**CSE344 SYSTEM PROGRAMMING
HOMEWORK #3 REPORT**

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1. Introduction

There is a parking lot for automobiles and pickups. Valets have to manage this parking lot. New cars come to their special parking spots in temporary parking lot and leaves the car. If there is no space in temporary parking lot, car leaves.

Valets take the cars (one car at a time) from temporary parking lot and moves it into the main parking lot.

2. Mechanism

```c
pthread_t owners[TOTAL_CAR_NUM], attendants[2];
int vehicleTypes[TOTAL_CAR_NUM];

srand(time(NULL));

for (int i = 0; i < TOTAL_CAR_NUM; i++) { // 1 for Automobiles, 2 for Pickups
    vehicleTypes[i] = rand() % 2 + 1;
}

pthread_create(&attendants[0], NULL, automobileAttendant, NULL);
pthread_create(&attendants[1], NULL, pickupAttendant, NULL);

for (int i = 0; i < TOTAL_CAR_NUM; i++) {
    if (vehicleTypes[i] == 1) {
        pthread_create(&owners[i], NULL, automobileOwner, NULL);
    } else {
        pthread_create(&owners[i], NULL, pickupOwner, NULL);
    }
}

for (int i = 0; i < TOTAL_CAR_NUM; i++) {
    pthread_join(owners[i], NULL);
}

for (int i = 0; i < 2; i++) {
    pthread_cancel(attendants[i]); // It is safer to impelement like that.
    pthread_join(attendants[i], NULL);
}
```

This is the main function. Car array a.k.a vehicleTypes is filled with random numbers between [1,2]. 1 stands for automobiles and 2 stands for pickups.

You can change the total car number at the beginning of the file by changing TOTAL_CAR_NUM macro.

Attendants threads will be created first and then the carOwner threads will be created according to the types of the cars in array. Then program will wait for carOwners to finish but attendants cannot finish on their own. They need a signal to finish and that signal is the killing their threads. Of course without the end of the carOwners they cannot finish. But it is fine because their finish is after joining the owners' threads.

```
int mFree_automobile = MAX_AUTOMOBILES;
int mFree_pickup = MAX_PICKUPS;
int mAutomobile_main = 0;
int mPickup_main = 0;
```

These are the global variables for all therads to use. mFree_automobile and mFree_pickup are representing the empty spaces in temporary parking lot. mAutomobile_main and mPickup_main are representing the full spaces in main parking lot.

```
void *automobileOwner() {
    sem_wait(&lock);
    if (mFree_automobile > 0) {
        sem_post(&newAutomobile);
        mFree_automobile--;

        printf("Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: %d\n", mFree_automobile);

        sem_post(&inChargeforAutomobile);
    } else {
        printf("No parking space available for automobiles. Owner is leaving.\n");
    }
    sem_post(&lock);
    return NULL;
}

void *pickupOwner() {
    sem_wait(&lock);
    if (mFree_pickup > 0) {
        sem_post(&newPickup);
        mFree_pickup--;

        printf("Pickup came to the temporary parking lot. Remaining spots in temporary lot for pickups: %d\n", mFree_pickup);

        sem_post(&inChargeforPickup);
    } else {
        printf("No parking space available for pickups. Owner is leaving.\n");
    }
    sem_post(&lock);
    return NULL;
}
```

These are the carOwner threads. They first lock the system for themselves and check the available spots in temporary parking lot. If there is a space for them, they signal the valet and the available space count in temporary space will be decreased by one. Then the thread prints the rest of the available spots number. Then notifies the corresponding valet.

If there isn't a space for them, they will leave.

```c
void *automobileAttendant() {
    while (1) {
        sem_wait(&inChargeforAutomobile);

        sem_wait(&lock);
        if (mAutomobile_main < MAX_AUTOMOBILES) {
            mFree_automobile++;
            mAutomobile_main++;
            printf("Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: %d\n", MAX_AUTOMOBILES - mAutomobile_main);
        } else {
            printf("Automobile Valet: No parking space in main lot for automobiles.\n");
        }
        sem_post(&lock);
    }
    return NULL;
}

void *pickupAttendant() {
    while (1) {
        sem_wait(&inChargeforPickup);

        sem_wait(&lock);
        if (mPickup_main < MAX_PICKUPS) {
            mFree_pickup++;
            mPickup_main++;
            printf("Pickup Valet: Pickup attendant is moving the pickup. Spots available in main lot: %d\n", MAX_PICKUPS - mPickup_main);
        } else {
            printf("Pickup Valet: No parking space in main lot for pickups.\n");
        }
        sem_post(&lock);
    }
    return NULL;
}
```

Attendants are waiting for their type of cars to come into the temporary parking lot. When a car shows up, they lock the system and checks the available spot number in main parking lot. If there is a space, they increments the number of available spots in temporary parking lot and the number of the taken spaces in main parking lot because they will put the car in a second. If there is no space in the main parking lot, they are leaving the cars in the temporary parking lot.

3. Test Cases

30 Automobiles:

```
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 7
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 6
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 5
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 4
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 3
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 2
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 1
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 0
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 7
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 6
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 5
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 4
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 3
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 2
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 1
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 0
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 7
Automobile Valet: No parking space in main lot for automobiles.
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 6
Automobile Valet: No parking space in main lot for automobiles.
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 5
Automobile Valet: No parking space in main lot for automobiles.
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 4
Automobile Valet: No parking space in main lot for automobiles.
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 3
Automobile Valet: No parking space in main lot for automobiles.
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 2
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 1
Automobile Valet: No parking space in main lot for automobiles.
Automobile Valet: No parking space in main lot for automobiles.
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 0
Automobile Valet: No parking space in main lot for automobiles.
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
koso@koso-ABRA-A5-V17-2:~/Desktop/24/cys/hw3$
```

First 8 automobiles went into the temporary parking lot.
Next 3 couldn't get in because valet wasn't fast enough. So they left.
Valet moved the automobiles to main parking lot. There is 8 spaces for automobiles in temporary park space right now.

8 more automobiles came to the temporary parking space but valet couldn't move them.

There is no space in main nor temporary parking space right now. So the rest of the automobiles left.

500 Automobiles:

```
koso@koso-ABRA-A5-V17-2:~/Desktop/24/sys/hw3$ ./park
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 7
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 6
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 5
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 4
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 3
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 2
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 1
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 0
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 7
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 6
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 5
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 4
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 3
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 2
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 5
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 1
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 0
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 6
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 5
Automobile Valet: No parking space in main lot for automobiles.
Automobile Valet: No parking space in main lot for automobiles.
Automobile Valet: No parking space in main lot for automobiles.
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 4
Automobile Valet: No parking space in main lot for automobiles.
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 3
Automobile Valet: No parking space in main lot for automobiles.
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 2
Automobile Valet: No parking space in main lot for automobiles.
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 1
Automobile Valet: No parking space in main lot for automobiles.
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 0
Automobile Valet: No parking space in main lot for automobiles.
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
No parking space available for automobiles. Owner is leaving.
```

Same scenario as the 30 Automobiles but I wanted to show that it works.

8 Automobiles and 4 Pickups:

```
koso@koso-ABRA-A5-V17-2:~/Desktop/24/sys/hw3$ ./park
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 7
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 6
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 5
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 4
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 3
Pickup came to the temporary parking lot. Remaining spots in temporary lot for pickups: 3
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 7
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 6
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 5
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 4
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 3
Pickup Valet: Pickup attendant is moving the pickup. Spots available in main lot: 3
Pickup came to the temporary parking lot. Remaining spots in temporary lot for pickups: 3
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 7
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 6
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 5
Pickup Valet: Pickup attendant is moving the pickup. Spots available in main lot: 2
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 2
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 1
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 0
Pickup came to the temporary parking lot. Remaining spots in temporary lot for pickups: 3
Pickup Valet: Pickup attendant is moving the pickup. Spots available in main lot: 1
Pickup came to the temporary parking lot. Remaining spots in temporary lot for pickups: 3
Pickup Valet: Pickup attendant is moving the pickup. Spots available in main lot: 0
koso@koso-ABRA-A5-V17-2:~/Desktop/24/sys/hw3$
```

At the end the number of the available spaces in main parking lot is 0 for both type of cars.

16 Automobiles and 8 Pickups:

```
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 7
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 6
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 5
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 4
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 3
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 2
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 7
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 6
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 5
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 4
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 3
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 2
Pickup came to the temporary parking lot. Remaining spots in temporary lot for pickups: 3
Pickup Valet: Pickup attendant is moving the pickup. Spots available in main lot: 3
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 7
Pickup came to the temporary parking lot. Remaining spots in temporary lot for pickups: 3
Pickup Valet: Pickup attendant is moving the pickup. Spots available in main lot: 2
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 6
Pickup came to the temporary parking lot. Remaining spots in temporary lot for pickups: 3
Pickup Valet: Pickup attendant is moving the pickup. Spots available in main lot: 1
Pickup came to the temporary parking lot. Remaining spots in temporary lot for pickups: 3
Pickup Valet: Pickup attendant is moving the pickup. Spots available in main lot: 0
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 5
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 4
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 1
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 0
Automobile Valet: No parking space in main lot for automobiles.
Automobile Valet: No parking space in main lot for automobiles.
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 5
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 4
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 3
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 2
Automobile Valet: No parking space in main lot for automobiles.
Automobile Valet: No parking space in main lot for automobiles.
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 1
Pickup came to the temporary parking lot. Remaining spots in temporary lot for pickups: 3
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 0
Automobile Valet: No parking space in main lot for automobiles.
Automobile Valet: No parking space in main lot for automobiles.
Pickup Valet: No parking space in main lot for pickups.
Pickup came to the temporary parking lot. Remaining spots in temporary lot for pickups: 2
Pickup Valet: No parking space in main lot for pickups.
Automobile Valet: No parking space in main lot for automobiles.
Automobile Valet: No parking space in main lot for automobiles.
Pickup came to the temporary parking lot. Remaining spots in temporary lot for pickups: 1
Pickup Valet: No parking space in main lot for pickups.
Pickup came to the temporary parking lot. Remaining spots in temporary lot for pickups: 0
Pickup Valet: No parking space in main lot for pickups.
```

Perfect behaviour was 8 automobiles and 4 pickups in main lot. And 8 automobiles and 4 pickups in temporary lot. But because the speed of the valets some of the cars came and saw that there isn't space in temporary parking lot (Because valets couldn't do it faster than the speed of the new cars coming) so they left.

Random 30 cars:

```
Pickup came to the temporary parking lot. Remaining spots in temporary lot for pickups: 3
Pickup came to the temporary parking lot. Remaining spots in temporary lot for pickups: 2
Pickup came to the temporary parking lot. Remaining spots in temporary lot for pickups: 1
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 7
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 7
Pickup came to the temporary parking lot. Remaining spots in temporary lot for pickups: 0
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 7
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 6
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 5
Pickup Valet: Pickup attendant is moving the pickup. Spots available in main lot: 3
Pickup Valet: Pickup attendant is moving the pickup. Spots available in main lot: 2
Pickup Valet: Pickup attendant is moving the pickup. Spots available in main lot: 1
Pickup Valet: Pickup attendant is moving the pickup. Spots available in main lot: 0
Pickup came to the temporary parking lot. Remaining spots in temporary lot for pickups: 3
Pickup Valet: No parking space in main lot for pickups.
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 6
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 5
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 4
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 7
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 3
Pickup came to the temporary parking lot. Remaining spots in temporary lot for pickups: 2
Pickup Valet: No parking space in main lot for pickups.
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 7
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 2
Pickup came to the temporary parking lot. Remaining spots in temporary lot for pickups: 1
Pickup Valet: No parking space in main lot for pickups.
Pickup came to the temporary parking lot. Remaining spots in temporary lot for pickups: 0
Pickup Valet: No parking space in main lot for pickups.
No parking space available for pickups. Owner is leaving.
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 7
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 1
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 7
Automobile Valet: Automobile attendant is moving the car. Spots available in main lot: 0
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 7
Automobile Valet: No parking space in main lot for automobiles.
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 6
Automobile Valet: No parking space in main lot for automobiles.
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 5
Automobile Valet: No parking space in main lot for automobiles.
No parking space available for pickups. Owner is leaving.
No parking space available for pickups. Owner is leaving.
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 4
Automobile Valet: No parking space in main lot for automobiles.
No parking space available for pickups. Owner is leaving.
No parking space available for pickups. Owner is leaving.
No parking space available for pickups. Owner is leaving.
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 3
Automobile Valet: No parking space in main lot for automobiles.
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 2
Automobile Valet: No parking space in main lot for automobiles.
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 1
Automobile Valet: No parking space in main lot for automobiles.
Automobile came to the temporary parking lot. Remaining spots in temporary lot for automobiles: 0
Automobile Valet: No parking space in main lot for automobiles.
```