

Design a Parking Lot

Let's make an object-oriented design for a multi-floor parking lot.

We'll cover the following ^

- System Requirements
- Use case diagram
- Class diagram
- Activity diagrams
- Code

A parking lot or car park is a dedicated cleared area that is intended for parking vehicles. In most countries where cars are a major mode of transportation, parking lots are a feature of every city and suburban area. Shopping malls, sports stadiums, megachurches, and similar venues often feature parking lots over large areas.



A Parking Lot

System Requirements

#

We will focus on the following set of requirements while designing the parking lot:

1. The parking lot should have multiple floors where customers can park their cars.
2. The parking lot should have multiple entry and exit points.
3. Customers can collect a parking ticket from the entry points and can pay the parking fee at the exit points on their way out.
4. Customers can pay the tickets at the automated exit panel or to the parking attendant.
5. Customers can pay via both cash and credit cards.
6. Customers should also be able to pay the parking fee at the customer's info portal on each floor. If the customer has paid at the info portal, they don't have to pay at the exit.
7. The system should not allow more vehicles than the maximum capacity of the parking lot. If the parking is full, the system should be able to show a message at the entrance panel and on the parking display board on the ground floor.
8. Each parking floor will have many parking spots. The system should support multiple types of parking spots such as Compact, Large, Handicapped, Motorcycle, etc.
9. The Parking lot should have some parking spots specified for electric cars. These spots should have an electric panel through which customers can pay and charge their vehicles.
10. The system should support parking for different types of vehicles like car, truck, van, motorcycle, etc.
11. Each parking floor should have a display board showing any free parking spot for each spot type.
12. The system should support a per-hour parking fee model. For example, customers have to pay \$4 for the first hour, \$3.5 for the second and third hours, and \$2.5 for all the remaining hours.

Use case diagram

#

Here are the main Actors in our system:

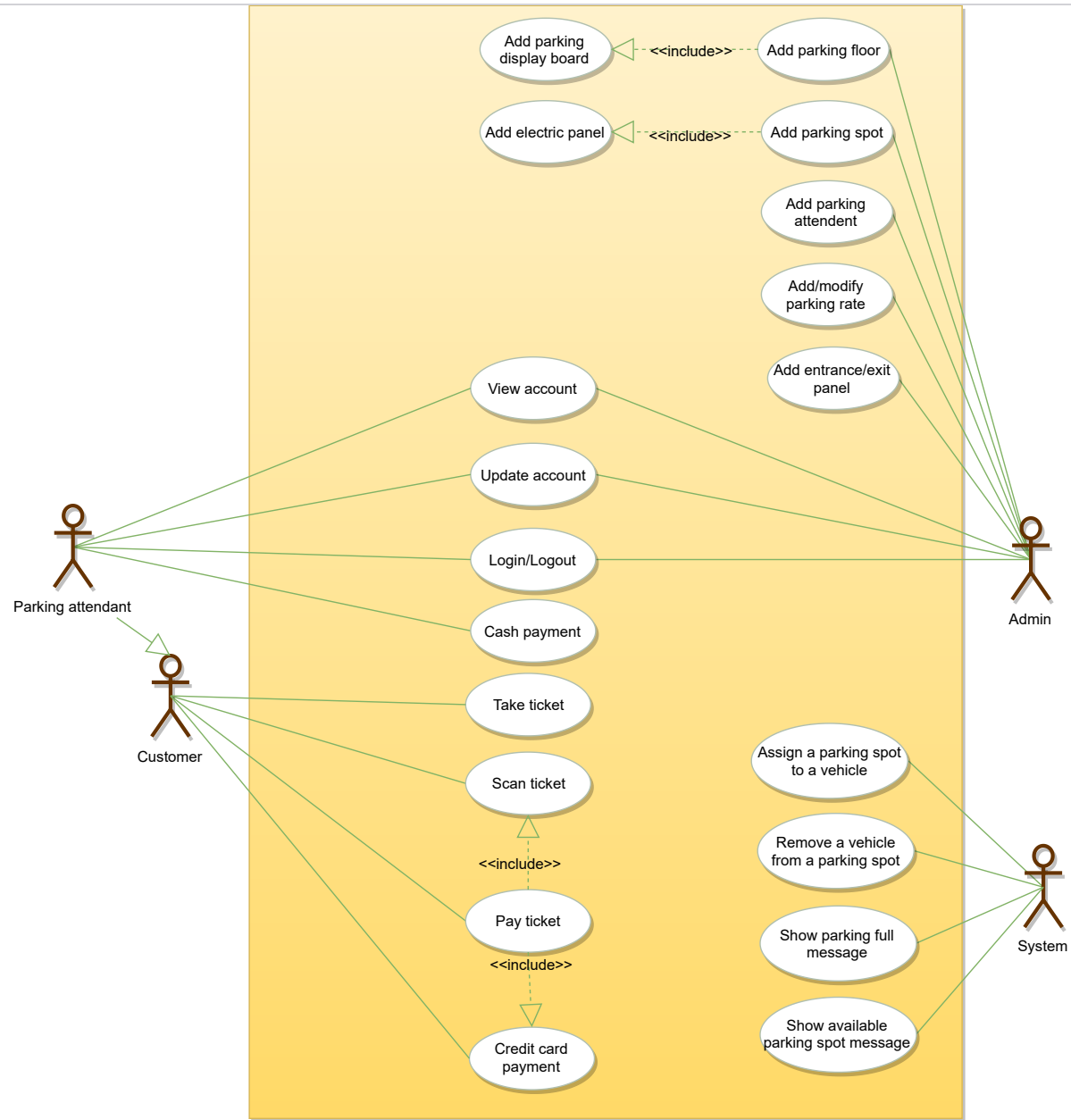
- **Admin:** Mainly responsible for adding and modifying parking floors, parking spots, entrance, and exit panels, adding/removing parking attendants, etc.
- **Customer:** All customers can get a parking ticket and pay for it



- **Customer:** All customers can get a parking ticket and pay for it.
- **Parking attendant:** Parking attendants can do all the activities on the customer's behalf, and can take cash for ticket payment.
- **System:** To display messages on different info panels, as well as assigning and removing a vehicle from a parking spot.

Here are the top use cases for Parking Lot:

- **Add/Remove/Edit parking floor:** To add, remove or modify a parking floor from the system. Each floor can have its own display board to show free parking spots.
- **Add/Remove/Edit parking spot:** To add, remove or modify a parking spot on a parking floor.
- **Add/Remove a parking attendant:** To add or remove a parking attendant from the system.
- **Take ticket:** To provide customers with a new parking ticket when entering the parking lot.
- **Scan ticket:** To scan a ticket to find out the total charge.
- **Credit card payment:** To pay the ticket fee with credit card.
- **Cash payment:** To pay the parking ticket through cash.
- **Add/Modify parking rate:** To allow admin to add or modify the hourly parking rate.



Use case diagram

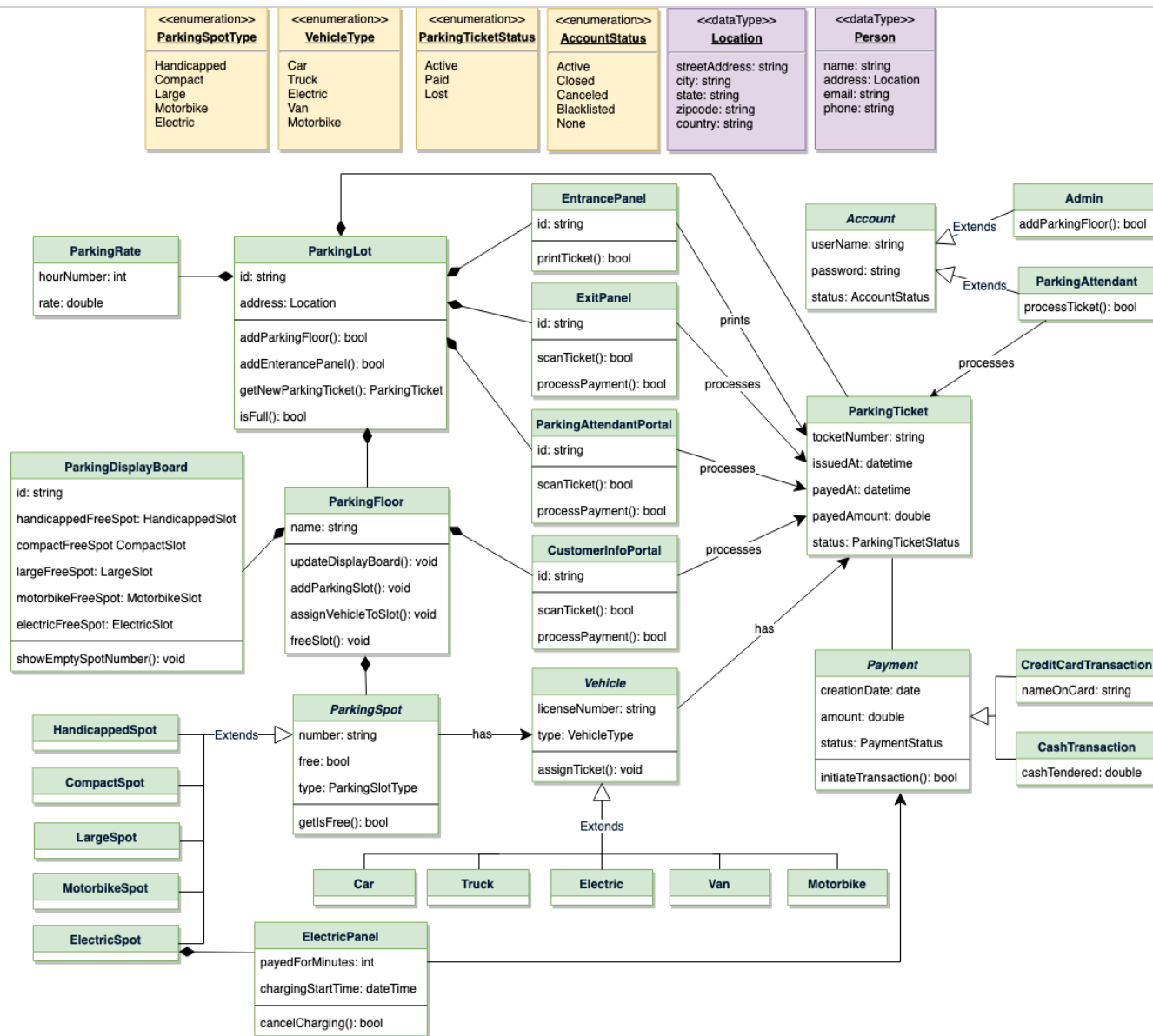
Class diagram

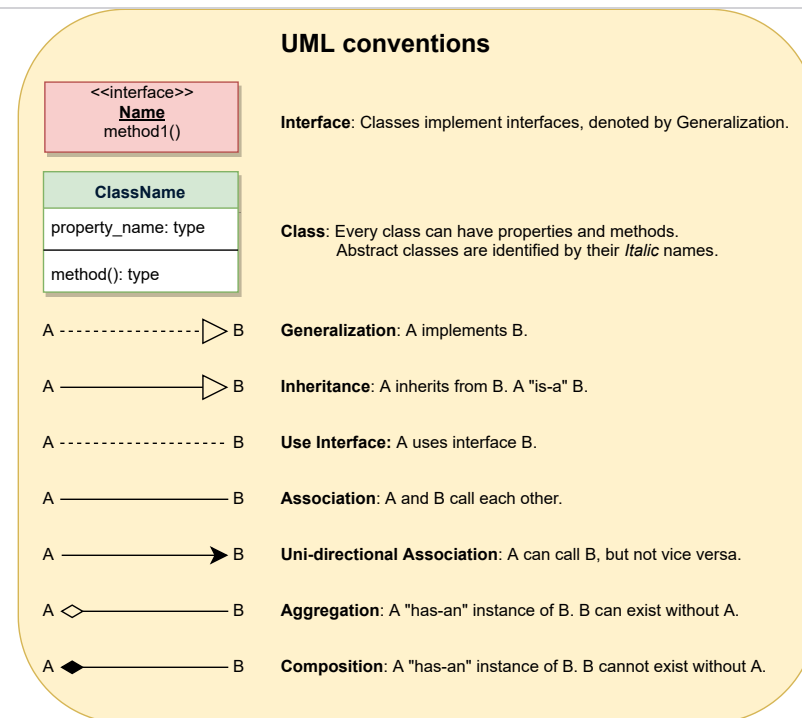
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Here are the main classes of our Parking Lot System:



- **ParkingLot:** The central part of the organization for which this software has been designed. It has attributes like ‘Name’ to distinguish it from any other parking lots and ‘Address’ to define its location.
- **ParkingFloor:** The parking lot will have many parking floors.
- **ParkingSpot:** Each parking floor will have many parking spots. Our system will support different parking spots 1) Handicapped, 2) Compact, 3) Large, 4) Motorcycle, and 5) Electric.
- **Account:** We will have two types of accounts in the system: one for an Admin, and the other for a parking attendant.
- **Parking ticket:** This class will encapsulate a parking ticket. Customers will take a ticket when they enter the parking lot.
- **Vehicle:** Vehicles will be parked in the parking spots. Our system will support different types of vehicles 1) Car, 2) Truck, 3) Electric, 4) Van and 5) Motorcycle.
- **EntrancePanel and ExitPanel:** EntrancePanel will print tickets, and ExitPanel will facilitate payment of the ticket fee.
- **Payment:** This class will be responsible for making payments. The system will support credit card and cash transactions.
- **ParkingRate:** This class will keep track of the hourly parking rates. It will specify a dollar amount for each hour. For example, for a two hour parking ticket, this class will define the cost for the first and the second hour.
- **ParkingDisplayBoard:** Each parking floor will have a display board to show available parking spots for each spot type. This class will be responsible for displaying the latest availability of free parking spots to the customers.
- **ParkingAttendantPortal:** This class will encapsulate all the operations that an attendant can perform, like scanning tickets and processing payments.
- **CustomerInfoPortal:** This class will encapsulate the info portal that customers use to pay for the parking ticket. Once paid, the info portal will update the ticket to keep track of the payment.
- **ElectricPanel:** Customers will use the electric panels to pay and charge their electric vehicles.

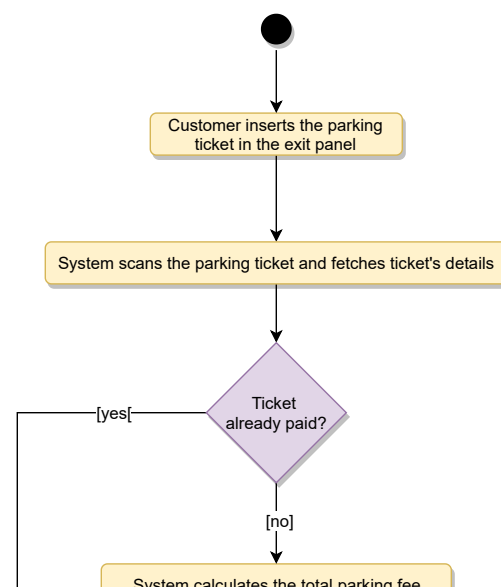


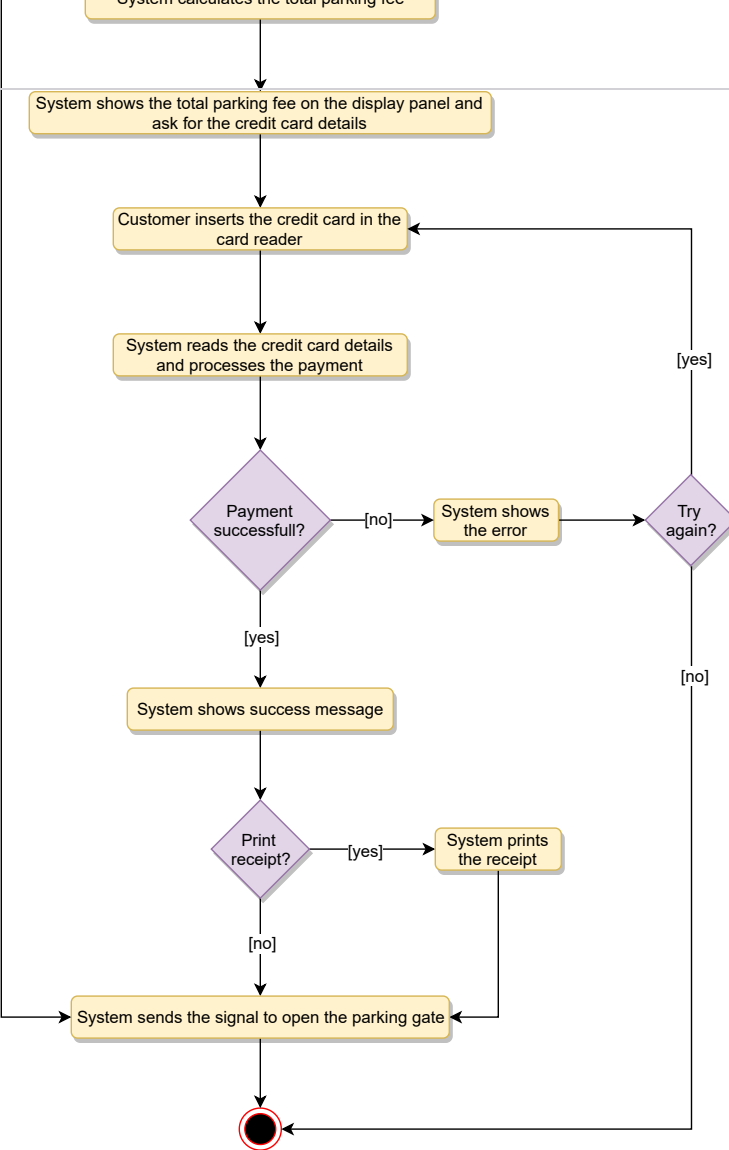


Activity diagrams

#

Customer paying for parking ticket: Any customer can perform this activity. Here are the set of steps:





Code

#

Following is the skeleton code for our parking lot system:

Enums and Constants: Here are the required enums, data types, and constants:

Java

Python

```

1 class VehicleType(Enum):
2     CAR, TRUCK, ELECTRIC, VAN, MOTORBIKE = 1, 2, 3, 4, 5
3
4

```



```

5 class ParkingSpotType(Enum):
6     HANDICAPPED, COMPACT, LARGE, MOTORBIKE, ELECTRIC = 1, 2, 3, 4, 5
7
8
9 class AccountStatus(Enum):
10     ACTIVE, BLOCKED, BANNED, COMPROMISED, ARCHIVED, UNKNOWN = 1, 2, 3, 4, 5, 6
11
12
13 class ParkingTicketStatus(Enum):
14     ACTIVE, PAID, LOST = 1, 2, 3
15
16
17 class Address:
18     def __init__(self, street, city, state, zip_code, country):
19         self.__street_address = street
20         self.__city = city
21         self.__state = state
22         self.__zip_code = zip_code
23         self.__country = country
24
25
26 class Person():
27     def __init__(self, name, address, email, phone):
28         self.__name = name
29         self.__address = address
30         self.__email = email
31         self.__phone = phone

```

Account, Admin, and ParkingAttendant: These classes represent various people that interact with our system:

 Java


 Python


```

11
12 class Admin(Account):
13     def __init__(self, user_name, password, person, status=AccountStatus.Active):
14         super().__init__(user_name, password, person, status)
15
16     def add_parking_floor(self, floor):
17         None
18
19     def add_parking_spot(self, floor_name, spot):
20         None
21
22     def add_parking_display_board(self, floor_name, display_board):
23         None
24
25     def add_customer_info_panel(self, floor_name, info_panel):
26         None
27
28     def add_entrance_panel(self, entrance_panel):
29         None
30
31     def add_exit_panel(self, exit_panel):
32         None
33
34
35 class ParkingAttendant(Account):
36     def __init__(self, user_name, password, person, status=AccountStatus.Active):
37         super().__init__(user_name, password, person, status)
38
39

```

ParkingSpot: Here is the definition of ParkingSpot and all of its children classes:

 Java


 Python


```

1 class ParkingSpot(ABC):
2     def __init__(self, number, parking_spot_type):
3         self.__number = number
4         self.__free = True
5         self.__vehicle = None
6         self.__parking_spot_type = parking_spot_type
7
8     def is_free(self):
9         return self.__free
10
11    def assign_vehicle(self, vehicle):
12        self.__vehicle = vehicle
13        free = False
14
15    def remove_vehicle(self):
16        self.__vehicle = None
17        free = True
18
19
20    class HandicappedSpot(ParkingSpot):
21        def __init__(self, number):
22            super().__init__(number, ParkingSpotType.HANDICAPPED)
23
24
25    class CompactSpot(ParkingSpot):
26        def __init__(self, number):
27            super().__init__(number, ParkingSpotType.COMPACT)
28
29
30    class LargeSpot(ParkingSpot):
31        def __init__(self, number):

```

Vehicle: Here is the definition for Vehicle and all of its child classes:

 Java

 Python

```

1 from abc import ABC, abstractmethod
2
3 class Vehicle(ABC):
4     def __init__(self, license_number, vehicle_type, ticket=None):
5         self.__license_number = license_number
6         self.__type = vehicle_type
7         self.__ticket = ticket
8
9     def assign_ticket(self, ticket):
10        self.__ticket = ticket
11
12
13    class Car(Vehicle):
14        def __init__(self, license_number, ticket=None):
15            super().__init__(license_number, VehicleType.CAR, ticket)


```

```

15 super().__init__(license_number, VehicleType.CAR, ticket)
16
17
18 class Van(Vehicle):
19     def __init__(self, license_number, ticket=None):
20         super().__init__(license_number, VehicleType.VAN, ticket)
21
22
23 class Truck(Vehicle):
24     def __init__(self, license_number, ticket=None):
25         super().__init__(license_number, VehicleType.TRUCK, ticket)
26
27
28 # Similarly we can define classes for Motorcycle and Electric vehicles

```

ParkingFloor: This class encapsulates a parking floor:

 Java	 Python
<pre> 1 class ParkingFloor: 2 def __init__(self, name): 3 self.__name = name 4 self.__handicapped_spots = {} 5 self.__compact_spots = {} 6 self.__large_spots = {} 7 self.__motorbike_spots = {} 8 self.__electric_spots = {} 9 self.__info_portals = {} 10 self.__display_board = ParkingDisplayBoard() 11 12 def add_parking_spot(self, spot): 13 switcher = { 14 ParkingSpotType.HANDICAPPED: self.__handicapped_spots.put(spot.get_number(), spot), 15 ParkingSpotType.COMPACT: self.__compact_spots.put(spot.get_number(), spot), 16 ParkingSpotType.LARGE: self.__large_spots.put(spot.get_number(), spot), 17 ParkingSpotType.MOTORBIKE: self.__motorbike_spots.put(spot.get_number(), spot), 18 ParkingSpotType.ELECTRIC: self.__electric_spots.put(spot.get_number(), spot), 19 } 20 switcher.get(spot.get_type(), 'Wrong parking spot type') 21 22 def assign_vehicleToSpot(self, vehicle, spot): 23 spot.assign_vehicle(vehicle) 24 switcher = { 25 ParkingSpotType.HANDICAPPED: self.update_display_board_for_handicapped(spot), 26 ParkingSpotType.COMPACT: self.update_display_board_for_compact(spot), 27 ParkingSpotType.LARGE: self.update_display_board_for_large(spot), 28 ParkingSpotType.MOTORBIKE: self.update_display_board_for_motorbike(spot), 29 ParkingSpotType.ELECTRIC: self.update_display_board_for_electric(spot), 30 } 31 switcher(spot.get_type(), 'Wrong parking spot type!') </pre>	

ParkingDisplayBoard: This class encapsulates a parking display board:

 Java	 Python
<pre> 1 class ParkingDisplayBoard: 2 def __init__(self, id): </pre>	

```

3     self.__id = id
4     self.__handicapped_free_spot = None
5     self.__compact_free_spot = None
6     self.__large_free_spot = None
7     self.__motorbike_free_spot = None
8     self.__electric_free_spot = None
9
10    def show_empty_spot_number(self):
11        message = ""
12        if self.__handicapped_free_spot.is_free():
13            message += "Free Handicapped: " + self.__handicapped_free_spot.get_number()
14        else:
15            message += "Handicapped is full"
16        message += "\n"
17
18        if self.__compact_free_spot.is_free():
19            message += "Free Compact: " + self.__compact_free_spot.get_number()
20        else:
21            message += "Compact is full"
22        message += "\n"
23
24        if self.__large_free_spot.is_free():
25            message += "Free Large: " + self.__large_free_spot.get_number()
26        else:
27            message += "Large is full"
28        message += "\n"
29
30        if self.__motorbike_free_spot.is_free():
31            message += "Free Motorbike: " + self.__motorbike_free_spot.get_number()

```

ParkingLot: Our system will have only one object of this class. This can be enforced by using the Singleton (https://en.wikipedia.org/wiki/Singleton_pattern) pattern. In software engineering, the singleton pattern is a software design pattern that restricts the instantiation of a class to only one object.

 Java

 Python

```

1  import threading
2
3  class ParkingLot:
4      # singleton ParkingLot to ensure only one object of ParkingLot in the system,
5      # all entrance panels will use this object to create new parking ticket: get_new_parking_ticket(),
6      # similarly exit panels will also use this object to close parking tickets
7      instance = None
8
9      class __OnlyOne:
10         def __init__(self, name, address):
11             # 1. initialize variables: read name, address and parking_rate from database
12             # 2. initialize parking floors: read the parking floor map from database,
13             #     this map should tell how many parking spots are there on each floor. This
14             #     should also initialize max spot counts too.
15             # 3. initialize parking spot counts by reading all active tickets from database
16             # 4. initialize entrance and exit panels: read from database
17
18             self.__name = name
19             self.__address = address
20             self.__parking_rate = ParkingRate()
21
22             self.__compact_spot_count = 0
23             self.__large_spot_count = 0

```

```
24     self.__motorbike_spot_count = 0
25     self.__electric_spot_count = 0
26     self.__max_compact_count = 0
27     self.__max_large_count = 0
28     self.__max_motorbike_count = 0
29     self.__max_electric_count = 0
30
31     self.__entrance_panels = {}
```

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