IE 580: System Simulations
Homework 3
Omar Zu'bi

Question 1: Build a simulation model of Example 1 in Handout 4. Using the simulation model, conduct a sensitivity analysis of variables α and θ to 1) average time in system for customers who join the system and complete the service, 2) number of customers who decide not to join the system, and 3) number of customers who join the system but decide to leave before starting the service.

Arrival of customers: Expo(1)
Service time: Expo(1)
Termination condition: control run length by creating 150 customers
Replications: 100

The following simulation was built in Arena and a sensitivity analysis of α and θ was performed using the process analyzer tool. The values of α and θ were changed; the values for α are between $0 < \alpha < 1$, whereas θ is any real number. Each scenario was replicated for one hundred times and the following response variables, average time in system for customers who joined the system and completed the service, number of customers who decided not to join the system, and number of customers who joined the system but decided to leave before starting the service were recorded in the table below:

Scenario #	α	θ	Average time in system for customers who joined the system	Number of customers who decided not to join the system	Number leaving from queue
1	1	1	1.269	54.52	0
2	0.95	1	1.212	43.29	13.13
3	0.9	1	1.186	35.66	23.1
4	0.85	1	1.126	28.65	31.28
5	0.8	1	1.145	23.97	40.16
6	0.75	1	1.124	19.59	46.02
7	0.7	1	1.096	14.96	52.33
8	0.65	1	1.139	26.13	36.03
9	0.6	1	1.054	7.23	63.36
10	0.55	1	1.015	3.55	68.82
11	1	2	1.524	45.29	0
12	0.95	2	1.417	34.36	15.41
13	0.9	2	1.347	26.43	26.91
14	0.85	2	1.288	21.08	35.3

15	0.8	2	1.239	16.64	43.06
16	0.75	2	1.189	13.98	48.59
17	0.7	2	1.15	9.82	55.29
18	0.65	2	1.108	7.39	60.28
19	0.6	2	1.09	4.75	65.27
20	0.55	2	1.032	2.07	69.24

From the table above, we can conclude a few things above the effects of α and θ on the response variables. The table above indicates that as θ increases, the average number of customers not entering the queue decreases. The average number of customers leaving from the queue behaves similarly, that is, it decreases as the value of θ increases. The average number of customers served, in contrast, increases as θ increase.

The response variables are more sensitive to α; small changes in the value of α will cause larger impacts on the response values when θ is constant in comparison to the changes to θ. As α decreases, the value for both the average time in the system and number of customers that did not join the system decreases, whereas, the number of customers leaving from the queue increases.

Question 2: Build a simulation model of Example 3 in Handout 4. Using the simulation model, conduct a sensitivity analysis of a variable of your choice. Please set up parameters and variables other than those below, by yourself but with discretion.

Number of zones: 10
Number of hospitals: 2
Number of ambulances: 5
Termination condition: control run length by creating 200 patients
Replications: 100

The following simulation was created in the arena and a sensitivity analysis was conducted using the process analyzing tool. The values for speed were changed in increments of +/- 1 and the response time was recorded. The table below shows the distances between each of the ten locations simulated in the model (the probability of arrival is 0.1 for each location):

Locations	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	0	3	4	5	6	7	8	9	10	11
2	3	0	5	6	7	8	9	10	11	12
3	4	5	0	7	8	9	10	11	12	13
4	5	6	7	0	9	10	11	12	13	14
5	6	7	8	9	0	11	12	13	14	15
6	7	8	9	10	11	0	13	14	15	16

7	8	9	10	11	12	13	0	15	16	17
8	9	10	11	12	13	14	15	0	17	18
9	10	11	12	13	14	15	16	17	0	19
10	11	12	13	14	15	16	17	18	19	0

From the sensitivity analysis, we can see that there is an overall trend that as the arrival rates increase, the response time decreases. Despite the few discrepancies, the trend is quite clear. Each scenario was replicated for one hundred times for twenty two different scenarios shown in the table below:

Scenario #	**Arrival**	**Response Time**
1	1.25	353.093
2	1.5	358.079
3	1.75	366.436
4	2	170.481
5	2.25	327.846
6	2.5	283.669
7	2.75	12.214
8	3	261.496
9	3.25	309.266
10	3.5	237.814
11	3.75	226.23
12	4	216.168
13	4.25	203.249
14	4.5	194.508
15	4.75	180.606
16	5	170.481
17	5.25	160.955
18	5.5	148.806
19	5.75	142.8
20	6	128.974
21	6.25	122.329
22	6.5	109.81