

CSE 344 HW3 REPORT

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Introduction

The program implements a parking lot management system using concurrency constructs such as threads, semaphores, and mutexes. The goal is to manage parking for automobiles and pickups. The system simulates car owners arriving at a parking lot and attendants handling the parking process, ensuring efficient utilization of parking spaces while dealing with synchronization challenges.

Problem-Solving Approach

The primary challenge is to manage multiple car owners and parking attendants concurrently while ensuring that parking spots are allocated correctly. Key issues include:

- Synchronizing access to shared resources (parking spots).
- Handling temporary parking when the main lot is full.
- Ensuring that car owners do not leave before their vehicle is parked.

To address these issues, the solution involves:

- Using semaphores to signal the arrival of new vehicles and the completion of the parking process.
- Using mutexes to protect shared counter variables representing available parking spots.
- Creating separate threads for car owners and attendants to simulate concurrent behavior.

Implementation Details

Semaphores and Mutexes

Semaphores `newPickup` and `newAutomobile` are used to signal the arrival of pickups and automobiles, respectively. `inChargeforPickup` and `inChargeforAutomobile` signal the completion of the parking process.

Mutexes `pickup_lock` and `automobile_lock` protect the counter variables for available spots in the main lot. Similarly, `temporary_pickup_lock` and `temporary_automobile_lock` protect the counters for the temporary parking lot.

Car Owner Function

The carOwner function handles the logic for car owners. Depending on the type of vehicle:

- The car owner attempts to park in the temporary lot.
- If a spot is available, the owner signals the attendant and waits for the parking process to complete.
- If no spot is available in the temporary parking lot, the owner leaves.

Car Attendant Function

The carAttendant function handles the attendants' logic:

- Attendants wait for a signal indicating the arrival of a new vehicle. They are hardworking attendants. They do not wait until the temporary parking lot is filled, they do a parking operation when a new vehicle is entered to the parking lot.
- They attempt to move vehicles from the temporary lot to the main lot.
- If the main lot is full, the vehicle remains in the temporary lot.

Thread Management

Two types of threads are created:

- Car owner threads simulate the arrival of car owners at random intervals.
- Car attendant threads run indefinitely, waiting for new vehicles and managing the parking process.

Resource Cleanup

After simulating the arrival of car owners, the semaphores are destroyed to clean up resources. The attendant threads are not joined in this simulation, as they are designed to run indefinitely.

Program Utilization

To compile the program, use the following command: `make`

To run the program, use the following command: `make run`

To clean the unnecessary files, use the following command: `make clean`

Expected Output

The output will display messages indicating:

- When car owners park in the temporary lot.
- When attendants park vehicles in the main lot.

- If no spots are available, either in the temporary or main lot, car owners will leave.

Example Output

```
./main
Pickup owner: parked in temporary lot. Available temporary pickup spots: 3
Pickup attendant: parked a pickup. Available pickup spots: 3
Pickup owner: my pickup is parked in the main lot.
Automobile owner: parked in temporary lot. Available temporary auto spots: 7
Automobile attendant: parked an automobile. Available automobile spots: 7
Automobile owner: my automobile is parked in the main lot.
Pickup owner: parked in temporary lot. Available temporary pickup spots: 3
Pickup attendant: parked a pickup. Available pickup spots: 2
Pickup owner: my pickup is parked in the main lot.
Pickup owner: parked in temporary lot. Available temporary pickup spots: 3
Pickup attendant: parked a pickup. Available pickup spots: 1
Pickup owner: my pickup is parked in the main lot.
Pickup owner: parked in temporary lot. Available temporary pickup spots: 3
Pickup attendant: parked a pickup. Available pickup spots: 0
Pickup owner: no parking spot available in the main lot. Leaving...
Pickup owner: parked in temporary lot. Available temporary pickup spots: 3
Pickup attendant: no parking spot available in the main lot. The pickup is waiting in the temporary parking lot...
Pickup owner: no parking spot available in the main lot. Leaving...
Automobile owner: parked in temporary lot. Available temporary auto spots: 7
Automobile attendant: parked an automobile. Available automobile spots: 6
Automobile owner: my automobile is parked in the main lot.
Automobile owner: parked in temporary lot. Available temporary auto spots: 7
Automobile attendant: parked an automobile. Available automobile spots: 5
Automobile owner: my automobile is parked in the main lot.
Pickup owner: parked in temporary lot. Available temporary pickup spots: 2
Pickup attendant: no parking spot available in the main lot. The pickup is waiting in the temporary parking lot...
Pickup owner: no parking spot available in the main lot. Leaving...
Pickup owner: parked in temporary lot. Available temporary pickup spots: 1
Pickup attendant: no parking spot available in the main lot. The pickup is waiting in the temporary parking lot...
Pickup owner: no parking spot available in the main lot. Leaving...
Automobile owner: parked in temporary lot. Available temporary auto spots: 7
Automobile attendant: parked an automobile. Available automobile spots: 4
Automobile owner: my automobile is parked in the main lot.
Pickup owner: parked in temporary lot. Available temporary pickup spots: 0
Pickup attendant: no parking spot available in the main lot. The pickup is waiting in the temporary parking lot...
Pickup owner: no parking spot available in the main lot. Leaving...
Automobile owner: parked in temporary lot. Available temporary auto spots: 7
Automobile attendant: parked an automobile. Available automobile spots: 3
Automobile owner: my automobile is parked in the main lot.
Pickup owner: no temporary parking spot available. Leaving...
Pickup owner: no temporary parking spot available. Leaving...
Automobile owner: parked in temporary lot. Available temporary auto spots: 7
Automobile attendant: parked an automobile. Available automobile spots: 2
Automobile owner: my automobile is parked in the main lot.
Automobile owner: parked in temporary lot. Available temporary auto spots: 7
Automobile attendant: parked an automobile. Available automobile spots: 1
Automobile owner: my automobile is parked in the main lot.
Automobile owner: parked in temporary lot. Available temporary auto spots: 7
Automobile attendant: parked an automobile. Available automobile spots: 0
Automobile owner: no parking spot available in the main lot. Leaving...
Automobile owner: parked in temporary lot. Available temporary auto spots: 7
Automobile attendant: no parking spot available in the main lot. The automobile is waiting in the temporary lot...
Automobile owner: no parking spot available in the main lot. Leaving...
Automobile owner: parked in temporary lot. Available temporary auto spots: 6
Automobile attendant: no parking spot available in the main lot. The automobile is waiting in the temporary lot...
Automobile owner: no parking spot available in the main lot. Leaving...
```

In the test scenario, the initial capacity in the parking lot and temporary parking lot are the same. 8 for automobiles and 4 for pickups. The initial number of car owners is 20. When 24 car owners enter the parking lot, the program ends. You can change the predefined variable MAX_CAR_OWNERS to a value as you desire. Until the main parking lot capacity is full, the temporary capacity remains the same because when the car owner comes, its car is parked right away by the car attendant because there is empty space in the main parking lot. But when the main parking lot capacity is full, the temporary parking lot starts to fill. And when the main parking lot and temporary parking lot is full, the car owner can not park. So it gives an error message “no temporary parking spot is available. Leaving...”. After this message appears, no car can park.

The Meanings Of The Print Messages

- "Pickup/Automobile owner: parked in a temporary lot. Available temporary pickup/automobile spots: X" -> This message appears when a car owner parks its car in the temporary parking lot.
- "Pickup/automobile attendant: parked a pickup/automobile. Available pickup/automobile spots: X" -> This message appears when a park attendant does the park operation from temporary lot to main lot.
- "Pickup/automobile owner: my pickup/automobile is parked in the main lot." ->This message appears when a car is parked successfully in the main lot. The car owner is informed after the parking operation is successful.
- "no temporary parking spot is available. Leaving..." ->This message appears when there is no free space for the selected vehicle type in the temporary parking lot.
- "Pickup attendant: no parking spot available in the main lot. The pickup is waiting in the temporary parking lot..." ->This message appears when there is no empty space for the selected vehicle type in the main lot. That is where the temporary park starts to fill.