C Family Coursework

Design Choices

Design Choices

Linked List for Traffic Queue

To tackle the queues for the traffic on the left and right, I decided to use a linked list that means I could implement a queue. This is because of the dynamic nature of the randomly increasing traffic, meaning that the linked list can handle the varying amount of the nodes currently in the queue. This means that there is no need for an arbitrary limit on the size of the list.

Random Number Generation using a random number library

To create the randomness of the oncoming traffic during the iterations, I used the *rand()* library to generate random numbers. I did this because the in-built environment variables made it easy to generate random numbers of my choice.

Struct for vehicle and node Structures

I used the struct structure for these because I felt that it meant that it would be easier for me to create the statistics at the end of the program. If I had used a circular list of some sort, it would mean that I would not be able to store the current iteration that the vehicle has, meaning that the statistics would be far harder to calculate. This meant I had a lot easier of a time manoeuvring the program.

QueueInfo to store information for further statistics

I have decided to create a *data structure* called QueueInfo that will allow me to store valuable data for the statistics. Within this I will have the total number of cars that will pass through each direction, the total number of iterations that have occurred for each direction in order for me to find the average, the max iterations calculated by comparing the biggest iteration each time, and then collating the total clearance times for each direction.

Assumptions Made

Left light will always start green

This is an assumption that I have made in my program that may potentially skew experiments that I conduct. This is because the program will always start with the left light being green, meaning that there will be a slight bias towards the left green light. I have decided to leave this in the program as I believe that if I used a random number it would introduce more variance to the program, and due to the clearance at the end of the program the assumption has minimal effect on the iterations, especially with such a large amount as 50,000 in total.

Vehicle will always pass on a green light

From the specification I ascertained that a vehicle will always go through the protected area during a time step, which is an assumption that could skew the results. This is because I have experimented with the vehicles having a probability to go through, however this introduced more variance to the program as the probability alongside the arrival rate meant that the program had a lot more outliers outside of a standard deviation of the actual average.

Simulator Experiments

Same Vehicle Arriving Probability

The first experiment that I carried out was an experiment that carried the parameter values of:

Left

Arrival Rate: 60

Light Period: 2

Right

Arrival Rate: 60

Light Period: 50

My assumption for this experiment was that there would be very similar results for both sides of the experiment due to the probabilities and light periods being the same. The result of the experiment yielded:

```
   from left:
      traffic arrival rate: 60
      traffic light period: 2
   from right:
      traffic arrival rate: 60
      traffic light period: 2
Results (averaged over 100 runs):
   from left:
      number of vehicles: 203
      average waiting time: 60
      maximum waiting time: 110
      clearance time: 36
   from right:
      number of vehicles: 201
      average waiting time: 60
      maximum waiting time: 109
      clearance time: 38
```

The experiment gave results that I expected, with the number of vehicles being very similar. However when I conducted the experiment again the values were overall considerably lower, showing the potential variance that this simulator yields.
The results show that for the most part, the results may vary however from experiment to experiment but the values for both directions will finish being very similar to each other.

Different Vehicle Arriving Probability

For this experiment, I decided to tweak the values of the arrival rates instead. For this experiment, I used the following parameters:

Left

Arrival Rate: 40

Light Period: 2

Right

Arrival Rate: 70

Light Period: 2

My assumption for this experiment was that there would be a large increase in the waiting times and clearance times for the right direction as the arrival rate would be much higher, and due to the light period staying the same there would be a lot of slow progress in regards to the queue. The experiment yielded.

```
Results (averaged over 100 runs):
   from left:
      number of vehicles: 130
      average waiting time: 3
      maximum waiting time: 17
      clearance time: 1
   from right:
      number of vehicles: 240
      average waiting time: 113
      maximum waiting time: 219
      clearance time: 74
```

This experiment was what I expected to happen, and the results reflect the assumption. For the left direction there is a low average waiting time with maximum only being 17, however for the right direction the average waiting time for the queue was 113 iterations. This shows how when the arrival rate for the queue is raised above 50%, there is an exponential increase in the waiting time due to there only being the potential for the movement of one car during every time step. This is compounded by the fact that there can also be a car each being added to each queue every time, meaning there will be large waiting times.

Different Light Periods

For my final experiment I decided to change the values of the time periods. For this experiment the parameters were:

Left

Arrival Rate: 60

Light Period: 2

Right

Arrival Rate: 60

Light Period: 4

The code yielded:

```
   from left:
      traffic arrival rate: 60
      traffic light period: 2
   from right:
      traffic arrival rate: 60
      traffic light period: 4
Results (averaged over 100 runs):
   from left:
      number of vehicles: 224
      average waiting time: 210
      maximum waiting time: 403
      clearance time: 100
   from right:
      number of vehicles: 214
      average waiting time: 439
      maximum waiting time: 401
      clearance time: 202
```

This experiment yielded an interesting result, with the maximum waiting time being much larger for the left direction due to the disparity in light period. This shows how skewing the time that the cars can move whilst also maintaining a high arrival rate can mean that the simulation will tend towards

Code Outputs

Below is a sample output with some parameters.

```
   from left:
      traffic arrival rate: 70
      traffic light period: 2
   from right:
      traffic arrival rate: 70
      traffic light period: 2
Results (averaged over 100 runs):
   from left:
      number of vehicles: 232
      average waiting time: 91
      maximum waiting time: 198
      clearance time: 65
   from right:
      number of vehicles: 225
      average waiting time: 92
      maximum waiting time: 195
      clearance time: 66
```

Sample output with left arrival rate = 70, left light period = 2, right arrival rate = 70, right light period = 2.

NOTE: MY CODE UNFORTUNATELY DOES NOT CONTAIN PASS BY REFERENCE, MAIN.C PARAMETER VALUES MUST BE MANIPULATED.