Group 14: Abdullah Furkan Ilisu - Giray Eryilmaz

1 – Fit the distribution:

We used input analyzer of ARENA and it gave as a Gamma distribution as a best fit. But we recalled you saying in the class something like “Arena just fits the graph, it does not concern about meaning of those numbers” , “If you don’t concern where those numbers come from, which kind of process generates it, ‘size öyle bir gol atar ki...’”. So regarding your warnings we user the second choice that arena suggested, the Exponential distribution. Exponential distribution makes sense because we are trying to simulate arrival times of customers which is more likely to be exponentially distributed rather than gamma distribution. Besides although Arena gives Gamma as a better fit to the unknown distribution based on error values, error value of exponential is just slightly higher than Gamma’s, also sampled standard deviation and mean of unknown distribution are almost the same which also points to exponential distribution. So based on all the above mentioned points and ease of use of Exponential distribution we picked Exponential distribution as the best fit.

```
================================================================
Fit All Summary
Data File: C:\Users\IEUser\Downloads\ie\interarrival_times.csv


Function       Sq Error
-----------------------
Gamma          0.000608
Exponential    0.000621
Erlang         0.000621
Weibull        0.000841
Beta           0.00124
Lognormal      0.0135
Normal         0.0755
Triangular     0.109
```

```
        Distribution Summary

Distribution:   Gamma
Expression:     GAMM(0.543, 0.938)
Square Error:   0.000608

Chi Square Test
  Number of intervals   = 4
  Degrees of freedom    = 1
  Test Statistic        = 0.195
  Corresponding p-value = 0.684

Kolmogorov-Smirnov Test
  Test Statistic        = 0.0395
  Corresponding p-value > 0.15

        Data Summary

Number of Data Points   = 100
Min Data Value          = 0.003
Max Data Value          = 2.93
Sample Mean             = 0.509
Sample Std Dev          = 0.51
```

```
        Distribution Summary

Distribution:   Exponential
Expression:     EXPO(0.509)
Square Error:   0.000621

Chi Square Test
  Number of intervals   = 4
  Degrees of freedom    = 2
  Test Statistic        = 0.238
  Corresponding p-value > 0.75

Kolmogorov-Smirnov Test
  Test Statistic        = 0.0533
  Corresponding p-value > 0.15

        Data Summary

Number of Data Points   = 100
Min Data Value          = 0.003
Max Data Value          = 2.93
Sample Mean             = 0.509
Sample Std Dev          = 0.51
```

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2 – We revised parameters as wanted. Set initial number of tickets to 50, set costumers to exponential distribution with mean 0.509 (calculated by arena), set the probabilities etc.

3 – Relevant statistics of 30 replications:

soldout1: 36.9679341627 - 39.1226658373
soldout2: 36.1369652309 - 38.8403014358
renege1: 15.0736426979 - 18.3263573021
renege2: 15.4014695362 - 20.3985304638
waitingTime: 5.48022119633 - 6.29071880367
utilization: 0.742861468093 - 0.764662531907

4 – Relevant statistics of 15 replications counter capacity is 2:

soldout1: 21.1529971854 - 25.3700694813
soldout2: 21.2440228394 - 25.6547771606
renege1: 0.224859808395 - 1.37514019161
renege2: 0.233296160203 - 1.5667038398
waitingTime: 0.104898152361 - 0.171200514305
utilization: 0.245645571077 - 0.25721309559

5 – Which configuration is the best ? :

Well, it depends on your point of view but if we consider the point of a greedy theater owner :

All the tickets get sold anyways so the income is fixed.

In second case (2 counters) utilization reduces and also owner will probably need to pay for a second counter officer

So although average waiting time and number of people wait in the queue but end up leaving without buying tickets reduces (which are good for customers) we will say that the first configuration (counter capacity = 1) is better for the owner (in the short run at least, if people gets bored of long lines thing may change).

6 -

3 – double rate, relevant statistics of 30 replications:

soldout1: 36.9343256464 - 39.0656743536
soldout2: 36.0855332068 - 38.8011334599
renege1: 54.3341726542 - 63.3658273458
renege2: 52.2812324565 - 61.0187675435
waitingTime: 8.7562057746 - 9.6234942254
utilization: 0.805867736605 - 0.822812263395

4 – double rate, relevant statistics of 15 replications counter capacity is 2:

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soldout1: 18.2995546246 - 20.5637787087
soldout2: 16.6581397055 - 19.4079936278
renege1: 12.5039989236 - 18.4960010764
renege2: 8.70969506303 - 16.690304937
waitingTime: 0.595743250345 - 0.804951416322
utilization: 0.332341881992 - 0.344031451341

5 – Which configuration is the best ?:

With the same reasons, again from the point of greedy owner first configuration is better in the short run. But notice that values of waiting times and people renege are more drastical this time so in the long run this actually may be a problem. (Also its a shame making so many people wait like that).

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

If we are mainly interested in selling all the tickets, yes we can because all the tickets are sold in the first hour, with 95% confidence we can safely say this.

8 – Statistics:

soldout1: 23.0035922162 - 26.3536744505
soldout2: 33.2001136946 - 36.0636196387
soldout3: 32.3190591104 - 35.4468742229
renege1: 14.4060210911 - 17.3939789089
renege2: 4.08198323833 - 5.91801676167
renege3: 3.87418913922 - 6.12581086078
average time lost arguing: 16.5580888931 - 17.4085777735
waitingTime: 1.8245361623 - 2.20864317103
utilization: 0.448161256707 - 0.45947940996

Output Analysis:

Comparing 1 counter to 2 counter capacity:

Clearly double capacity reduces waiting time averages and number of reneging people
On the other hand reduces utilization as expected. Also due to faster service soldout times are earlier when the capacity is doubled which is also expected.

Comparing normal to double rate arrivals:

Capacity 1:
Since the service is slow people were already lining-up, higher arrival rate only makes lines longer and increases people renege when sold-out. Also utilization slightly increases when rate increases since counter is less likely to be idle with frequently arriving customers.

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Capacity 2:
Result are similar to capacity=1 case one difference we can mention is that in capacity = 1 case since service already sluggish people were lining up anyways and increasing rates almost did not effect sold-out times, here we can see that movies sell out earlier when people come more frequently which shows us 2 counters are doing better at “keeping-up” to customers.

3 Movies Case:

Since people are found of movie1 it sells out earlier than the others and the other two sells out about the same time as expected. And with the same reason more people renege when movie1 sells out.

It is hard to compare results of this to other 2 movie cases since more than one parameter changes. We can not make healthy judgments

Note: We used some parameters as given and assumed argue time to be 0.1 minutes on average.
Note: we did not really need to use output analyzer but send a file to show you that we know that it exists and can be used.