

Beomjin Han
Dr. Mitchell
CSC 148
HW3

1.

Del Taco

2200 Arden Way, Sacramento, CA 95825

Sample collected on 10/19/2019.

This establishment is a medium-sized Mexican fast food restaurant with a drive-thru.



The number of service centers $n_{\text{Steps}} = 2$ because O is done at one step, and P & G at the same station next step.

3.

$s_{\text{is}} = 5$ minutes

216 minutes / 5 minutes = 43.2 sis intervals

100 Cj arrivals / 43.2 sis intervals = 2.315 arrivals/interval (sample mean \hat{x})

2.315 arrivals/interval / 300 seconds/interval = 0.0077 customers/sec

4.

Little's Law check

A stable system satisfies $L = \lambda * w$

$L^{\wedge} = \text{avg}(\text{the value of } L \text{ as each } c \text{ arrives}) / (\text{total number of } c)$
 $= (206/100) = \mathbf{2.06}$

$\lambda^{\wedge} = (\text{number of } c \text{ that arrived}) / (\text{observation duration})$
 $= 100 \text{ customers} / 12983 \text{ seconds} = 0.0077 \text{ customers/sec}$

$w^{\wedge} = (\text{total time spent in } S \text{ by all } c) / (\text{total number of } c)$
 $= 29575 \text{ seconds} / 100 = 295.75$

$\lambda^{\wedge} * w^{\wedge} = \mathbf{2.278}$

$L^{\wedge} / (\lambda^{\wedge} * w^{\wedge}) = \mathbf{0.904}$

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Data Sampling in an M_{10} System

t start

t end

T

12:49:47

16:26:10

03:36:23

12983 seconds

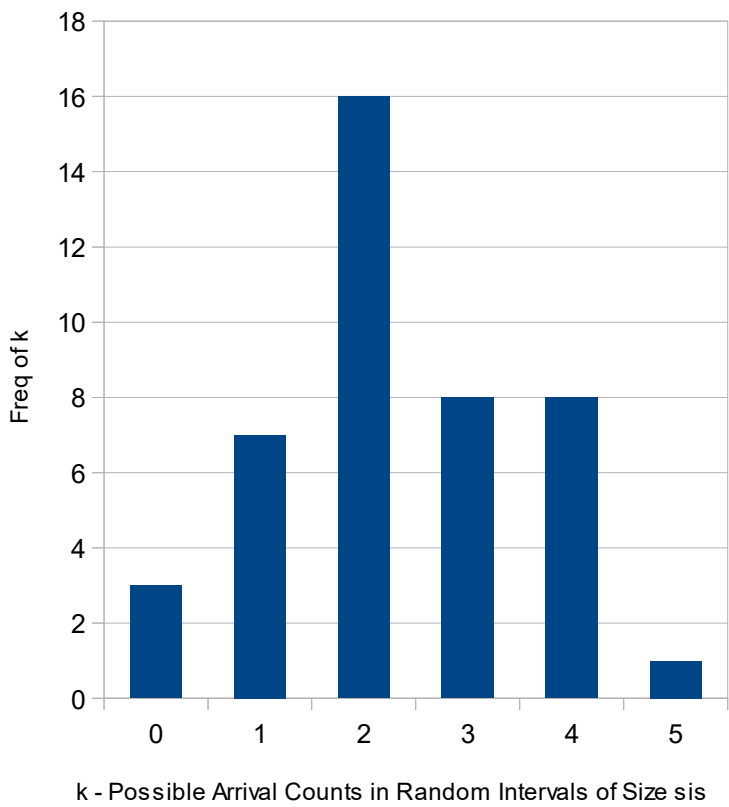
Cj#	Arrival Time	L	Start Service Time	Finish Service Time	Service Duration	Residence Duration
1	12:49:47	0	12:49:47	12:51:53	00:02:06	00:02:06
2	12:50:01	1	12:50:36	12:54:48	00:04:12	00:04:47
3	13:00:52	0	13:00:52	13:02:59	00:02:07	00:02:07
4	13:02:55	1	13:02:55	13:05:00	00:02:05	00:02:05
5	13:03:01	1	13:04:05	13:06:27	00:02:22	00:03:26
6	13:05:25	1	13:05:25	13:07:48	00:02:23	00:02:23
7	13:06:58	1	13:06:58	13:10:02	00:03:04	00:03:04
8	13:07:40	2	13:08:12	13:12:02	00:03:50	00:04:22
9	13:08:24	2	13:09:58	13:12:27	00:02:29	00:04:03
10	13:09:49	3	13:10:57	13:13:21	00:02:24	00:03:32
11	13:11:07	3	13:11:54	13:15:25	00:03:31	00:04:18
12	13:12:37	2	13:12:54	13:16:31	00:03:37	00:03:54
13	13:14:54	2	13:14:54	13:17:40	00:02:46	00:02:46
14	13:17:28	1	13:17:28	13:19:48	00:02:20	00:02:20
15	13:18:02	1	13:18:32	13:22:55	00:04:23	00:04:53
16	13:18:48	2	13:21:44	13:27:10	00:05:26	00:08:22
17	13:19:19	3	13:23:29	13:28:09	00:04:40	00:08:50
18	13:22:23	3	13:24:42	13:29:07	00:04:25	00:06:44
19	13:24:34	3	13:26:09	13:30:12	00:04:03	00:05:38
20	13:26:48	4	13:26:59	13:31:00	00:04:01	00:04:12
21	13:27:43	4	13:28:51	13:33:46	00:04:55	00:06:03
22	13:33:02	1	13:33:02	13:36:55	00:03:53	00:03:53
23	13:33:56	1	13:34:39	13:40:41	00:06:02	00:06:45
24	13:34:36	2	13:36:20	13:42:29	00:06:09	00:07:53
25	13:36:30	3	13:39:16	13:43:51	00:04:35	00:07:21
26	13:37:37	3	13:40:53	13:44:47	00:03:54	00:07:10
27	13:38:45	4	13:41:35	13:45:37	00:04:02	00:06:52
28	13:39:21	5	13:42:33	13:46:31	00:03:58	00:07:10
29	13:41:09	5	13:44:07	13:49:03	00:04:56	00:07:54
30	13:42:33	5	13:45:07	13:50:02	00:04:55	00:07:29
31	13:44:45	5	13:45:46	13:51:52	00:06:06	00:07:07
32	13:47:20	3	13:47:20	13:52:49	00:05:29	00:05:29
33	13:48:12	4	13:48:53	13:53:15	00:04:22	00:05:03
34	13:48:55	5	13:49:26	13:55:27	00:06:01	00:06:32
35	13:54:00	1	13:54:00	13:56:21	00:02:21	00:02:21
36	13:55:46	1	13:55:46	13:58:35	00:02:49	00:02:49
37	13:57:00	1	13:57:00	13:59:26	00:02:26	00:02:26
38	13:58:08	2	13:58:08	14:00:43	00:02:35	00:02:35
39	13:58:53	2	13:59:03	14:00:58	00:01:55	00:02:05
40	13:59:13	3	13:59:49	14:03:20	00:03:31	00:04:07
41	14:02:17	1	14:02:17	14:05:29	00:03:12	00:03:12
42	14:03:08	2	14:04:11	14:07:56	00:03:45	00:04:48
43	14:05:46	1	14:06:04	14:09:40	00:03:36	00:03:54
44	14:11:01	0	14:11:01	14:12:30	00:01:29	00:01:29
45	14:13:07	0	14:13:07	14:15:30	00:02:23	00:02:23
46	14:15:13	1	14:15:13	14:17:02	00:01:49	00:01:49

47	14:16:54	1	14:16:54	14:20:12	00:03:18	00:03:18
48	14:18:04	1	14:18:47	14:21:50	00:03:03	00:03:46
49	14:18:43	2	14:21:10	14:23:57	00:02:47	00:05:14
50	14:20:45	2	14:22:14	14:25:15	00:03:01	00:04:30
51	14:20:51	3	14:23:34	14:27:59	00:04:25	00:07:08
52	14:22:45	3	14:24:53	14:28:21	00:03:28	00:05:36
53	14:23:30	4	14:25:50	14:30:37	00:04:47	00:07:07
54	14:24:31	5	14:28:20	14:40:00	00:11:40	00:15:29
55	14:25:34	4	14:32:41	14:40:54	00:08:13	00:15:20
56	14:28:20	4	14:33:22	14:41:35	00:08:13	00:13:15
57	14:32:35	3	14:38:18	14:42:23	00:04:05	00:09:48
58	14:40:42	3	14:40:42	14:44:48	00:04:06	00:04:06
59	14:41:03	3	14:42:29	14:46:08	00:03:39	00:05:05
60	14:48:06	0	14:48:06	14:51:16	00:03:10	00:03:10
61	14:53:48	0	14:53:48	14:56:08	00:02:20	00:02:20
62	14:53:56	1	14:55:01	14:58:10	00:03:09	00:04:14
63	14:57:23	1	14:57:23	15:00:48	00:03:25	00:03:25
64	14:58:29	1	14:58:56	15:01:48	00:02:52	00:03:19
65	15:02:31	0	15:02:31	15:06:58	00:04:27	00:04:27
66	15:03:37	1	15:04:36	15:08:34	00:03:58	00:04:57
67	15:04:51	2	15:06:21	15:10:08	00:03:47	00:05:17
68	15:09:39	1	15:09:39	15:13:12	00:03:33	00:03:33
69	15:12:58	1	15:12:58	15:18:33	00:05:35	00:05:35
70	15:14:15	1	15:14:34	15:19:12	00:04:38	00:04:57
71	15:15:38	2	15:15:50	15:21:22	00:05:32	00:05:44
72	15:16:25	3	15:18:08	15:22:45	00:04:37	00:06:20
73	15:18:08	4	15:19:05	15:23:54	00:04:49	00:05:46
74	15:18:52	4	15:19:36	15:25:27	00:05:51	00:06:35
75	15:20:58	4	15:20:58	15:26:02	00:05:04	00:05:04
76	15:23:59	2	15:23:59	15:28:38	00:04:39	00:04:39
77	15:24:12	3	15:25:01	15:30:12	00:05:11	00:06:00
78	15:27:01	2	15:27:01	15:31:00	00:03:59	00:03:59
79	15:29:10	2	15:29:10	15:32:11	00:03:01	00:03:01
80	15:31:44	1	15:31:44	15:38:26	00:06:42	00:06:42
81	15:36:03	1	15:36:03	15:39:41	00:03:38	00:03:38
82	15:38:59	1	15:38:59	15:42:20	00:03:21	00:03:21
83	15:42:07	1	15:42:07	15:45:44	00:03:37	00:03:37
84	15:43:17	1	15:44:01	15:48:48	00:04:47	00:05:31
85	15:48:58	0	15:48:58	15:51:21	00:02:23	00:02:23
86	15:56:07	0	15:56:07	15:58:04	00:01:57	00:01:57
87	15:58:31	0	15:58:31	16:02:35	00:04:04	00:04:04
88	16:01:28	1	16:01:28	16:05:11	00:03:43	00:03:43
89	16:03:43	1	16:03:43	16:09:03	00:05:20	00:05:20
90	16:04:14	2	16:07:19	16:10:01	00:02:42	00:05:47
91	16:04:29	3	16:08:14	16:10:43	00:02:29	00:06:14
92	16:07:02	3	16:09:03	16:12:16	00:03:13	00:05:14
93	16:08:26	4	16:10:01	16:13:05	00:03:04	00:04:39
94	16:09:03	4	16:10:45	16:14:27	00:03:42	00:05:24
95	16:11:22	3	16:11:34	16:15:48	00:04:14	00:04:26
96	16:12:51	3	16:12:51	16:16:31	00:03:40	00:03:40
97	16:17:18	0	16:17:18	16:18:56	00:01:38	00:01:38
98	16:20:09	0	16:20:09	16:24:39	00:04:30	00:04:30

99	16:20:54	1	16:21:23	16:25:17	00:03:54	00:04:23
100	16:22:01	2	16:22:01	16:26:10	00:04:09	00:04:09
		Sum			max	avg W
		206			00:11:40	04:55.75
		avg(L)				
		2.06				

sis			
5			
arrival time buckets	f	frequency buckets	f
12:49:00	0	0	3
12:54:00	2	1	7
12:59:00	0	2	16
13:04:00	3	3	8
13:09:00	4	4	8
13:14:00	3	5	1
13:19:00	4		
13:24:00	2		
13:29:00	3		
13:34:00	2		
13:39:00	4		
13:44:00	3		
13:49:00	4		
13:54:00	1		
13:59:00	4		
14:04:00	3		
14:09:00	1		
14:14:00	2		
14:19:00	4		
14:24:00	4		
14:29:00	3		
14:34:00	1		
14:39:00	0		
14:44:00	2		
14:49:00	1		
14:54:00	2		
14:59:00	2		
15:04:00	2		
15:09:00	1		
15:14:00	2		
15:19:00	5		
15:24:00	2		
15:29:00	2		
15:34:00	2		
15:39:00	2		
15:44:00	2		
15:49:00	1		
15:54:00	0		
15:59:00	2		
16:04:00	2		
16:09:00	4		
16:14:00	3		
16:19:00	1		
16:24:00	3		
max	5	min	0

Histogram of Frequency Distribution of Cj Arrivals



residence duration buckets	f
00:00	0
00:01	0
00:02	5
00:03	20
00:04	33
00:05	26
00:06	8
00:07	5
00:08	0
00:09	2
00:10	0
00:11	0
00:12	1

Histogram of Service Durations

