Car Park Management System

CSC 506 – Computer Programming Laboratory

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GS/COMP/313

1. Introduction

This project implements a Console-based Car Park Management System using the C programming language. The system is designed to manage parking spaces efficiently while enforcing real-world constraints such as customer priorities, reserved parking percentages, time-based pricing, and discounts. It maintains real-time statistics and supports persistent storage through text files.

This Implementation was done using

Apple clang version 17.0.0 (clang-1700.6.3.2)
Target: arm64-apple-darwin25.1.0

2. System Features

1. Multiple vehicle types: Motorcycle, Three-wheeler, Car, Van, Bus
2. Multiple customer categories: Disabled, VIP, Staff, Registered, Guest
3. Priority-based parking allocation
4. Time-based fee calculation with discounts
5. Parking space visualization
6. Persistent data storage and restoration
7. Menu-driven console interface

1. Enter Vehicle Process

When a vehicle arrives at the car park, the system performs the following steps:

The user inputs:

- Vehicle number
- Vehicle type
- Customer type

1) The system first checks whether a parking slot is available under the same customer category for the given vehicle type.
2) If no slot is available, the system attempts to allocate a slot from a higher-priority customer category, subject to predefined rules:
   Disabled slots can only be used if more than 60% remain free

3) VIP slots can only be used if more than 50% remain free
4) If a suitable slot is found:
   i) The vehicle is accepted
   ii) The arrival time is recorded using the system clock
   iii) Slot allocation statistics are updated in real time
   iv) If no suitable slot is available, the vehicle is rejected with an appropriate message.
   This approach ensures fairness while maximizing the utilization of available parking spaces.

2. Exit Vehicle Process

When a vehicle exits the car park:

1. The user enters the vehicle number.
2. The system searches the active parking records.
3. If the vehicle is found, the exit time is captured
4. The allocated parking slot is released
5. Parking statistics are updated
6. A detailed parking bill is generated and displayed
7. If the vehicle is not found, the system displays an error message.

This process guarantees accurate slot management and billing.

3. Bill Calculation

The parking bill is calculated based on the actual parking duration and customer type:

3.1 Parking Duration

Parking duration is calculated using the difference between exit time and arrival time Duration is displayed in hours and minutes. For billing purposes, the duration is rounded up to the nearest hour. A minimum of one hour is charged.

3.2 Fee Structure

Each vehicle type has a predefined pricing structure: A fixed charge for the first hour A separate charge for each additional hour

Parking fees are based on **vehicle type**:

Vehicle Type	First Hour (Rs)	Additional Hour (Rs)
Motorcycle	20	30
Three-wheeler	30	40
Car	40	50
Van	50	60
Bus	80	100

3.3 Discounts

After calculating the total charge, a discount is applied based on the customer type:

Customer Type	Discount
Disabled	60%
VIP	50%
Staff	80%
Registered	30%
Guest	0%

The generated bill includes:

1. Vehicle number
2. Vehicle type
3. Customer type
4. Entry and exit date & time
5. Total parking duration
6. Total charge
7. Discount amount
8. Final payable amount

3. Data Persistence

The system stores all active parking records in a text file upon exit. When the application restarts, the data is reloaded to restore the previous parking state.

Text file format

<number_of_vehicles>
<vehicle_number> <vehicle_type> <customer_type> <arrival_time>

4. Testing & Validations

Test Case ID	Scenario / Functionality	Input Data	Expected Result / Output	Remarks / Notes
TC01	Enter Vehicle - Normal Slot	Vehicle No: `MOTO001`, Vehicle Type: Motorcycle, Customer Type: Guest	Vehicle accepted, allocated to Guest slot, arrival time recorded	Slot count updated
TC02	Enter Vehicle - Priority Slot	Vehicle No: `VIP123`, Vehicle Type: Car, Customer Type: VIP	Vehicle accepted, allocated to VIP slot, arrival time recorded	Enforces VIP priority
TC03	Enter Vehicle - Overflow Disabled	Vehicle No: `DIS999`, Vehicle Type: Van, Customer Type: Staff	Allocated to Staff slot if Disabled slots are <60% free	Tests priority fallback
TC04	Enter Vehicle - No Slot Available	Vehicle No: `BUS777`, Vehicle Type: Bus, Customer Type: Guest	Rejected, "No suitable slot available" message	Edge case: all slots full
TC05	Exit Vehicle - Normal	Vehicle No: `MOTO001`	Exit time recorded, slot freed, parking bill displayed with fee, discount applied	Fee calculated based on duration

TC06	Exit Vehicle - Vehicle Not Found	Vehicle No: `UNKNOWN`	Error message displayed: "Vehicle not found in the parking system"	Invalid vehicle exit
TC07	Fee Calculation - 1 hour	Vehicle No: `CAR001`, Vehicle Type: Car, Customer Type: Registered, Duration: 45 mins	Total charge Rs 40, Discount Rs 12, Payable Rs 28	Minimum 1-hour charge
TC08	Fee Calculation - Multiple Hours	Vehicle No: `VAN001`, Vehicle Type: Van, Customer Type: Staff, Duration: 3 hours 10 mins	First hour Rs 50, Additional 2 hours Rs 60*2 = 120, Total Rs 170, Discount 80% => Payable Rs 34	Duration rounded up to nearest hour
TC09	Check Availability	N/A	Display free slots per vehicle and customer type	Should reflect accurate real-time slot allocation
TC10	View Parking Space Visualization	N/A	Display each vehicle type with customer symbols and free slots	E.g., `Bus: { DDFF
TC11	View Statistics - Table View	N/A	Show allocated and free slots per vehicle type and customer type in table format	Matches availability data
TC12	View Statistics - Graph View	N/A	Display bar-style graph of slots (allocated vs free) per vehicle and customer type	Graph scaled appropriately
TC13	Data Persistence - Save	Exiting program	All parking data written to text file (`parking_data.txt`)	Data restored on next program run
TC14	Data Persistence - Load	Starting program	Parking data restored from file; vehicle counts, slots, and allocations reflect previous state	Validates persistent storage

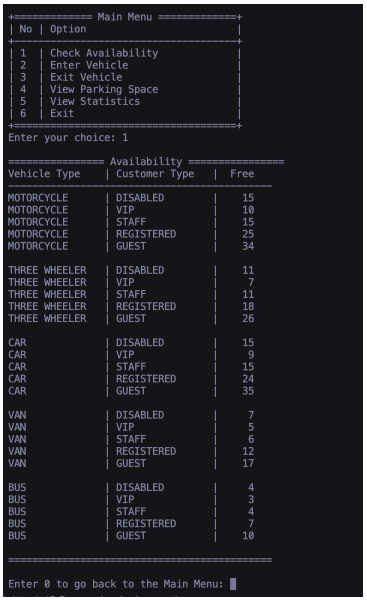
TC15	Edge Case - Disabled Priority Rule	Vehicle No: `DIS002`, Vehicle Type: Car, Customer Type: Guest	Allocated only if >60% Disabled slots free, otherwise fallback to lower-priority slot	Tests enforcement of special rules
TC16	Edge Case - VIP Priority Rule	Vehicle No: `VIP999`, Vehicle Type: Van, Customer Type: Staff	Allocated only if >50% VIP slots free, otherwise fallback to lower-priority slot	Validates VIP allocation rule
TC17	Full Parking Scenario	Fill all slots for Cars, attempt to enter another Car	Rejected message: "Parking is full"	Ensures TOTAL_SLOTS limit respected

5. Appendix

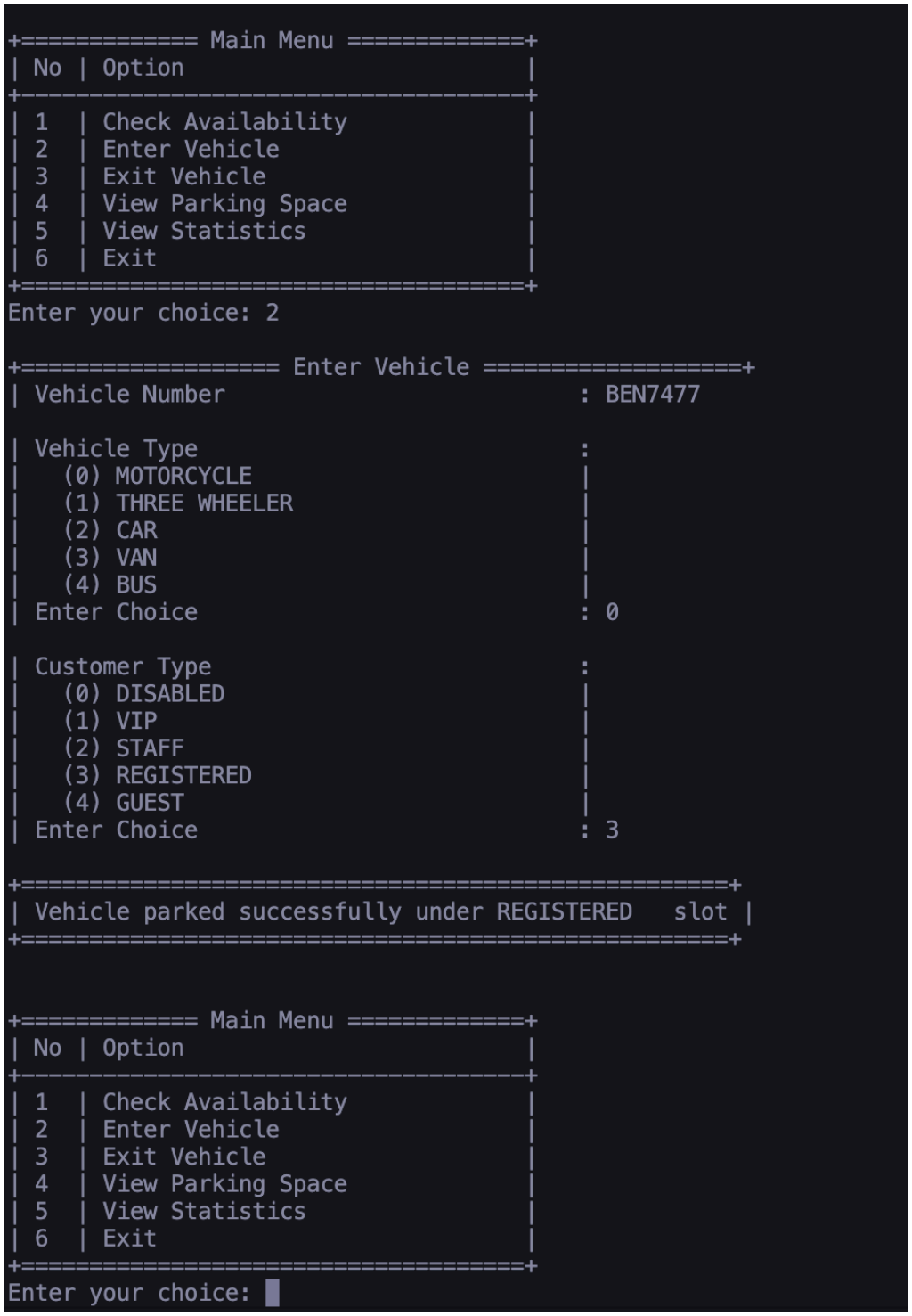
Initial Text file state

4
MOTO001 0 4 1768578707
VIP123 2 1 1768578955
CAR001 2 3 1768579000
VAN001 3 2 1768579500

5.1 Check Availability



5.2 Enter Vehicle



5.3 View Parking Space

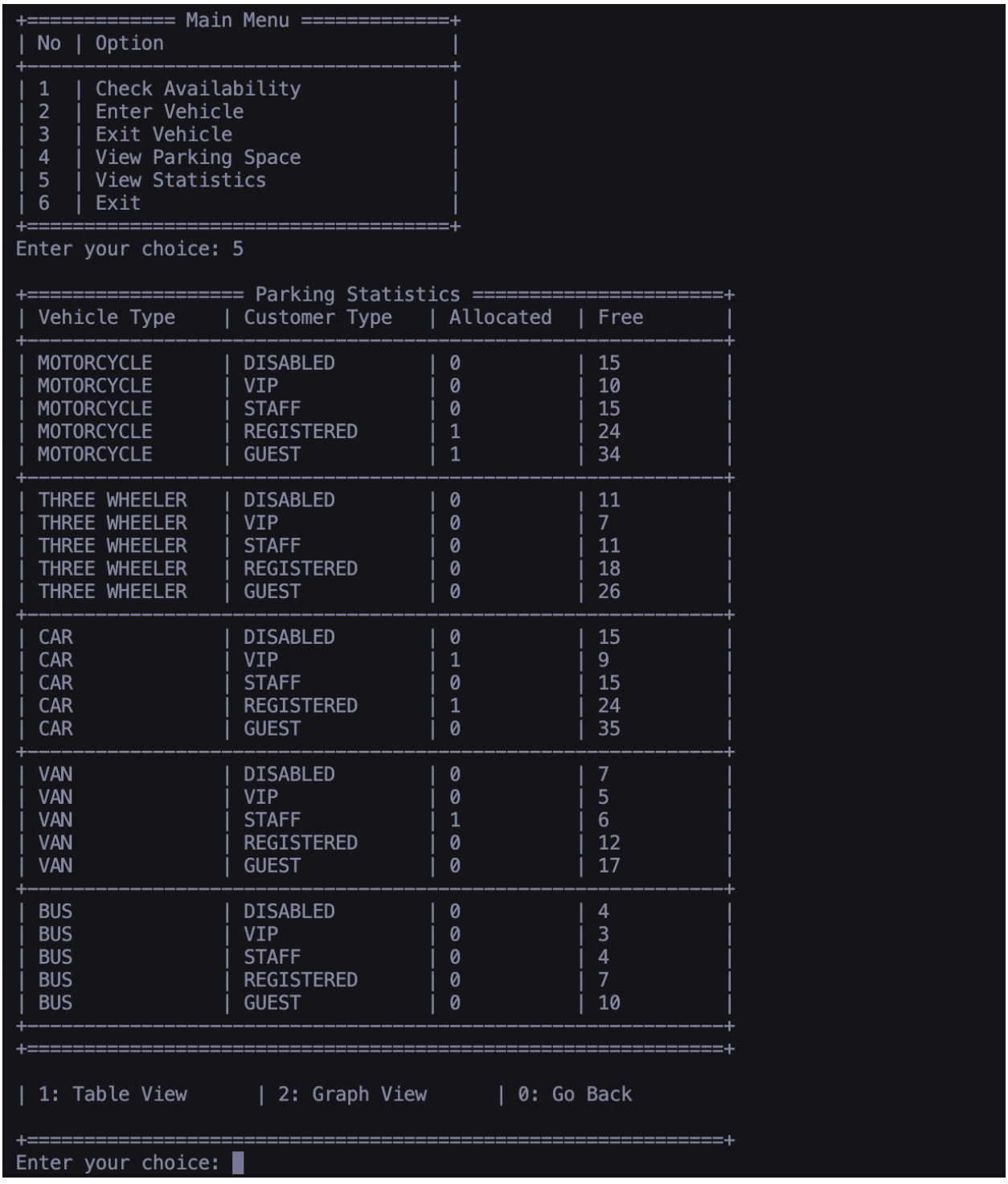
```
+============ Main Menu ============+
| No | Option                       |
+-----------------------------------+
| 1  | Check Availability           |
| 2  | Enter Vehicle                |
| 3  | Exit Vehicle                 |
| 4  | View Parking Space           |
| 5  | View Statistics              |
| 6  | Exit                         |
+===================================+
Enter your choice: 4

+================================================== Parking Space ==================================================

MOTORCYCLE     : { FFFFFFFFFFFFFF | FFFFFFFFFF | FFFFFFFFFFFFFF | RFFFFFFFFFFFFFFFFFFFFFFF | GFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF }
THREE WHEELER  : { FFFFFFFFFFF | FFFFFFF | FFFFFFFFFFF | FFFFFFFFFFFFFFFFF | FFFFFFFFFFFFFFFFFFFFFFFFF }
CAR            : { FFFFFFFFFFFFFF | VFFFFFFFFF | FFFFFFFFFFFFFF | RFFFFFFFFFFFFFFFFFFFFFFFFF | FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF }
VAN            : { FFFFFFF | FFFFF | SFFFFFF | FFFFFFFFFFF | FFFFFFFFFFFFFFF }
BUS            : { FFFF | FFF | FFFF | FFFFFF | FFFFFFFFF }

+=================================================================================================================================+
```

5.4 Parking Statistics




+===+
| 1: Table View | 2: Graph View | 0: Go Back
+===+
Enter your choice: 2
+== Parking Graph ==+
| Vehicle Type | DISABLED VIP STAFF REGISTERED GUEST
|MOTORCYCLE |**********
|THREE WHEELER |**********
|CAR |**********
|VAN |*******
|BUS |****
+===+
| 1: Table View | 2: Graph View | 0: Go Back
+===+
Enter your choice:
GitHub Desktop

5.5 Exit Vehicle

```
==================== Exit Vehicle ====================
| Enter vehicle number          : BEN7477

+==================== Parking Bill ====================+
| Vehicle Number       : BEN7477
| Vehicle Type         : MOTORCYCLE
| Customer Type        : REGISTERED
| Entered Time         : Fri Jan 16 22:34:06 2026
| Exit Time            : Fri Jan 16 22:39:36 2026
| Parking Duration     : 0 hours 5 minutes
| Total Charge         : Rs 20.00
| Discount             : Rs 6.00
| Total Payable        : Rs 14.00
+=========================================================+


+-----------------------------------------+
| Vehicle successfully exited the parking!  |
+-----------------------------------------+


+============= Main Menu =============+
| No | Option                          |
+-------------------------------------+
| 1  | Check Availability              |
| 2  | Enter Vehicle                   |
| 3  | Exit Vehicle                    |
| 4  | View Parking Space              |
| 5  | View Statistics                 |
| 6  | Exit                            |
+=====================================+
Enter your choice:
```

```
| 3  | Exit Vehicle                 |
| 4  | View Parking Space           |
| 5  | View Statistics              |
| 6  | Exit                         |
+=======================================+
Enter your choice: 3

==================== Exit Vehicle ====================
| Enter vehicle number          : MOTO001

+==================== Parking Bill ====================+
| Vehicle Number       : MOTO001
| Vehicle Type         : MOTORCYCLE
| Customer Type        : GUEST
| Entered Time         : Fri Jan 16 21:21:47 2026
| Exit Time            : Fri Jan 16 22:41:37 2026
| Parking Duration     : 1 hours 19 minutes
| Total Charge         : Rs 50.00
| Discount             : Rs 0.00
| Total Payable        : Rs 50.00
+=========================================================+


+-----------------------------------------------+
| Vehicle successfully exited the parking!  |
+-----------------------------------------------+


+============== Main Menu =============+
| No | Option                           |
+---------------------------------------+
| 1  | Check Availability               |
| 2  | Enter Vehicle                    |
| 3  | Exit Vehicle                     |
| 4  | View Parking Space               |
| 5  | View Statistics                  |
| 6  | Exit                             |
+=======================================+
Enter your choice:
```

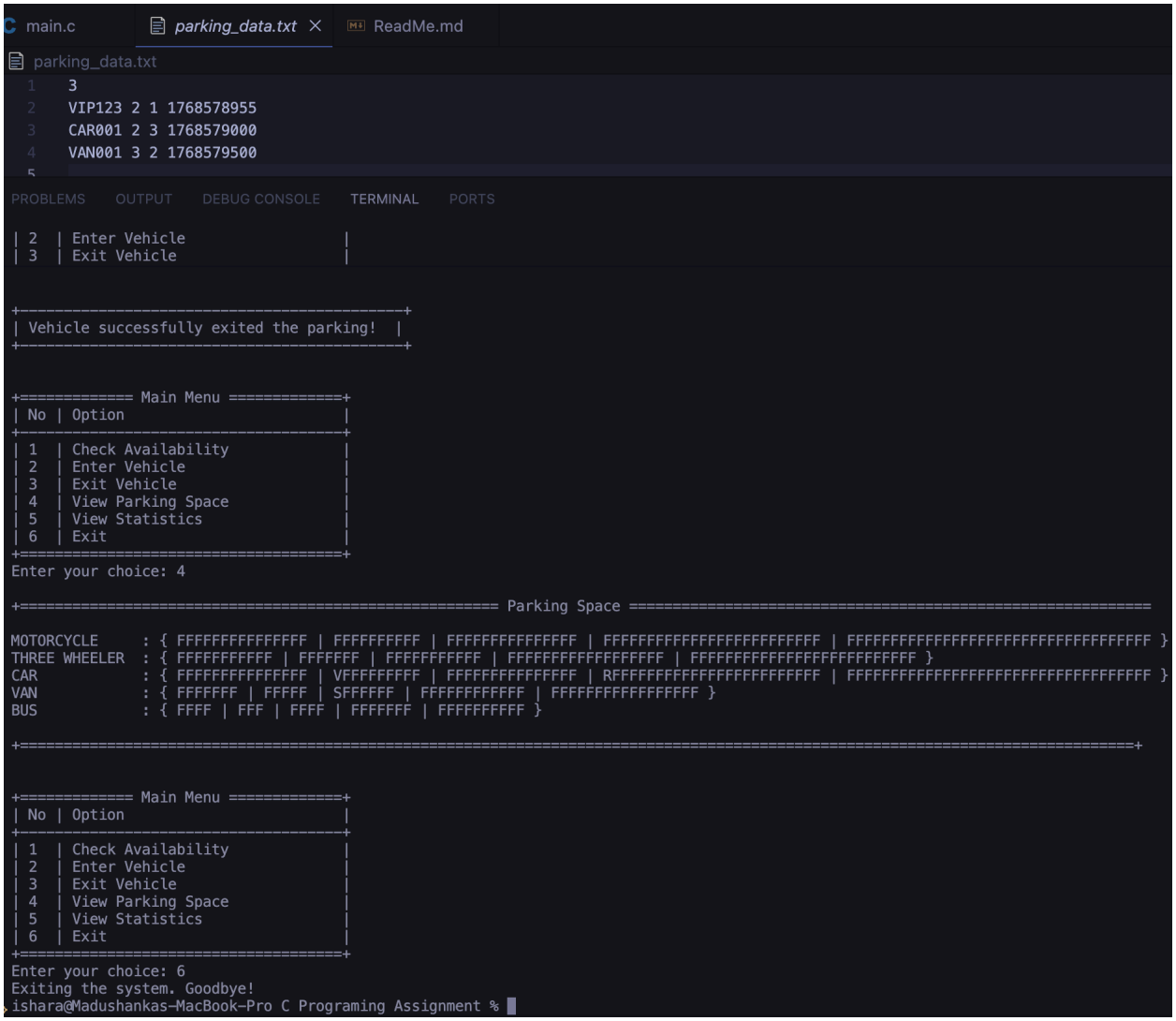
```
+============ Main Menu ============+
| No | Option                       |
+-----------------------------------+
| 1  | Check Availability           |
| 2  | Enter Vehicle                |
| 3  | Exit Vehicle                 |
| 4  | View Parking Space           |
| 5  | View Statistics              |
| 6  | Exit                         |
+===================================+
Enter your choice: 4

+================================================ Parking Space ================================================

MOTORCYCLE     : { FFFFFFFFFFFFFFF | FFFFFFFFFF | FFFFFFFFFFFFFFF | FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF | FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF }
THREE WHEELER  : { FFFFFFFFFFF | FFFFFFF | FFFFFFFFFFF | FFFFFFFFFFFFFFFFF | FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF }
CAR            : { FFFFFFFFFFFFFFF | VFFFFFFFFF | FFFFFFFFFFFFFFF | RFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF | FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF }
VAN            : { FFFFFFF | FFFFF | SFFFFFF | FFFFFFFFFFF | FFFFFFFFFFFFFFF }
BUS            : { FFFF | FFF | FFFF | FFFFFFF | FFFFFFFFF }

+=============================================================================================================================================+


+============ Main Menu ============+
| No | Option                       |
+-----------------------------------+
| 1  | Check Availability           |
| 2  | Enter Vehicle                |
| 3  | Exit Vehicle                 |
| 4  | View Parking Space           |
| 5  | View Statistics              |
| 6  | Exit                         |
+===================================+
Enter
```


main.c
parking_data.txt
ReadMe.md
parking_data.txt
3
VIP123 2 1 1768578955
CAR001 2 3 1768579000
VAN001 3 2 1768579500
PROBLEMS
OUTPUT
DEBUG CONSOLE
TERMINAL
PORTS
| 2 | Enter Vehicle |
| 3 | Exit Vehicle |
| Vehicle successfully exited the parking! |
+========== Main Menu ==========+
No	Option
1	Check Availability
2	Enter Vehicle
3	Exit Vehicle
4	View Parking Space
5	View Statistics
6	Exit
Enter your choice: 4
Parking Space
MOTORCYCLE : { FFFFFFFFFFFFFF | FFFFFFFFF | FFFFFFFFFFFFFF | FFFFFFFFFFFFFFFFFFFFFFFF | FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF }
THREE WHEELER : { FFFFFFFFFF | FFFFFF | FFFFFFFFFF | FFFFFFFFFFFFFFFF | FFFFFFFFFFFFFFFFFFFFFFFF }
CAR : { FFFFFFFFFFFFFF | VFFFFFFFFF | FFFFFFFFFFFFFF | RFFFFFFFFFFFFFFFFFFFFFFFF | FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF }
VAN : { FFFFFFF | FFFFF | SFFFFFF | FFFFFFFFFF | FFFFFFFFFFFFFF }
BUS : { FFFF | FFF | FFFF | FFFFFF | FFFFFFFFF }
Enter your choice: 6
Exiting the system. Goodbye!
ishara@Madushankas-MacBook-Pro C Programing Assignment %