IE306 Assignment 3

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Muhsin Etki - 2015400093

Mehmet Berk Kemaloğlu - 2015400081

Ali Batır – 2015400261

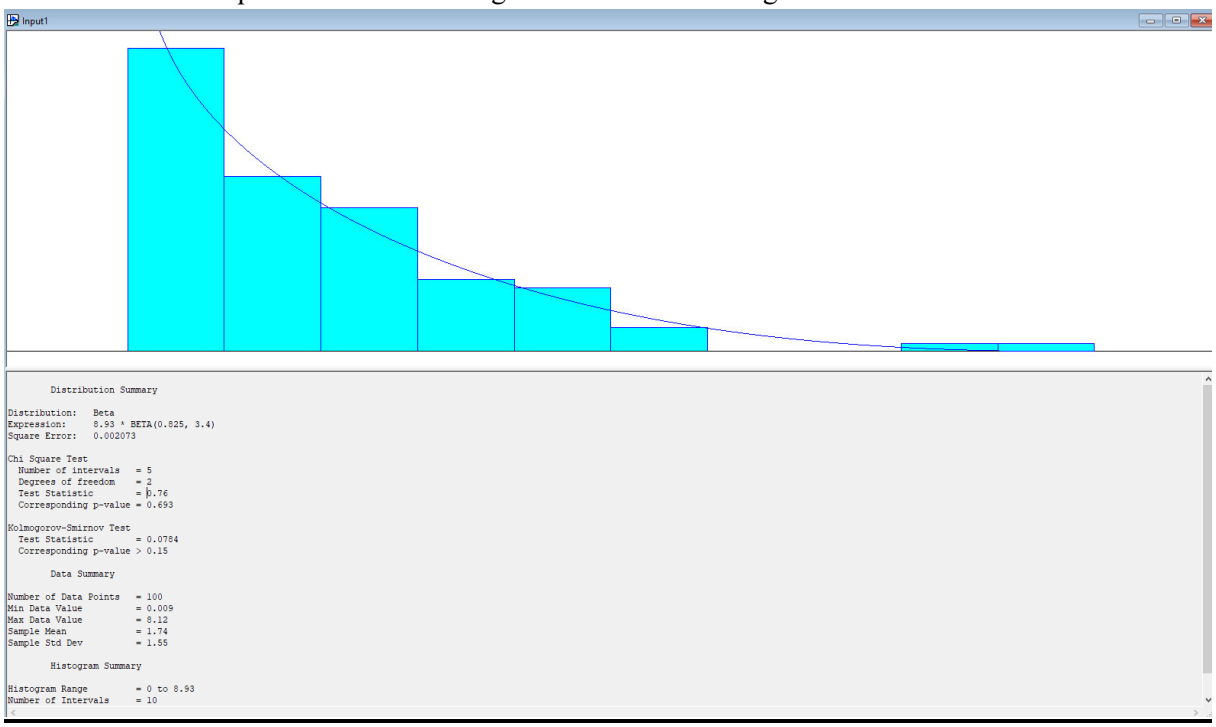
Description

We simulated moviegoers in a local cinema. The cinema has three theaters once a day. Each theater can hold 50 people. People arrive at the cinema at random times. The interarrival times (in minutes) are recorded in the past and we used this data to fit a distribution to the common arrival process. There is a single counter that sells tickets for all three films. People line up in a single queue in front of the counter. If they arrive at the counter they try to buy a random number of tickets distributed as uniform integer between [2–4] for a randomly chosen movie with equal probability. If not enough tickets are left, they try the remaining movies with equal probability, Their decision takes a fixed amount of time of 1 minute. If at most one ticket is left after the moviegoer bought her tickets, the “sold out” event for this movie is triggered. When a movie is sold out, all people waiting to buy a ticket for that movie renege (leave the queue). The counter stays open for 120 minutes before the films start showing and it is observed that the counter service time of printing tickets and receiving the payment shows no variability and can be taken to be a constant of one minute per customer one the customer finds tickets to buy. The statistics to collect are: for each movie, average time before the movie is sold out, average number of people reneged when the movie is sold out, and utilization of the personnel who is selling the tickets.

Question 1 :

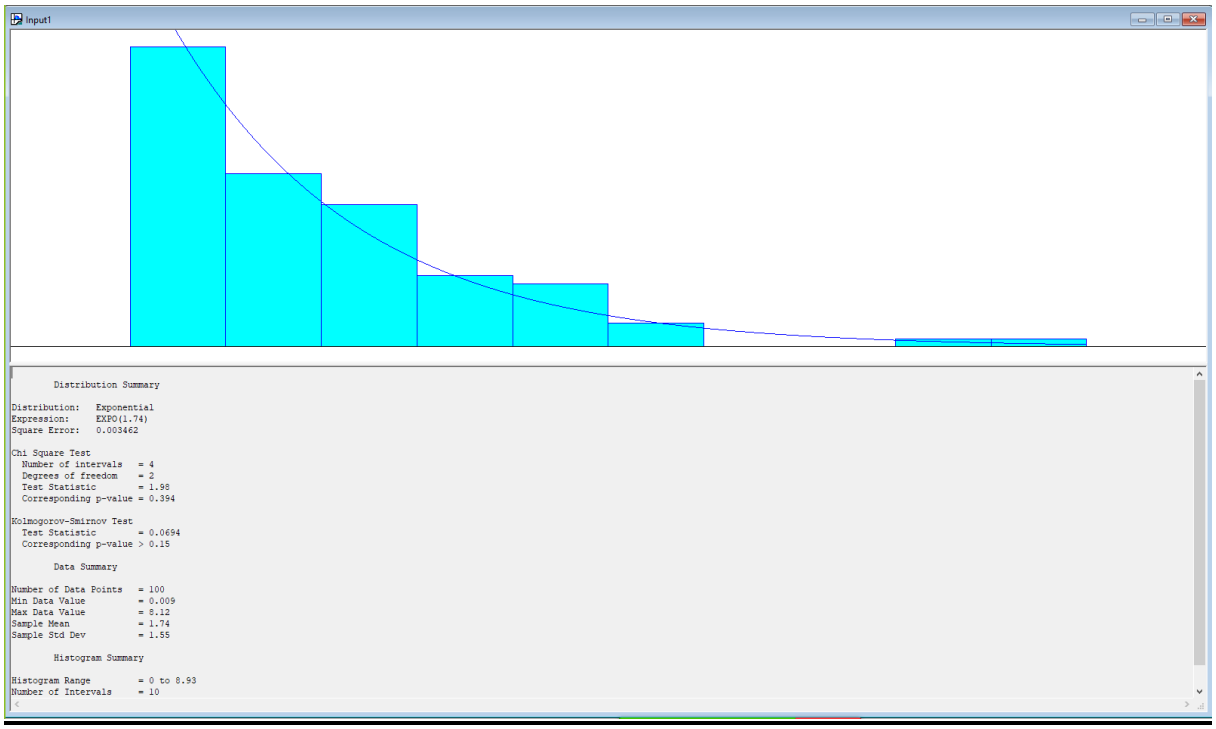
We used input analyzer to fit input arrival times to a distribution. After we use fit all, the interarrival times fit to the BETA distribution as the following figure.

The result of Chi-Square Test and Kolmogorov-Smirnov Test is given below:



However, the result show that EXPONENTIAL distribution is also fit and changing rate for Q5 is easier. Therefore we use EXPO(1.74) and EXPO(1.16) for the questions.

The result of Chi-Square Test and Kolmogorov-Smirnov Test is given below:



Question 2 :

Let's describe our simulation model. First we create moviegoer with expo(1.74) for interarrival times. Then we assign one of the three movies and number of tickets between [2-4] with equal probability. Then they enter one queue. Every customer leaves the queue one by one. Then the customer enters to his/her own movie branch. If there are enough tickets for the customer, he/she buys the ticket in the next steps. Else he/she decides to another movie and goes to that movie's branch. After one customer buys tickets from a movie and that movie becomes sold out, our model search customer who still stays on the queue for that movie. Then the model renege this customers.

Question 3 :

We run the model with 30 replications and we collected base case statistics at a confidence level of 95%.

Results;

Average time before the movie 1 is sold out: 54.4021 ± 17.69 minutes

Average time before the movie 2 is sold out: 49.1914 ± 19.36 minutes

Average time before the movie 3 is sold out: 47.8339 ± 17.65 minutes

Average number of people reneged when the movie 1 is sold out: 0.2667 ± 0.22

Average number of people reneged when the movie 2 is sold out: 0.1000 ± 0.11

Average number of people reneged when the movie 3 is sold out: 0.1000 ± 0.11

Utilization of the personnel who is selling the tickets: 56.43% ± 2%

Replications: 30 Time Units: Minutes

Queue

Time

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Join Counter Queue.Queue	0.5571	0,05	0.3102	0.8430	0.00	5.6227

Other

Number Waiting	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Join Counter Queue.Queue	0.3226	0,04	0.1577	0.5105	0.00	6.0000
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	0.5643	0,02	0.4777	0.6359	0.00	1.0000

Number Busy	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
counter	0.5643	0,02	0.4777	0.6359	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	0.5643	0,02	0.4777	0.6359

Total Number Seized	Average	Half Width	Minimum Average	Maximum Average
counter	67.9333	2,04	58.0000	77.0000

Values Across All Replications

Unnamed Project

Replications: 30 Time Units: Minutes

User Specified

Tally

Expression	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
soldoutTimeM1	54.4021	17,69	0.00	111.70	0.00	111.70
soldoutTimeM2	49.1914	19,36	0.00	119.59	0.00	119.59
soldoutTimeM3	47.8339	17,65	0.00	118.35	0.00	118.35

Counter

Count	Average	Half Width	Minimum Average	Maximum Average
Record Reneging Movie1 Customers	0.2667	0,22	0.00	2.0000
Record Reneging Movie2 Customers	0.1000	0,11	0.00	1.0000
Record Reneging Movie3 Customers	0.1000	0,11	0.00	1.0000

Question 4 :

We run the model with 30 replications and we collected base case statistics at a confidence level of 95%. We increased the counter capacity to three.

Results;

Average time before the movie 1 is sold out: 42.3990 ± 17.09 minutes

Average time before the movie 2 is sold out: 47.3729 ± 18.59 minutes

Average time before the movie 3 is sold out: 43.6891 ± 15.95 minutes

Average number of people reneged when the movie 1 is sold out: 0.1333 ± 0.19

Average number of people reneged when the movie 2 is sold out: 0.1333 ± 0.16

Average number of people reneged when the movie 3 is sold out: 0.1667 ± 0.17

Utilization of the personnel who is selling the movie1 tickets: 13.39% ± 2%

Utilization of the personnel who is selling the movie2 tickets: 13.61% ± 2%

Utilization of the personnel who is selling the movie3 tickets: 13.49% ± 2%

The result shows that after we change to three queues, “the average time before a movie is sold out” and “utilization of the personnel who is selling the movie tickets” decreased. Three queue accelerated the system because average waiting time of customers is decreased.

Replications: 30 Time Units: Minutes

Resource

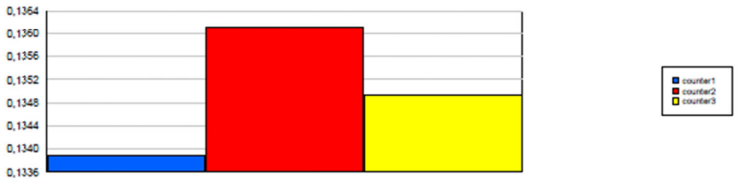
Usage

Instantaneous Utilization	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
counter1	0.1339	0,00	0.1000	0.1500	0.00	1.0000
counter2	0.1361	0,00	0.1167	0.1583	0.00	1.0000
counter3	0.1349	0,00	0.1167	0.1583	0.00	1.0000

Number Busy	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
counter1	0.1339	0,00	0.1000	0.1500	0.00	1.0000
counter2	0.1361	0,00	0.1167	0.1583	0.00	1.0000
counter3	0.1349	0,00	0.1167	0.1583	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	0.1339	0,00	0.1000	0.1500
counter2	0.1361	0,00	0.1167	0.1583
counter3	0.1349	0,00	0.1167	0.1583



Replications: 30 Time Units: Minutes

User Specified

Tally

Expression	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
soldoutTimeM1	42.3990	17,09	0.00	117.13	0.00	117.13
soldoutTimeM2	47.3729	18,59	0.00	117.01	0.00	117.01
soldoutTimeM3	43.6891	15,95	0.00	104.30	0.00	104.30

Counter

Count	Average	Half Width	Minimum Average	Maximum Average
Record Reneging Movie1 Customers	0.1333	0,19	0.00	2.0000
Record Reneging Movie2 Customers	0.1333	0,16	0.00	2.0000
Record Reneging Movie3 Customers	0.1667	0,17	0.00	2.0000

Question 5.1 :

We run the model with 30 replications and we collected base case statistics at a confidence level of 95%. In order to increase interarrival rate by 50%, we changed distribution to EXPO(1.16)

Results;

Average time before the movie 1 is sold out: 43.1965 ± 11.55 minutes

Average time before the movie 2 is sold out: 30.4015 ± 12.96 minutes

Average time before the movie 3 is sold out: 45.7641 ± 12.11 minutes

Average number of people reneged when the movie 1 is sold out: 0.8000 ± 0.51

Average number of people reneged when the movie 2 is sold out: 0.2667 ± 0.19

Average number of people reneged when the movie 3 is sold out: 0.4333 ± 0.27

Utilization of the personnel who is selling the tickets: 83.50% ± 2%

Replications: 30 Time Units: Minutes

Queue

Time

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Join Counter Queue.Queue	1.9654	0,31	0.7917	3.6848	0.00	11.1136

Other

Number Waiting	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Join Counter Queue.Queue	1.7630	0,31	0.6056	3.5045	0.00	12.0000
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	0.8350	0,02	0.7032	0.9560	0.00	1.0000

Number Busy	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
counter	0.8350	0,02	0.7032	0.9560	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	0.8350	0,02	0.7032	0.9560

Total Number Seized	Average	Half Width	Minimum Average	Maximum Average
counter	100.53	2,96	85.0000	115.00

Replications: 30 Time Units: Minutes

User Specified

Tally

Expression	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
soldoutTimeM1	43.1965	11,55	0.00	90.9271	0.00	90.9271
soldoutTimeM2	30.4015	12,96	0.00	95.8952	0.00	95.8952
soldoutTimeM3	45.7641	12,11	0.00	86.2984	0.00	86.2984

Counter

Count	Average	Half Width	Minimum Average	Maximum Average
Record Reneging Movie1 Customers	0.8000	0,51	0.00	6.0000
Record Reneging Movie2 Customers	0.2667	0,19	0.00	2.0000
Record Reneging Movie3 Customers	0.4333	0,27	0.00	2.0000

Question 5.2 :

We run the model with 30 replications and we collected base case statistics at a confidence level of 95%. We increased the counter capacity to three. In order to increase interarrival rate by 50%, we changed distribution to EXPO(1.16)

Results;

Average time before the movie 1 is sold out: 23.6789 ± 10.78 minutes

Average time before the movie 2 is sold out: 31.4562 ± 12.33 minutes

Average time before the movie 3 is sold out: 40.9840± 12.01 minutes

Average number of people reneged when the movie 1 is sold out: 0.1333 ± 0.16

Average number of people reneged when the movie 2 is sold out: 0.2333 ± 0.16

Average number of people reneged when the movie 3 is sold out: 0.1667 ± 0.17

Utilization of the personnel who is selling the movie1 tickets: 13.44% ± 2%

Utilization of the personnel who is selling the movie2 tickets: 13.56% ± 2%

Utilization of the personnel who is selling the movie3 tickets: 13.64% ± 2%

Replications: 30 Time Units: Minutes

Resource

Usage

Instantaneous Utilization	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
counter1	0.1344	0,00	0.1250	0.1500	0.00	1.0000
counter2	0.1356	0,00	0.1250	0.1583	0.00	1.0000
counter3	0.1364	0,00	0.1167	0.1583	0.00	1.0000

Number Busy	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
counter1	0.1344	0,00	0.1250	0.1500	0.00	1.0000
counter2	0.1356	0,00	0.1250	0.1583	0.00	1.0000
counter3	0.1364	0,00	0.1167	0.1583	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	0.1344	0,00	0.1250	0.1500
counter2	0.1356	0,00	0.1250	0.1583
counter3	0.1364	0,00	0.1167	0.1583

Replications: 30 Time Units: Minutes

User Specified

Tally

Expression	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
soldoutTimeM1	23.6789	10,78	0.00	77.5329	0.00	77.5329
soldoutTimeM2	31.4562	12,33	0.00	83.7070	0.00	83.7070
soldoutTimeM3	40.9840	12,01	0.00	93.6963	0.00	93.6963

Counter

Count	Average	Half Width	Minimum Average	Maximum Average
Record Reneging Movie1 Customers	0.1333	0,16	0.00	2.0000
Record Reneging Movie2 Customers	0.2333	0,16	0.00	1.0000
Record Reneging Movie3 Customers	0.1667	0,17	0.00	2.0000

Question 6 :

After we run the model in Q5 for only 60 minutes, we have seen that the movies didn't become 'Sold Out'. The interarrival rate is not sufficient for that. Therefore, we can't have the counters open for only 60 minutes instead of 120 minutes.