Result & Analysis:

To test the correctness of our program, we followed the instruction and test the program with following data sets:

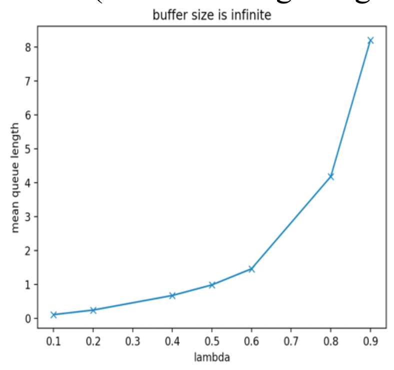
1)
Assume that μ = 1 packet/second. Plot the queue-length and the server utilization as a function of λ for λ = 0.1, 0.2, 0.4, 0.5, 0.6, 0.80, 0.90 packets/second when the buffer size is infinite.

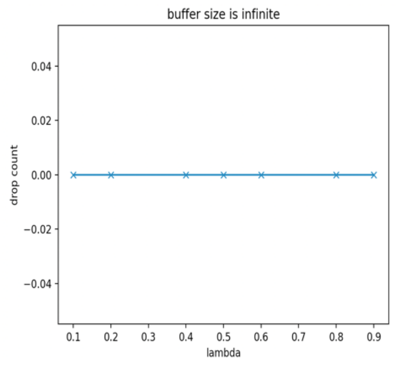
After inputting data into our program, we received the following results:

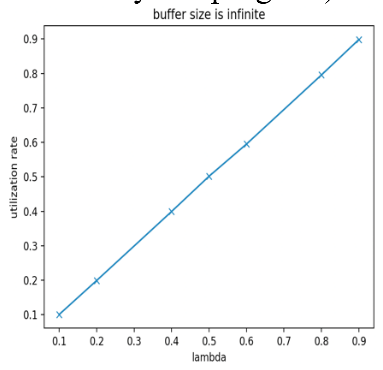
lambda	u	maxbuffer		dropcount	mean queue	utilization rate
0.1	1	-1		0	0.11142	0.100774
0.2	1	-1		0	0.245315	0.199309
0.4	1	-1		0	0.67566	0.399479
0.5	1	-1		0	0.98804	0.501785
0.6	1	-1		0	1.463251	0.5952
0.8	1	-1		0	4.18326	0.795634
0.9	1	-1		0	8.207232	0.898451

As you can see, with the buffer size set to infinite (we represent infinity with -1 in our program) and a fixed μ = 1 packet/second, the number of packets dropped is constantly zero as expected, and both mean queue length and utilization rate increases as λ increases.

(The following is a graphic representation of the data returned by our program)

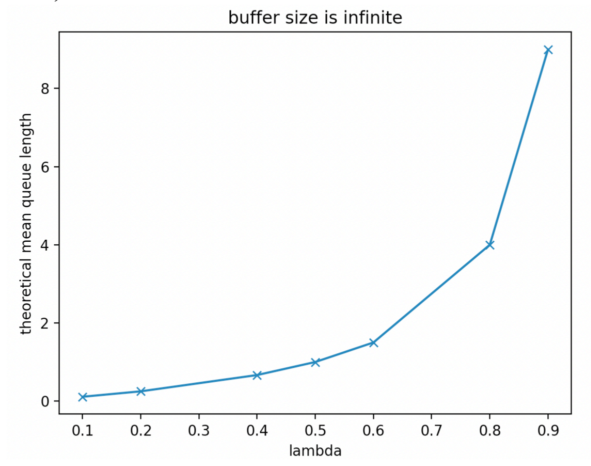


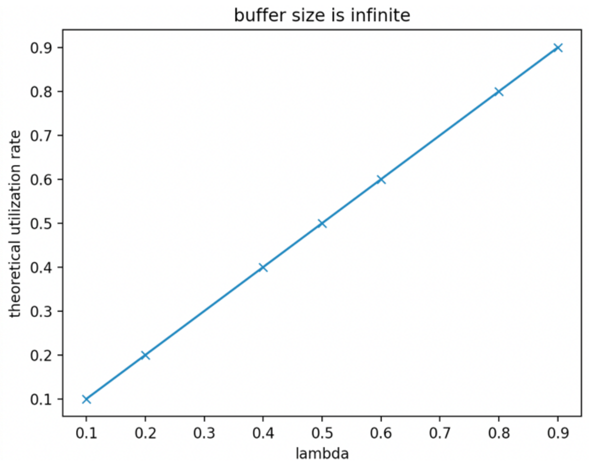




In order to further test the correctness of the results return by our program, we also compare it with the theoretical value:
We first compute the Utilization factor $p = \frac{\lambda}{\mu}$ and gets values with is essentially identical to the values of λ, and we also get the average utilization with the formula $p = \frac{\lambda}{\mu}$

(The follow is the graphic result for theoretical values of mean queue length and utilization rate.)





As the above pictures show, our results are the same as the theoretical values, which proven the correctness of our program.

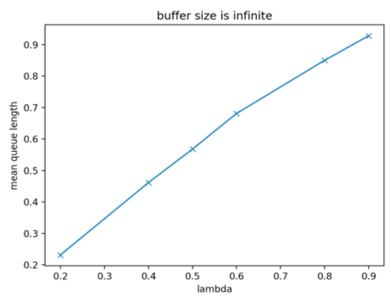
2)
Assume that μ = 1 packet/second. Plot the total number of dropped packets as a function of λ for λ = 0.2, 0.4, 0.5, 0.6, 0.8, 0.9 packets/second for MAXBUFFER = 1.

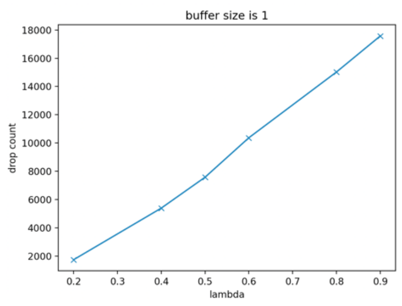
After inputting data into our program, we received the following results:

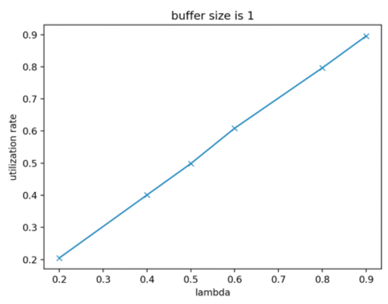
lambda	u	maxbuffer		dropcount	mean queue	utilization rate
0.2	1	1		1737	0.231674	0.204953
0.4	1	1		5387	0.461571	0.400925
0.5	1	1		7575	0.567896	0.49853
0.6	1	1		10369	0.681055	0.608637
0.8	1	1		15024	0.84986	0.796405
0.9	1	1		17575	0.927791	0.895581

As you can see, with the buffer size set to 1 and a fixed μ = 1 packet/second, the number of packets dropped, mean queue length and utilization rate increases as λ increases.

(The following is a graphic representation of the data returned by our program)



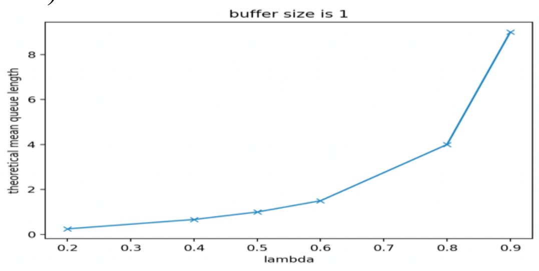


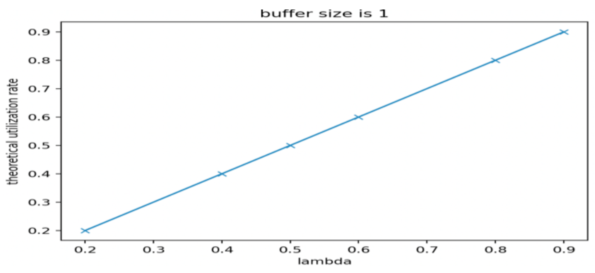


In order to further test the correctness of the results return by our program, we also compare it with the theoretical value:

We first compute the Utilization factor $p = \frac{\lambda}{\mu}$ and gets values with is essentially identical to the values of λ, and we also get the average utilization with the formula $p = \frac{\lambda}{\mu}$

(The follow is the graphic result for theoretical values of mean queue length and utilization rate.)



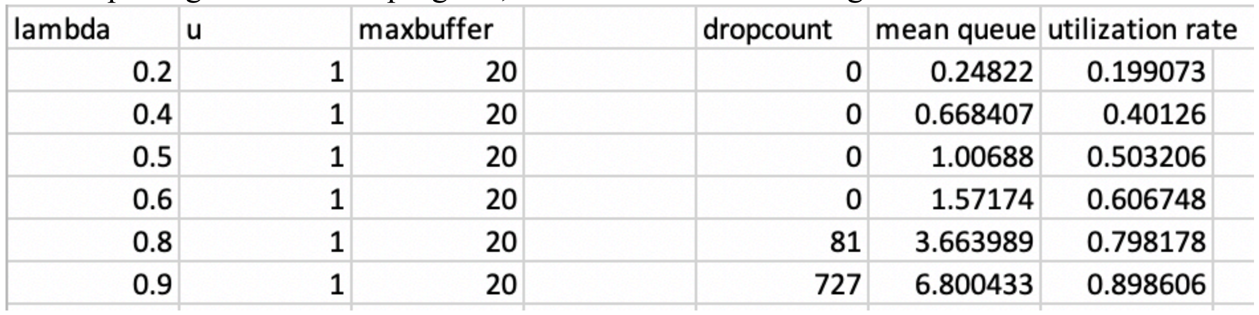


As the above pictures show, our result of utilization is the same as the theoretical value. However, also as above pictures show, the theoretical mean queue length is different from our result. This is because the theoretical value for mean queue length does not take the maximum buffer size into consideration, so the theoretical mean queue length is not realistic and is only for reference.

3)

Assume that μ = 1 packet/second. Plot the total number of dropped packets as a function of λ for λ = 0.2, 0.4, 0.5, 0.6, 0.8, 0.9 packets/second for MAXBUFFER = 20.

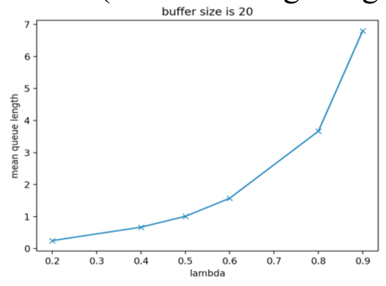
After inputting data into our program, we received the following results:

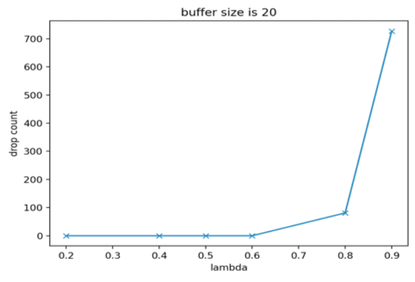


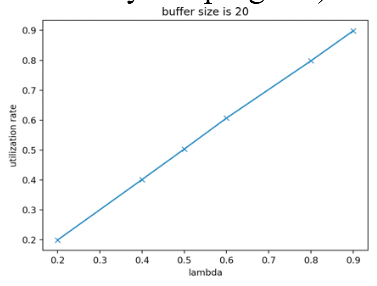
lambda	u	maxbuffer		dropcount	mean queue	utilization rate
0.2	1	20		0	0.24822	0.199073
0.4	1	20		0	0.668407	0.40126
0.5	1	20		0	1.00688	0.503206
0.6	1	20		0	1.57174	0.606748
0.8	1	20		81	3.663989	0.798178
0.9	1	20		727	6.800433	0.898606

As you can see, with the buffer size set to 1 and a fixed μ = 1 packet/second, the number of packets dropped, mean queue length and utilization rate increases as λ increases as always.

(The following is a graphic representation of the data returned by our program)



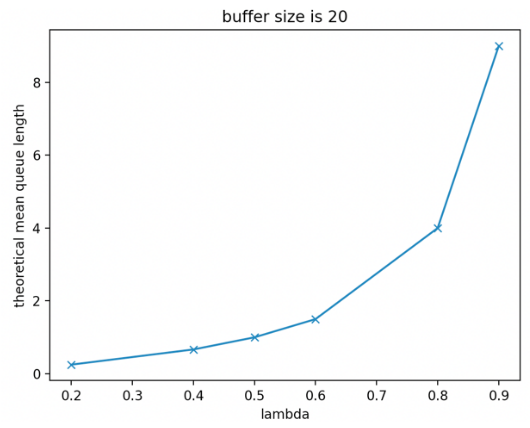


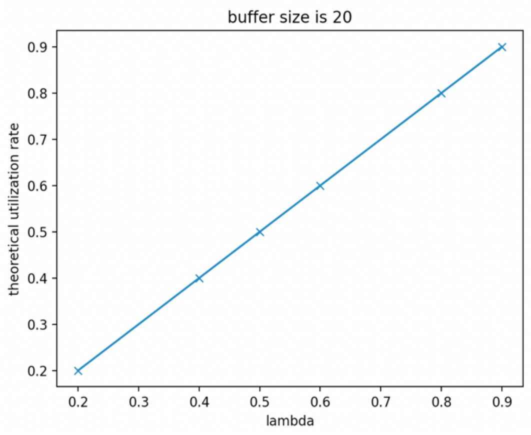


In order to further test the correctness of the results return by our program, we also compare it with the theoretical value:

We first compute the Utilization factor $p = \frac{\lambda}{\mu}$ and gets values with is essentially identical to the values of λ, and we also get the average utilization with the formula $p = \frac{\lambda}{\mu}$

(The follow is the graphic result for theoretical values of mean queue length and utilization rate.)



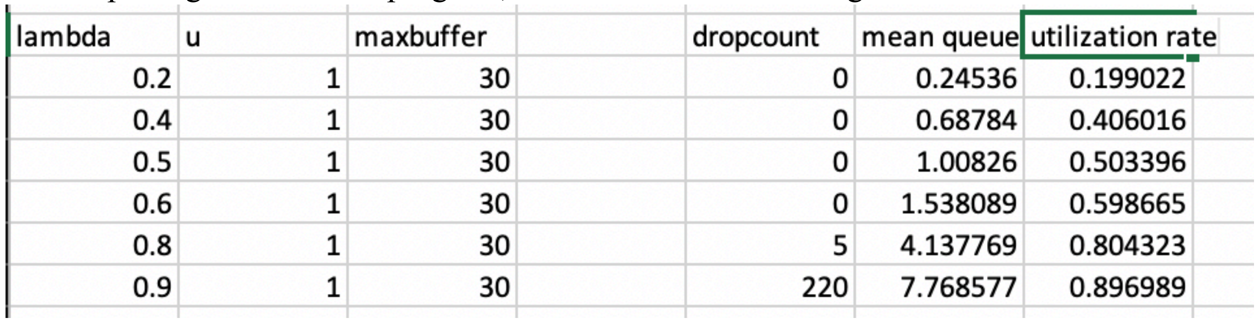


As the above pictures show, our results are the same as the theoretical values, which proven the correctness of our program.

4)

Assume that μ = 1 packet/second. Plot the total number of dropped packets as a function of λ for λ = 0.2, 0.4, 0.5, 0.6, 0.8, 0.9 packets/second for MAXBUFFER = 30.

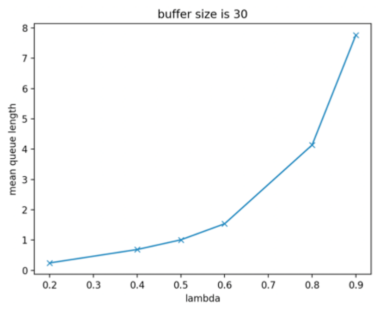
After inputting data into our program, we received the following results:

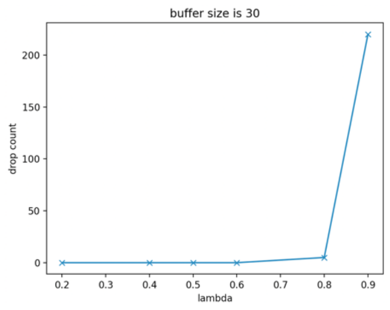


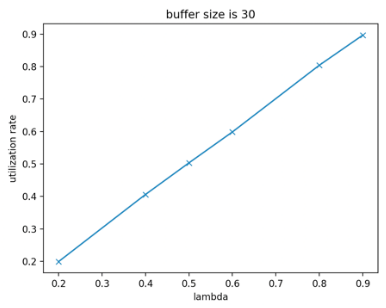
lambda	u	maxbuffer		dropcount	mean queue	utilization rate
0.2	1	30		0	0.24536	0.199022
0.4	1	30		0	0.68784	0.406016
0.5	1	30		0	1.00826	0.503396
0.6	1	30		0	1.538089	0.598665
0.8	1	30		5	4.137769	0.804323
0.9	1	30		220	7.768577	0.896989

As you can see, with the buffer size set to 1 and a fixed μ = 1 packet/second, the number of packets dropped, mean queue length and utilization rate increases as λ increases as always.

(The following is a graphic representation of the data returned by our program)

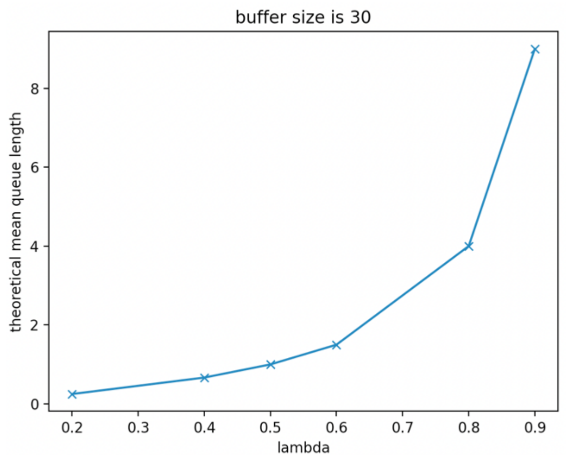


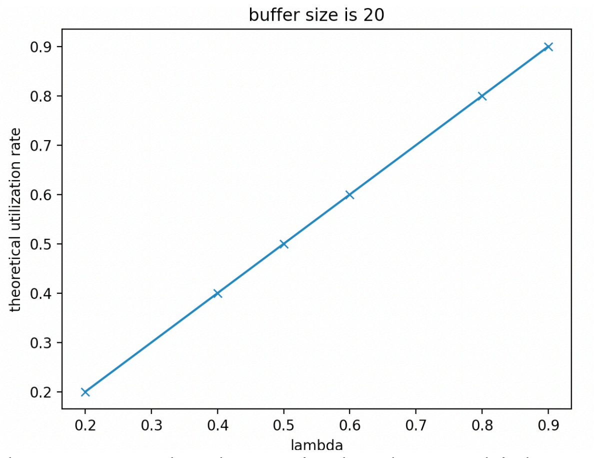




In order to further test the correctness of the results return by our program, we also compare it with the theoretical value:

We first compute the Utilization factor $p = \frac{\lambda}{\mu}$ and gets values with is essentially identical to the values of λ, and we also get the average utilization with the formula $p = \frac{\lambda}{\mu}$





As the above pictures show, our results are the same as the theoretical values, which proven the correctness of our program.

Conclusion:

By comparing the data returned by our program and the theoretical results, our program shows a satisfying result. The only inconsistency which happens when max buffer size is 1 can also be explain with the fact that the formula does not take buffer size limitation into consideration. Therefore, our program shows a promising result overall.