

IE 306 Assignment 3 Report

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INPUT ANALYSIS:

We apply Kolmogorov-Smirnov test for exponential distribution to given interarrival times in excel. For detail information you can check the excel file that we provided.

Column1	
Mean	1,744705644
Standard Error	0,154936545
Median	1,268829111
Mode	#N/A
Standard Deviation	1,549365451
Sample Variance	2,400533301
Kurtosis	3,190893763
Skewness	1,543558944
Range	8,10584022
Minimum	0,008737937
Maximum	8,114578156
Sum	174,4705644
Count	100

	D1=	0,058238	
	D(0.05,100)=	0,13403	
	failed to reject.		

ASSUMPTIONS:

For 3 counter case, if not enough tickets are left for the choosen movie, we assumed that they enter the queue for another movie.

SIMULATION LOGIC:

- 1- Create moviegoer
 - 2- Assign number of tickets to the moviegoer
 - 3- Check if not all the movies are sold out
 - 4- Pick a movie that is not sold out
 - 5- Join the counter queue
 - 6- Check if there are enough tickets for chosen movie
- If not
- a. Picking another movie takes 1 minute
 - b. Try to choose another movie and notes they cannot choose the current movie
 - c. If there are not enough tickets for any movies, they leave

- 7- If they manage to choose a movie, they buy the tickets and it takes 1 minute
- 8- Update tickets left for the current movie
- 9- Check if the current movie is sold out
- 10- If it is sold out, search the counter queue and remove all moviegoers that picked current movie
- 11- Current moviegoer leaves the counter

OUTPUT ANALYSIS:

Confidence Interval = CI

1 Counter Case:

Movie1:

Average time before the movie is sold out

CI: (50.9307 – 56.2907)

Average number of people reneged when movie is sold out

CI: (1.99 – 3.41)

Movie2:

Average time before the movie is sold out:

CI: (51.1742 – 56.5342)

Average number of people reneged when movie is sold out

CI: (2.0667 – 3.8667)

Movie3:

Average time before the movie is sold out:

CI: (49.8471 – 56.0071)

Average number of people reneged when movie is sold out

CI: (1.8067 – 3.3267)

Utilization of the personnel who is selling the tickets:

CI: (0.4217 – 0.4617)

Replications: 30 Time Units: Minutes

Key Performance Indicators

System

Number Out

Average

120

User Specified

Tally

Expression	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
time movie 1 sold out	53.6107	2,68	41.4329	68.8343	41.4329	68.8343
time movie 2 sold out	53.8542	2,68	35.4519	65.9646	35.4519	65.9646
time movie 3 sold out	52.9271	3,08	36.0000	67.0000	36.0000	67.0000

Counter

Count	Average	Half Width	Minimum Average	Maximum Average
Record Reneging Movie1 Customers	2.7000	0,71	0.00	6.0000
Record Reneging Movie2 Customers	2.9667	0,90	0.00	10.0000
Record Reneging Movie3 Customers	2.5667	0,76	0.00	7.0000

Queue

Time

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Join Counter Queue.Queue	2.9353	0,59	0.9069	8.4353	0.00	16.5794

Other

Number Waiting	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Join Counter Queue.Queue	1.5094	0,35	0.4005	5.1315	0.00	20.0000
Seize Counter for Movie Cust.Queue	0.00	0,00	0.00	0.00	0.00	0.00

Resource

Usage

Instantaneous Utilization	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
counter	0.4417	0,02	0.3917	0.5583	0.00	1.0000
Number Busy	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
counter	0.4417	0,02	0.3917	0.5583	0.00	1.0000
Number Scheduled	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
counter	1.0000	0,00	1.0000	1.0000	1.0000	1.0000
Scheduled Utilization	Average	Half Width	Minimum Average	Maximum Average		
counter	0.4417	0,02	0.3917	0.5583		
Total Number Seized	Average	Half Width	Minimum Average	Maximum Average		
counter	51.8333	1,70	45.0000	65.0000		

3 Counter Case:

Movie1:

Average time before the movie is sold out

CI: (45.0525 – 51.1525)

Average number of people reneged when movie is sold out

CI: (0.73 – 1.47)

Utilization of the personnel who is selling the tickets:

CI: (0.1336– 0.1536)

Movie2:

Average time before the movie is sold out:

CI: (46.932 – 53.292)

Average number of people reneged when movie is sold out

CI: (0.4133 – 1.0533)

Utilization of the personnel who is selling the tickets:

CI: (0.1347 – 0.1547)

Movie3:

Average time before the movie is sold out:

CI: (44.7353 – 51.2753)

Average number of people reneged when movie is sold out

CI: (0.3467 – 0.9867)

Utilization of the personnel who is selling the tickets:

CI: (0.1461 – 0.1461)

Replications: 30

Time Units: Minutes

Key Performance Indicators

System

Number Out

Average

120

User Specified

Tally

Expression	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
soldoutTime1	48.1025	3,05	35.0348	65.3263	35.0348	65.3263
soldoutTime2	50.1120	3,18	26.9340	63.4805	26.9340	63.4805
soldoutTime3	48.0053	3,27	33.1489	69.3413	33.1489	69.3413

Counter

Count	Average	Half Width	Minimum Average	Maximum Average
Record Reneging Movie1 Customers	1.1000	0,37	0.00	3.0000
Record Reneging Movie2 Customers	0.7333	0,32	0.00	3.0000
Record Reneging Movie3 Customers	0.6667	0,32	0.00	3.0000

Queue

Time

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Join Counter1 Queue.Queue	0.2972	0,07	0.0961	1.0590	0.00	3.0186
Join Counter2 Queue.Queue	0.3151	0,12	0.06022532	1.4347	0.00	4.6526
Join Counter3 Queue.Queue	0.2677	0,05	0.03046176	0.5652	0.00	2.3008

Other

Number Waiting	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Join Counter1 Queue.Queue	0.04691309	0,01	0.01280728	0.1500	0.00	4.0000
Join Counter2 Queue.Queue	0.05019388	0,02	0.00853192	0.2391	0.00	5.0000
Join Counter3 Queue.Queue	0.04167815	0,01	0.00431542	0.08477824	0.00	3.0000
Seize Counter for Movie Cust.Queue	0.00	0,00	0.00	0.00	0.00	0.00

Resource

Usage

Instantaneous Utilization	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
counter1	0.1436	0,01	0.1250	0.1917	0.00	1.0000
counter2	0.1447	0,01	0.1167	0.2333	0.00	1.0000
counter3	0.1461	0,00	0.1250	0.1833	0.00	1.0000

Number Busy	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
counter1	0.1436	0,01	0.1250	0.1917	0.00	1.0000
counter2	0.1447	0,01	0.1167	0.2333	0.00	1.0000
counter3	0.1461	0,00	0.1250	0.1833	0.00	1.0000

Number Scheduled	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
counter1	1.0000	0,00	1.0000	1.0000	1.0000	1.0000
counter2	1.0000	0,00	1.0000	1.0000	1.0000	1.0000
counter3	1.0000	0,00	1.0000	1.0000	1.0000	1.0000

Scheduled Utilization	Average	Half Width	Minimum Average	Maximum Average
counter1	0.1436	0,01	0.1250	0.1917
counter2	0.1447	0,01	0.1167	0.2333
counter3	0.1461	0,00	0.1250	0.1833

1 Counter Case With Increased Interarrival rate by %50 :

Movie1:

Average time before the movie is sold out

CI: (62.7714– 87.7914)

Average number of people reneged when movie is sold out

CI: (0.18 – 0.82)

Movie2:

Average time before the movie is sold out:

CI: (76.1722 - 95.8922)

Average number of people reneged when movie is sold out

CI: (0.31 – 0.89)

Movie3:

Average time before the movie is sold out:

CI: (78.4267 – 95.7867)

Average number of people reneged when movie is sold out

CI: (0.1 – 0.5)

Utilization of the personnel who is selling the tickets:

CI: (0.4193 – 0.4393)

Replications: 30

Time Units: Minutes

Key Performance Indicators

System

Number Out

Average

63

Tally

Expression	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
time movie 1 sold out	75.2814	12,51	0.00	115.92	0.00	115.92
time movie 2 sold out	86.0322	9,86	0.00	112.71	0.00	112.71
time movie 3 sold out	87.1067	8,68	0.00	119.55	0.00	119.55

Counter

Count	Average	Half Width	Minimum Average	Maximum Average
Record Reneging Movie1 Customers	0.5000	0,32	0.00	3.0000
Record Reneging Movie2 Customers	0.6000	0,29	0.00	3.0000
Record Reneging Movie3 Customers	0.3000	0,20	0.00	2.0000

Queue

Time

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Join Counter Queue.Queue	0.5108	0,07	0.2018	0.9181	0.00	4.5483

Other

Number Waiting	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Join Counter Queue.Queue	0.2218	0,03	0.0925	0.3749	0.00	5.0000
Seize Counter for Movie Cust.Queue	0.00	0,00	0.00	0.00	0.00	0.00

Resource

Usage

Instantaneous Utilization	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
counter	0.4293	0,01	0.3833	0.4917	0.00	1.0000
Number Busy	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
counter	0.4293	0,01	0.3833	0.4917	0.00	1.0000
Number Scheduled	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
counter	1.0000	0,00	1.0000	1.0000	1.0000	1.0000
Scheduled Utilization	Average	Half Width	Minimum Average	Maximum Average		
counter	0.4293	0,01	0.3833	0.4917		
Total Number Seized	Average	Half Width	Minimum Average	Maximum Average		
counter	50.3667	0.99	46.0000	55.0000		

3 Counter Case With Increased Interarrival rate by %50 :

Movie1:

Average time before the movie is sold out

CI: (62.1137 – 87.0337)

Average number of people reneged when movie is sold out

CI: (0.1367 – 0.5967)

Utilization of the personnel who is selling the tickets:

CI: (0.1323 – 0.1523)

Movie2:

Average time before the movie is sold out:

CI: (81.9408 – 97.8208)

Average number of people reneged when movie is sold out

CI: (0.2767 – 0.8567)

Utilization of the personnel who is selling the tickets:

CI: (0.1406 – 0.1406)

Movie3:

Average time before the movie is sold out:

CI: (77.1547 – 94.6947)

Average number of people reneged when movie is sold out

CI: (0.0433 – 0.4233)

Utilization of the personnel who is selling the tickets:

CI: (0.1423 – 0.1423)

Replications: 30 Time Units: Minutes

Key Performance Indicators

System

Number Out

Average

63

User Specified

Tally

Expression	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
soldoutTime1	74.5737	12,46	0.00	115.90	0.00	115.90
soldoutTime2	89.8808	7,94	0.00	117.93	0.00	117.93
soldoutTime3	85.9247	8,77	0.00	117.55	0.00	117.55

Counter

Count	Average	Half Width	Minimum Average	Maximum Average
Record Reneging Movie1 Customers	0.3667	0,23	0.00	2.0000
Record Reneging Movie2 Customers	0.5667	0,29	0.00	2.0000
Record Reneging Movie3 Customers	0.2333	0,19	0.00	2.0000

Queue

Time

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Join Counter1 Queue.Queue	0.1165	0,03	0.01240028	0.3362	0.00	1.8703
Join Counter2 Queue.Queue	0.1153	0,03	0.00103843	0.2904	0.00	1.6308
Join Counter3 Queue.Queue	0.0959	0,02	0.00	0.2259	0.00	1.2757

Other

Number Waiting	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Join Counter1 Queue.Queue	0.01756309	0,00	0.00174028	0.05602784	0.00	2.0000
Join Counter2 Queue.Queue	0.01713303	0,00	0.00014711	0.03979119	0.00	2.0000
Join Counter3 Queue.Queue	0.01470132	0,00	0.00	0.03817024	0.00	4.0000
Seize Counter for Movie Cust.Queue	0.00	0,00	0.00	0.00	0.00	0.00

Resource

Usage

Instantaneous Utilization	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
counter1	0.1423	0,01	0.1250	0.1833	0.00	1.0000
counter2	0.1406	0,00	0.1167	0.1667	0.00	1.0000
counter3	0.1423	0,00	0.1250	0.1667	0.00	1.0000
Number Busy	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
counter1	0.1423	0,01	0.1250	0.1833	0.00	1.0000
counter2	0.1406	0,00	0.1167	0.1667	0.00	1.0000
counter3	0.1423	0,00	0.1250	0.1667	0.00	1.0000
Number Scheduled	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
counter1	1.0000	0,00	1.0000	1.0000	1.0000	1.0000
counter2	1.0000	0,00	1.0000	1.0000	1.0000	1.0000
counter3	1.0000	0,00	1.0000	1.0000	1.0000	1.0000
Scheduled Utilization	Average	Half Width	Minimum Average	Maximum Average		
counter1	0.1423	0,01	0.1250	0.1833		
counter2	0.1406	0,00	0.1167	0.1667		
counter3	0.1423	0,00	0.1250	0.1667		

Can you have the counters open for only 60 minutes instead of 120 minutes?

When we check the outputs especially CI for average time before the movies are sold out, we can see that these CIs are strictly above 60 minutes so some people who normally would be able to buy tickets can not. We wouldn't want to deprive people the satisfaction of watching Star Wars. Thus we can't have counters open for only 60 minutes.