

Homework 3 – Chapter 3, exercise 1:

- (a) Using the event-scheduling approach, continue the (manual) checkout-counter simulation in Example 3.3, Table 3.1. Use the same interarrival and service times that were previously generated and used in Example 2.1. When the last interarrival time is used, continue the simulation (allowing no new arrivals) until the system is empty. Compare the results obtained here to those obtained in Example 2.1. The results should be identical
- (b) Do Exercise 1(a) again, adding the model components necessary to estimate mean response time and proportion of customers who spend 4 or more minutes in the system. [Hint: See Example 3.4, Table 3.2]**
- (c) Comment on the relative merits of manual versus computerized simulations.

Customer	Interrival time	Arrival Times	Service times
1	-	0	4
2	8	8	1
3	6	14	4
4	1	15	3
5	8	23	2
6	3	26	4
7	8	34	5
8	7	41	4
9	2	43	5
10	3	46	3
11	1	47	3
12	1	48	5
13	5	53	4
14	6	59	1
15	3	62	5
16	8	70	4
17	1	71	3
18	2	73	3
19	4	77	2
20	5	82	3

Tables 2.8 and 2.9 from Example 2.1, adding arrival time

(a)

Clock	System state		FEL	Comment	Response time	Customers in system >3 minutes	Customers in system
	LQ(t)	LS(t)					
0	0	1	(D,4), (A,8)	C1 arrival			1
4	0	0	(A,8)	C1 departure	8	1	
8	0	1	(D,9),(A,14)	C2 arrival			2
9	0	0	(A,14)	C2 departure	6	1	
14	0	1	(A,15),(D,18)	C3 arrival			3
15	1	1	(D,18),(A,23)	C4 arrival			3,4
18	0	1	(D,21),(A,23)	C4 start of service, C3 departure	4	1	4
21	0	0	(A,23)	C4 departure	6	1	
23	0	1	(D,25),(A,26)	C5 arrival			5
25	0	0	(A,26)	C5 departure	2		

26	0	1	(A,34),(D,30)	C6 arrival			6
30	0	0	(A,34)	C6 departure	4	1	
34	0	1	(D,39),(A,41)	C7 arrival			7
39	0	0	(A,41)	C7 departure	5	1	
41	0	1	(A,43),(D,45)	C8 arrival			8
43	1	1	(D,45),(A,46), (D,50)	C9 arrival			8,9
45	0	1	(A,46),(D,50)	C8 departure	4	1	9
46	1	1	(A,47),(D,50), (D,53)	C10 arrival			9,10
47	2	1	(A,48), (D,50), (D,53), (D,56)	C11 arrival			9,10,11
48	3	1	(D,50), (A,53), (D,53), (D,56), (D,61)	C12 arrival			9,10,11,12
50	2	1	(A,53), (D,53), (D,56), (D,61)	C9 departure	7	1	10,11,12
53	2	1	(D,56), (A,59), (D,61), (D,65)	C13 arrival, C10 departure	7	1	11,12,13
56	1	1	(A,59), (D,61), (D,65)	C11 departure	9	1	12,13
59	2	1	(D,61), (A,62), (D,62), (D,65)	C14 arrival			12,13,14
61	1	1	(A,62), (D,62), (D,65)	C12 departure	13	1	13,14
62	2	1	(D,65), (D,66), (A,70), (D,71)	C15 arrival			13,14,15
65	1	1	(D,66), (A,70), (D,71)	C13 departure	12	1	14,15
66	0	1	(A,70), (D,71)	C14 departure	7	1	15
70	1	1	(A,71), (D,71), (D,75)	C16 arrival			15,16
71	1	1	(A,73), (D,75), (D,78)	C15 departure, C17 arrival	9	1	16,17
73	2	1	(D,75), (A,77), (D,78), (D,81)	C18 arrival			16,17,18
75	1	1	(A,77), (D,78), (D,81)	C16 departure	5	1	17,18
77	2	1	(D,78), (D,81), (A,82), (D,83)	C19 arrival			17,18,19
78	1	1	(D,81), (A,82), (D,83)	C17 departure	7	1	18,19
81	0	1	(A,82), (D,83)	C18 departure	8	1	19
82	1	1	(D,83), (D,86)	C20 arrival			19,20
83	0	1	(D,86)	C19 departure	6	1	20
86	0	0	-	C20 departure	4	1	-

(b) See response time and customers waiting >3 minutes columns of table. Sum of response times is 133, average response time is $133/20=6.65$. 19 of 20 = 95% of customers spend 4 or minutes in system.

(c) With manual simulation, the results can be checked step by step to verify that the results are reasonable. With a computerized simulation, this option is not generally available unless the

simulation provides a means for single stepping the program. For short simulations, the work of performing the process manually may be comparable to the work of writing the simulation code. On the other hand, for longer, more complex simulations, the difficulty and likelihood of making a mistake in the manual method is far outweighed by the speed of a computerized simulation.