Report: Lab 11

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Exercise 1:

File: ex1.py

In this system we have a single queue with a single server, and two types of customers whose arrival as well as service rate differs. Simulating the queue for 1000 times, we get the following output. We considered Waiting Times (Waiting Time in queue+ Service Time) and Server Utilization as our performance metric.

```
>>> runfile('C:/Users/Aak/Desktop/Sem IV/IE 684/Lab 11/ex1.py', wdir='C:/Users/Aak
/Desktop/Sem IV/IE 684/Lab 11')
Enter the time horizon: 100
Average waiting time over 1000 simulations:  6.46814088523
Average Utilization of server over 1000 simulations:  79.5211954123 %
>>>
```

Figure 1: Average Waiting Time in Queue+Service Time and Average Server Utilization when time horizon T=100

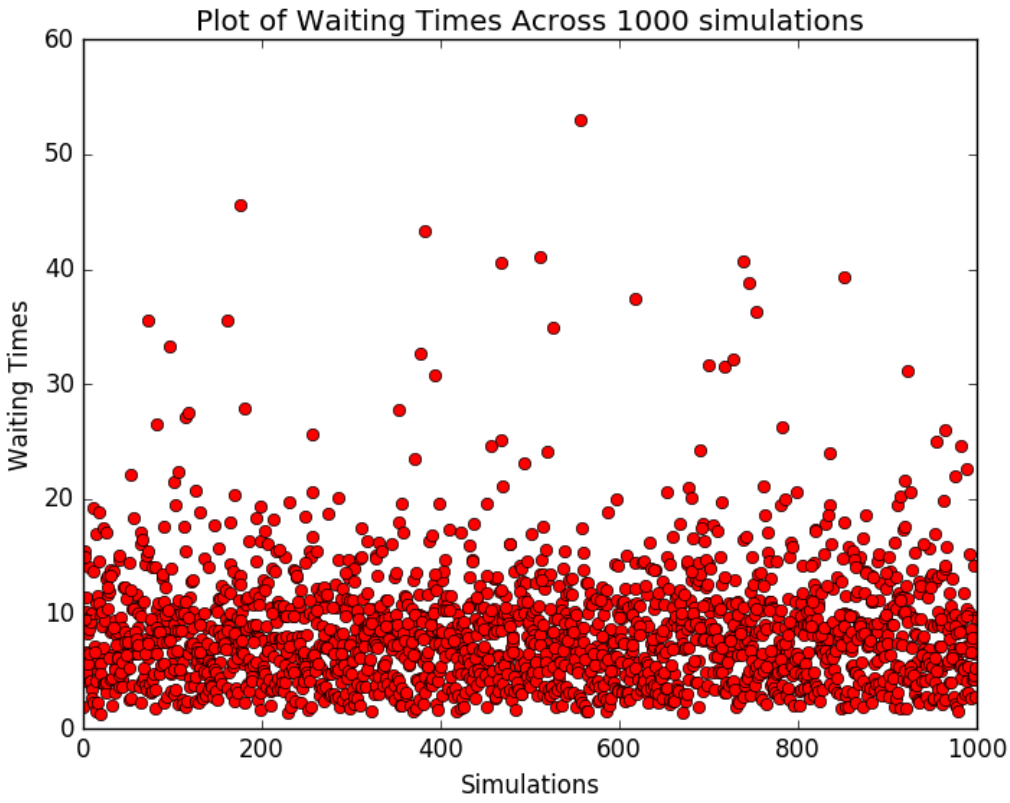

Figure 2: Plot of average Waiting Time across all simulations

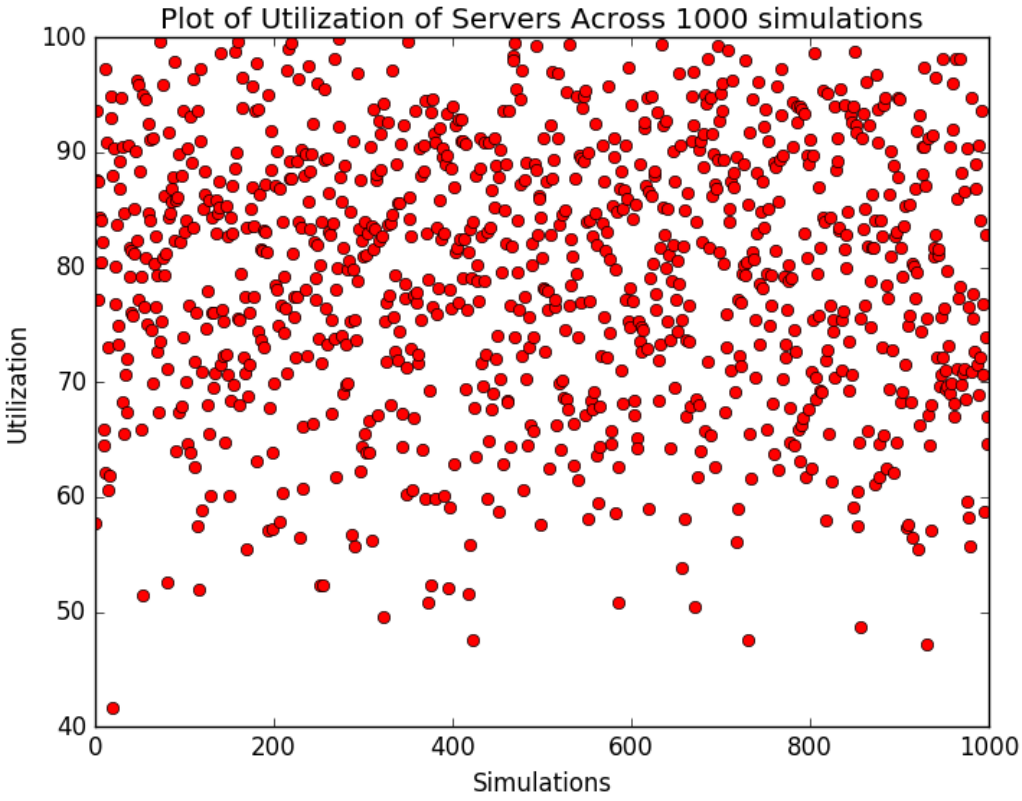

Figure 3: Plot of Server Utilization across all simulations

We can conclude from figure 2, that the the majority of the waiting times is below 10 mins with the average being around 6.5 mins. While from figure 3, we can conclude that the majority of the server utilization is uniformly distributed between 65% and 95% barring some outliers.

Exercise 2:

File: ex2.py

In this system we have two queues for two different types of customers whose arrival rate differs. There is just one server handling both the queues and the service time differs for both the customers. Simulating the queue for 1000 times, we get the following output. We considered Waiting Times (Waiting Time in queue+ Service Time) as our performance metric.

```
>>> runfile('C:/Users/Aak/Desktop/Sem IV/IE 684/Lab 11/ex2.py', wdir='C:/Users/Aak
/Desktop/Sem IV/IE 684/Lab 11')
Enter the time horizon: 100
Average Waiting Time for Queue 1 over 1000 simulations:  0.636828242979
Average Waiting Time for Queue 2 over 1000 simulations:  24.0427237525
>>>
```

Figure 4: Average Waiting Time in Queue+Service Time for both the queues when time horizon T=100

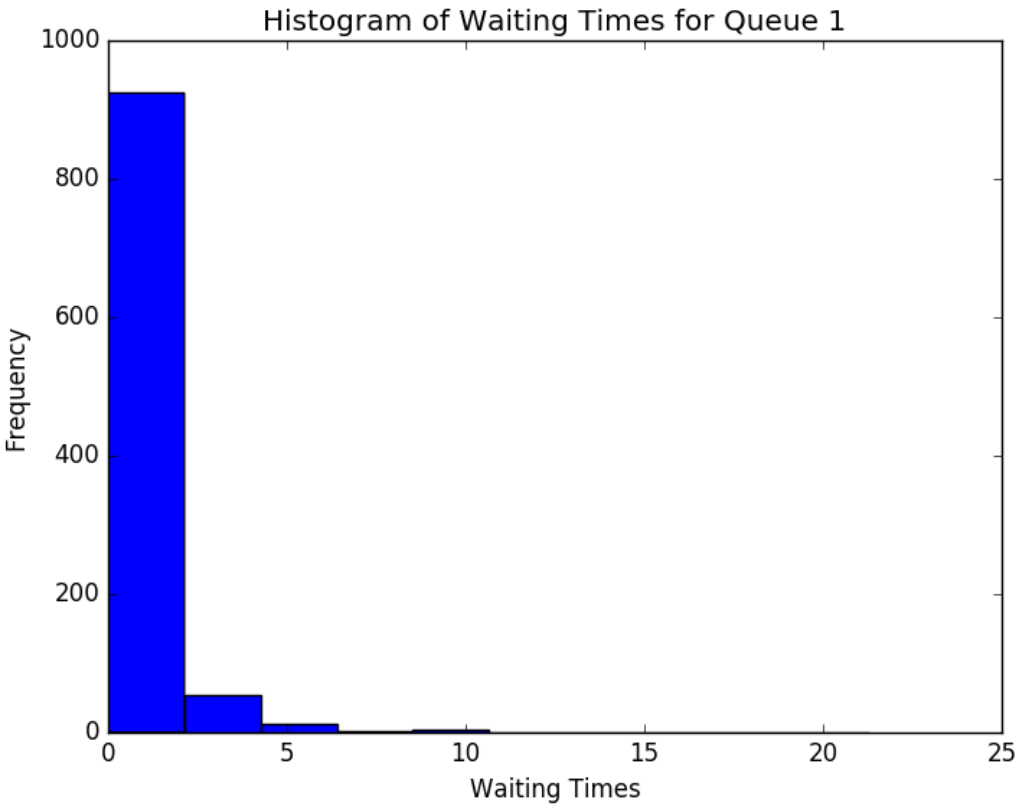

Figure 5: Histogram showing the distribution of waiting times of queue 1

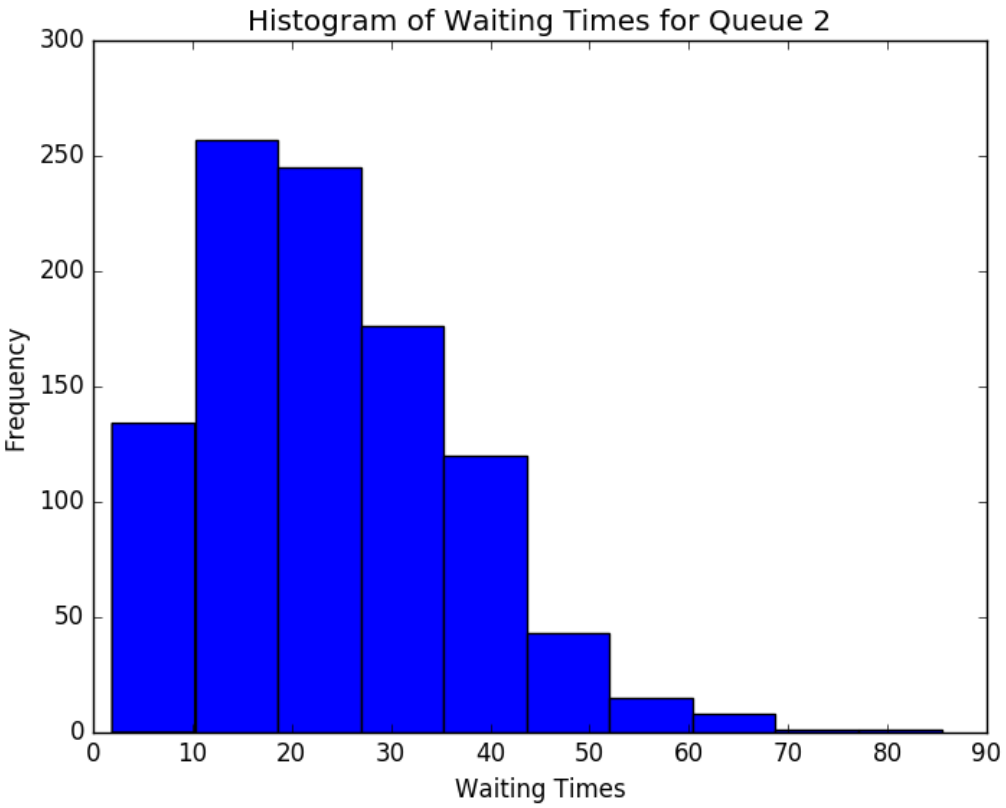

Figure 6: Histogram showing the distribution of waiting times of queue 2

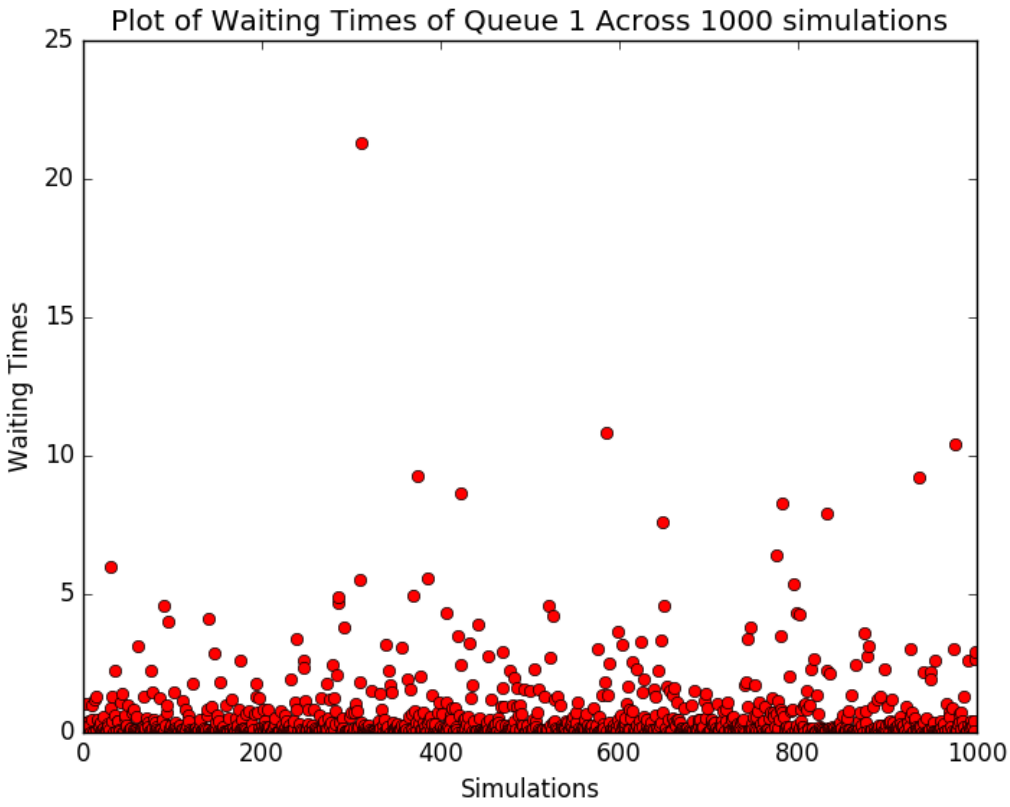

Figure 7: Plot of average Waiting Time across all simulations for queue 1

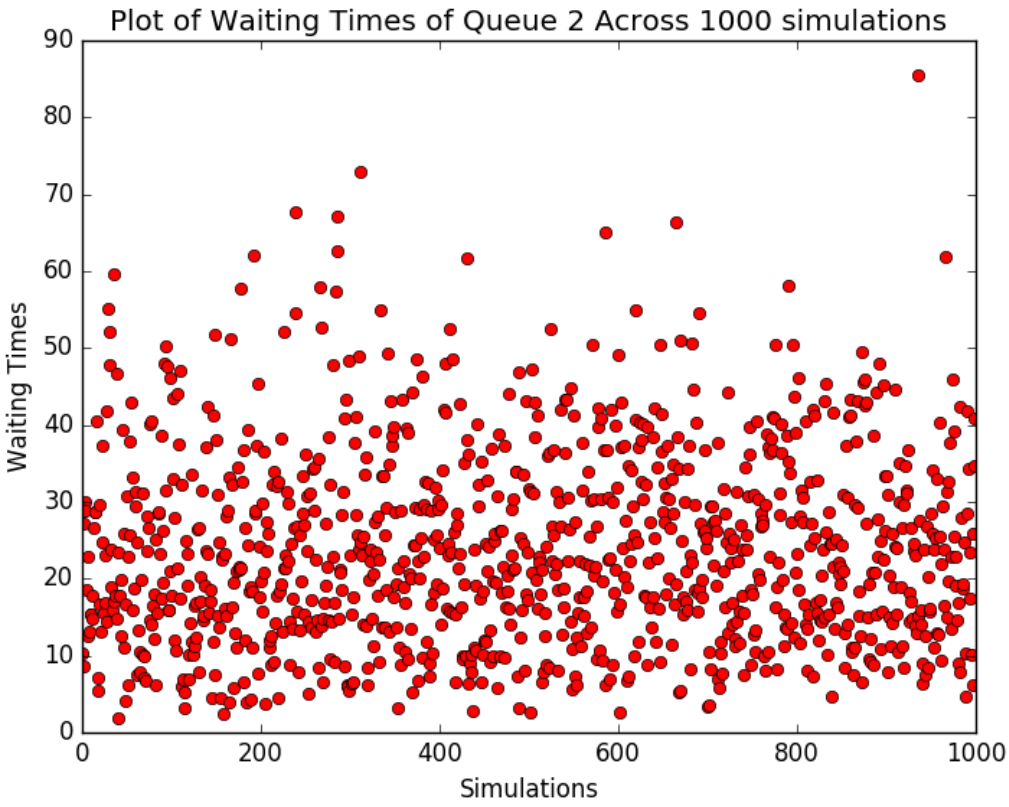

Figure 8: Plot of average Waiting Time across all simulations for queue 2

We can conclude from the above plots that the average waiting time for Type-1 customers is far less than that of Type-2 customers with the average of type 1 customers being around 0.6 mins while that of type 2 being around 24 mins. Furthermore from figures 5 and 6 we can see that the majority[more than 90%] of Waiting Times of type 1 customers lies between 0 and 4 while the waiting time distribution of type 2 customers is positively skewed between 0 and 80. Figure 7 shows that the most of the waiting times across simulations for type 1 customers is close to zero. While in figure 8, we can see that the waiting times of type 2 customers is evenly distributed more or less between 0 and 50.

While comparing the two systems of ex1 and ex2, we can see that the average waiting time in the second system is much more than that in system 1. We will prefer System 1 in general but when the priority of customers of queue 1 is very high, we will prefer system 2.