

# Output Data Analysis

CSE412 : Simulation and Modeling Sessional

## Assignment 4

### Specifications

A spreadsheet simulation for single-server queueing system is to be done for output data analysis.

1. Consider  $\rho$  is 0.9 and interarrival times has a mean of 60 seconds. Create a simulation of the attributes **Interarrival Time (s), Arrival Time, Service Time(s), Time Service Begins, Time Service Ends, Waiting Time in Queue (Delay)** - with at least  $m = 500$  customers. Example shown in figure 1 for  $m=10$ .
2. Then, simulate only the **Delay** value for  $m = 500$  customers, for at least  $n = 1000$  replications (runs) for each customer, using what-if analysis. Example shown in figure 2 for  $n=9$ .
3. The simulation described in step 1 and 2 should be repeated for different starting conditions. The starting conditions should be varied with the number of customers,  $s = 0, 5, 10, 12, 15$ . Here  $s$  represents the number in system at time zero. (For example,  $s=5$  means 5 customers will arrive at the system at time zero, so their **interarrival time, arrival time these attributes should be set to zero.**)
4. For each starting condition, show the plot of convergence of the transient mean,  $E(D_i)$  for  $n = 250, 500, 750, 1000$  replications in a single graph considering  $m = 500$  customers.
5. Finally, show the plot of  $E(D_i)$  for  $n = 1000$  replications and  $m = 500$  customers for different starting conditions  $s$  in a single graph.

### Submission Guidelines

- Create a folder having the same name as your 7-digit student id. Put one or all your **xlsx** files inside the folder.
- Zip the folder and submit it in Moodle.

Please note that usage of any unfair means will be duly punished and will result in a -100% mark.

**Submission Deadline : Sunday, 4 February, 2024 11:55 PM**

## Supporting Materials

Customer	Interarrival Time (s)	Arrival Time	Service Time(s)	Time Service Begins	Time Service Ends	Waiting Time in Queue (Delay)
1	0	0	18.63771942	0	18.63771942	0
2	87.64442919	87.64442919	10.77137776	87.64442919	98.41580695	0
3	34.43899181	122.083421	10.98666426	122.083421	133.0700853	0
4	54.62989214	176.7133131	18.63375516	176.7133131	195.3470683	0
5	74.10155804	250.8148712	56.67932749	250.8148712	307.4941987	0
6	59.82834223	310.6432134	61.93744377	172.3456476	189.2001506	0
7	12.64091766	133.4465674	52.42933114	189.2001506	263.3783982	49.29653
8	3.496819565	146.552305	2.302728667	292.3654911	308.8395911	98.22904
9	24.15448219	223.1105927	18.29472809	308.8395911	335.414369	76.37728
10	9.26892908	303.7875778	11.55947254	335.414369	352.0794096	85.40308

Figure 1: Example simulation shown for 10 customers

Customer	Interarrival Time (s)	Arrival Time	Service Time(s)	Time Service Begins	Time Service Ends	Waiting Time in Queue (Delay)
1	0	0	18.63771942	0	18.63771942	0
2	87.64442919	87.64442919	10.77137776	87.64442919	98.41580695	0
3	34.43899181	122.083421	10.98666426	122.083421	133.0700853	0
4	54.62989214	176.7133131	18.63375516	176.7133131	195.3470683	0
5	74.10155804	250.8148712	56.67932749	250.8148712	307.4941987	0
6	59.82834223	310.6432134	61.93744377	172.3456476	189.2001506	0
7	12.64091766	133.4465674	52.42933114	189.2001506	263.3783982	49.29653
8	3.496819565	146.552305	2.302728667	292.3654911	308.8395911	98.22904
9	24.15448219	223.1105927	18.29472809	308.8395911	335.414369	76.37728
10	9.26892908	303.7875778	11.55947254	335.414369	352.0794096	85.40308

Simulation for n = 1000 replications (runs)

=TRANSPOSE(START:END)

1	0	0	0	0	0	0	49.29653	98.22904	76.37728	85.40308
2	0	0	0	0	0	45.97512028	111.8291	164.5433	169.0669	157.4146
3	0	0	10.70024835	90.47842177	97.10025445	136.9838	83.40516	100.333	84.56233	92.10658
4	0	33.53191441	42.06781724	46.81163042	94.31203552	128.6136	96.94488	100.4194	44.78224	53.78425
5	0	24.22189821	26.73627139	4.948254263	0	20.88702	10.3364	9.304269	10.00745	0
6	0	0	14.01834348	18.73239467	0	5.574983	6.051762	0	2.937162	0
7	0	4.97921082	1.523312553	0	3.461132567	16.05186	0	16.52605	12.00215	11.63473
8	0	26.0825248	68.34993944	93.81521183	70.53414938	23.33237	80.81838	32.32882	6.32048	50.35289
9	0	7.673121692	10.52449188	19.55477701	16.16991546	10.3689	11.19267	0	0	11.27988
10	0	0	0	44.28230317	54.29615059	85.40979	53.75164	150.4397	224.9615	158.2968

Use what-if analysis to generate n simulations

Figure 2: Example delay simulation shown for n=9

Refer to chapter 4 and 9 of the textbook (Law). (Specifically, Example 4.19, Example 4.22, Example 9.2)

- $InterArrivalRate(\lambda) = \frac{1}{Inter\ Arrival\ Time\ (Mean)}$  [Inter Arrival Time (Mean) is given here, which is 60 seconds]
- $\rho = \frac{\lambda}{\omega}$  [Rho = 0.9 is given]
- $InterServiceRate(\omega) = \frac{1}{Inter\ Service\ Time\ (Mean)}$ . It should now be clear how to calculate the Inter Service Time (Mean).
- To generate values from a given mean, we have previously used the formula  $-mean * \ln(U)$ . You can use this idea for both the **interarrival time and service time** attributes in the simulation.
- To calculate the **Delay** values, utilize the formula explained in Example 4.19.
- To create a graph in Excel, first select the data, then go to **Insert**, and then **Recommended Charts**.