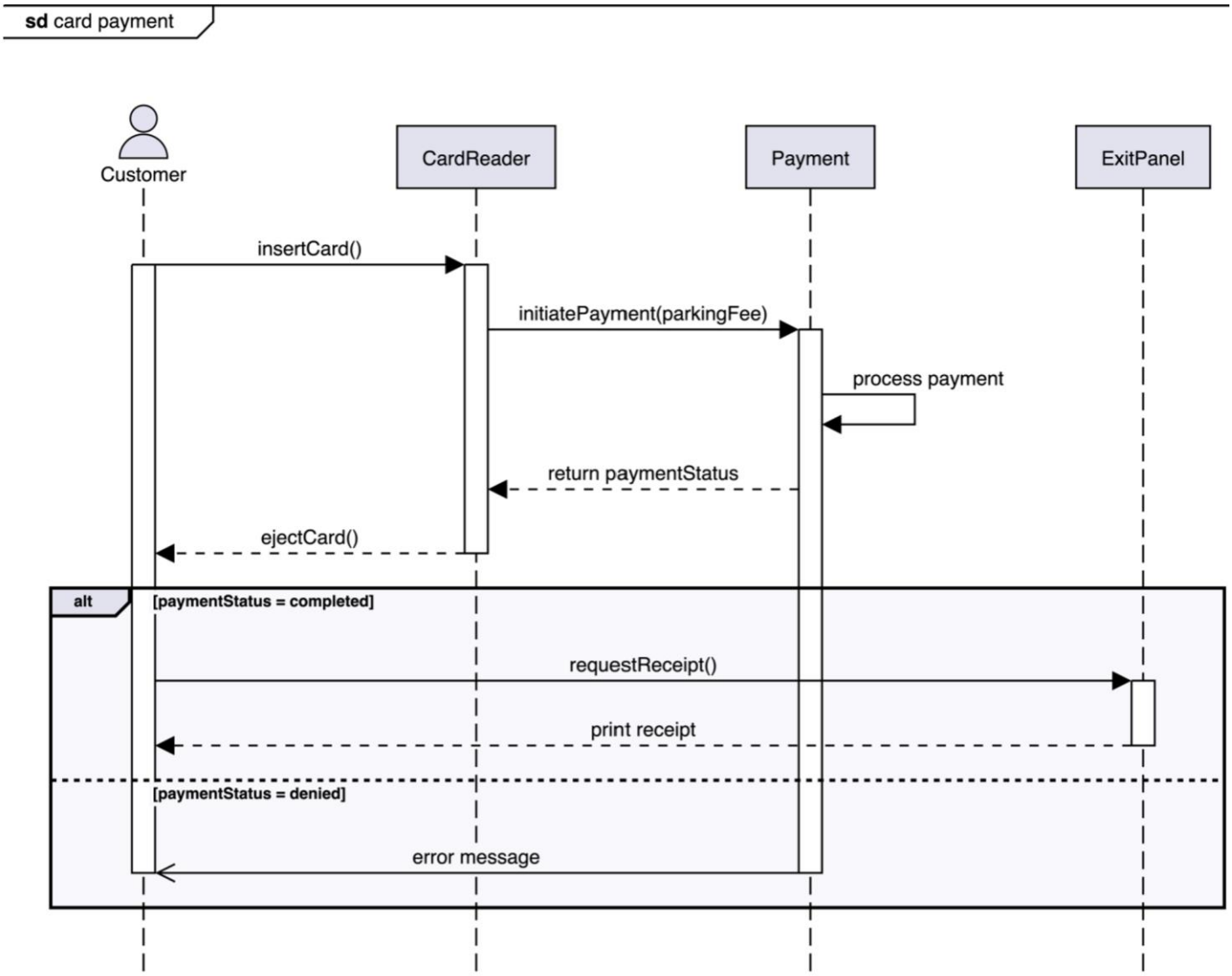
Here is the use case diagram of the parking lot system:



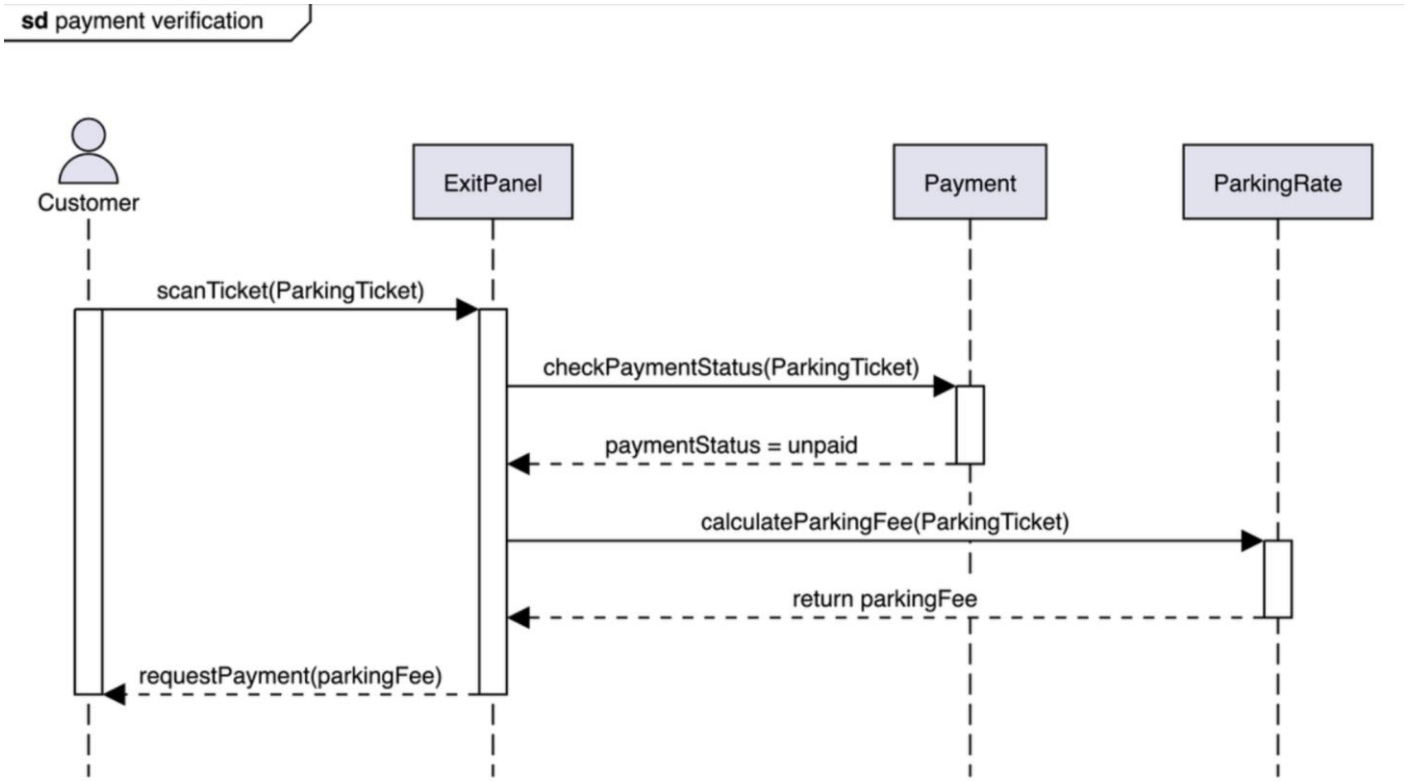
Class Diagram for the Parking Lot



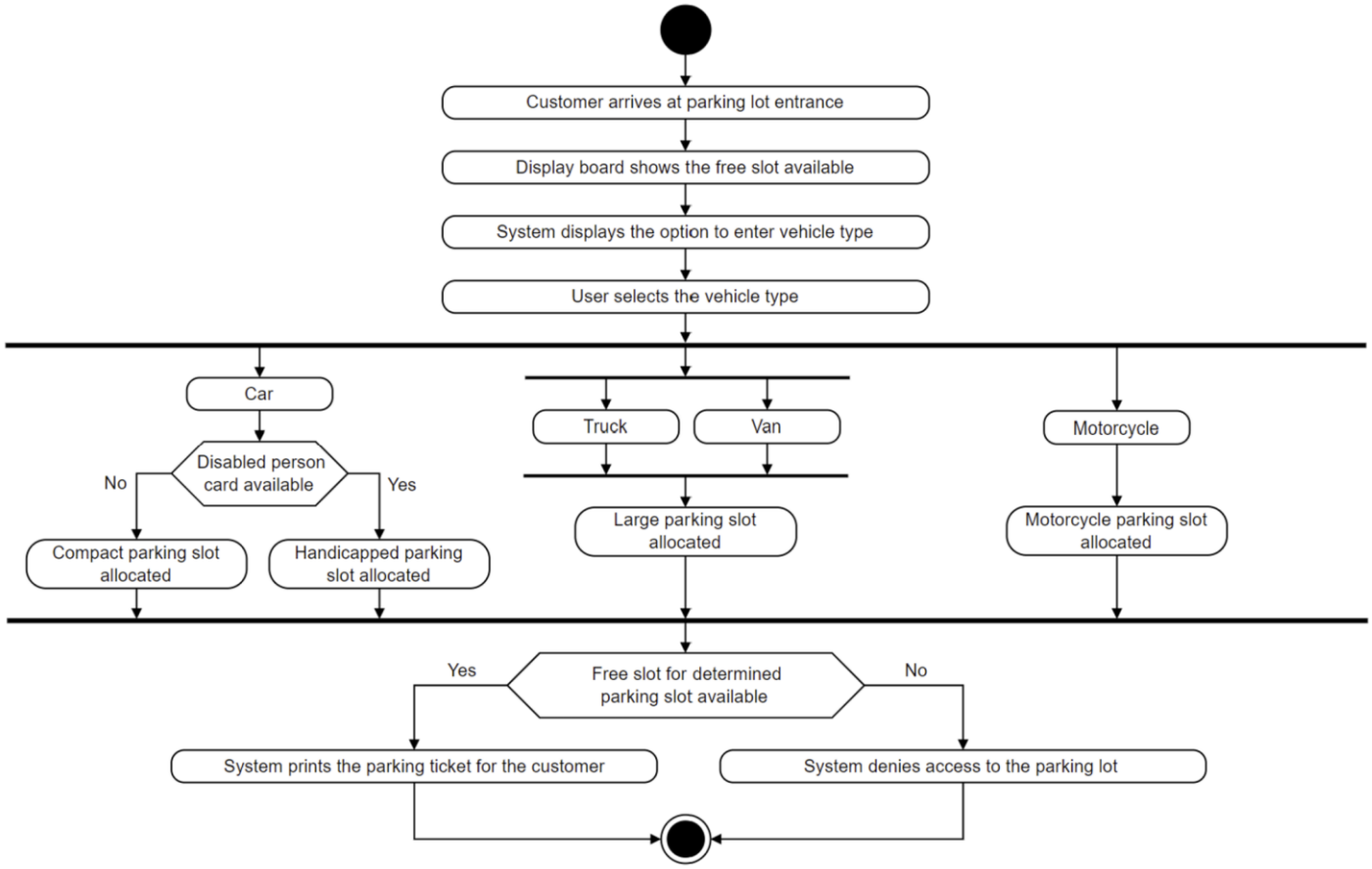
Sequence diagram of card payment:



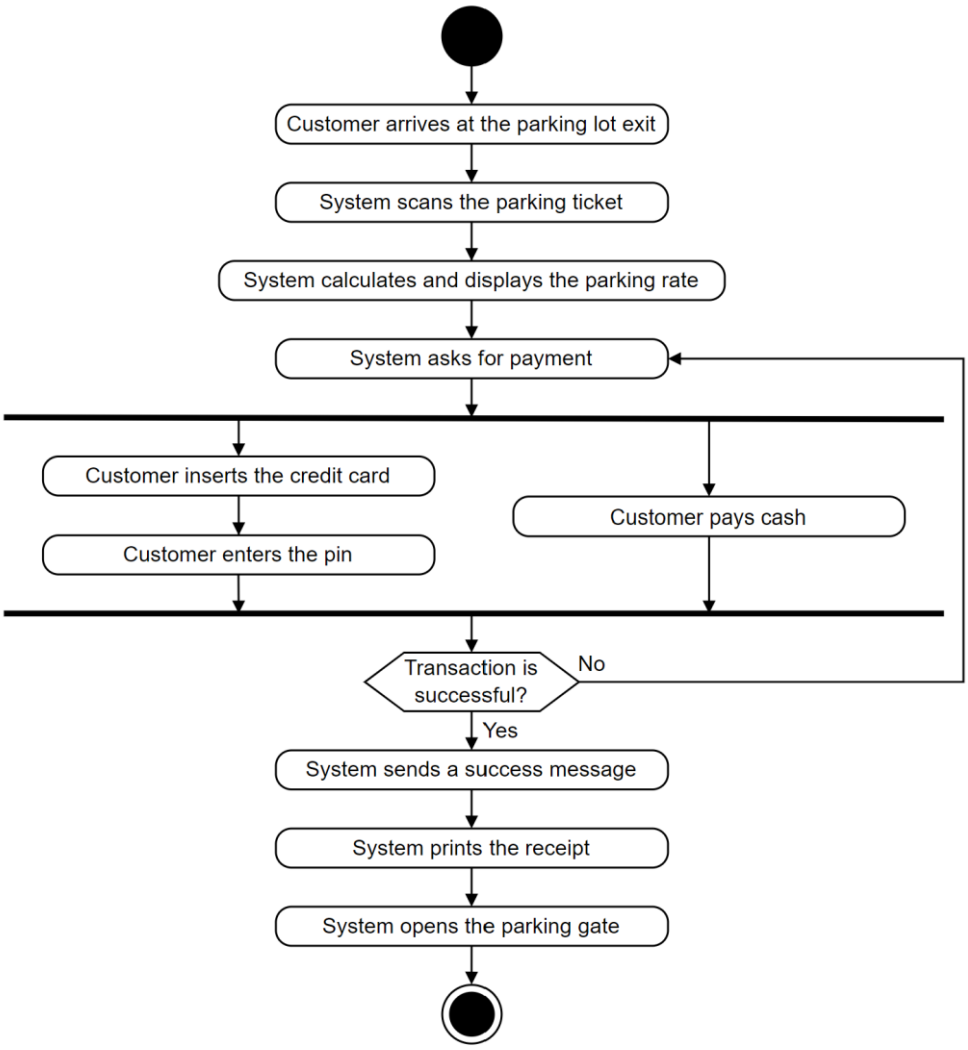
Sequence diagram of Payment verification



Activity diagram of a vehicle entering a parking lot



Activity diagram if customer pays the parking ticket


Customer arrives at the parking lot exit
System scans the parking ticket
System calculates and displays the parking rate
System asks for payment
Customer inserts the credit card
Customer enters the pin
Customer pays cash
Transaction is successful?
No
Yes
System sends a success message
System prints the receipt
System opens the parking gate