IE 306 - Homework 3
Group 4

Gülsüm Tuba Çibuk - 2016400210
Onur Kılıçoğlu - 2015400012
Emre Girgin - 2016400099

➢ Input Analysis

We did input analysis using the input analysis module of Arena Simulation Program. The input analyzer takes a text file containing the interarrival times of the customers and finds out the distribution that fits the data the best with calculated parameters among 9 different distributions. In our case input analyzer suggested us to use **8.93*BETA(0.825, 3.4)** for the interarrival times.

➢ Assumptions

1. We assume that the entities that enter the system are considered as customers, not the ones going to watch the movie. In other words, we didn't count the number of tickets bought from the ticket office, we only counted the entities as customers.
2. If a movie is sold out, the newcomers for that movie are automatically disposed of without getting counted for reneging.

➢ Simulation Logic

1 Counter

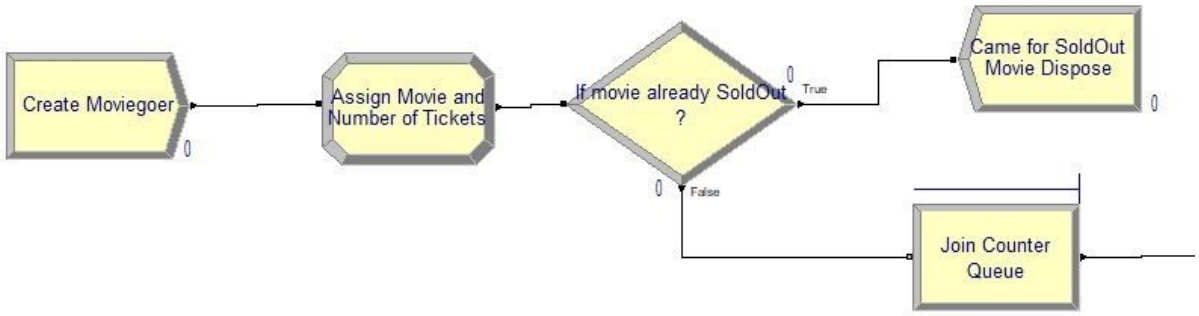

Figure 1

Firstly, we create moviegoers from the Beta distribution with an arrival rate of 8.93 * BETA(0.825, 3.4). Then moviegoers are assigned to a movie with a 50% chance and the number of tickets that moviegoers buy is determined by a 33.3% chance.

The simulation checks if the movie that moviegoer wants to watch is sold out. If it is already sold out when a moviegoer arrives then he balks, else he joins the counter queue.

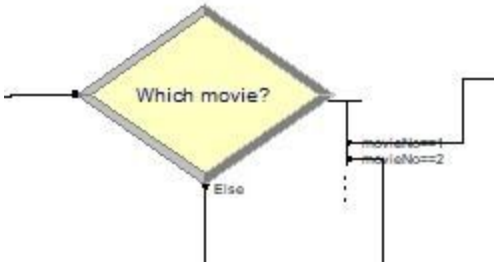

Figure 2

When a moviegoer gets the counter the simulation decides the path the moviegoer goes by the movie number he is assigned to.

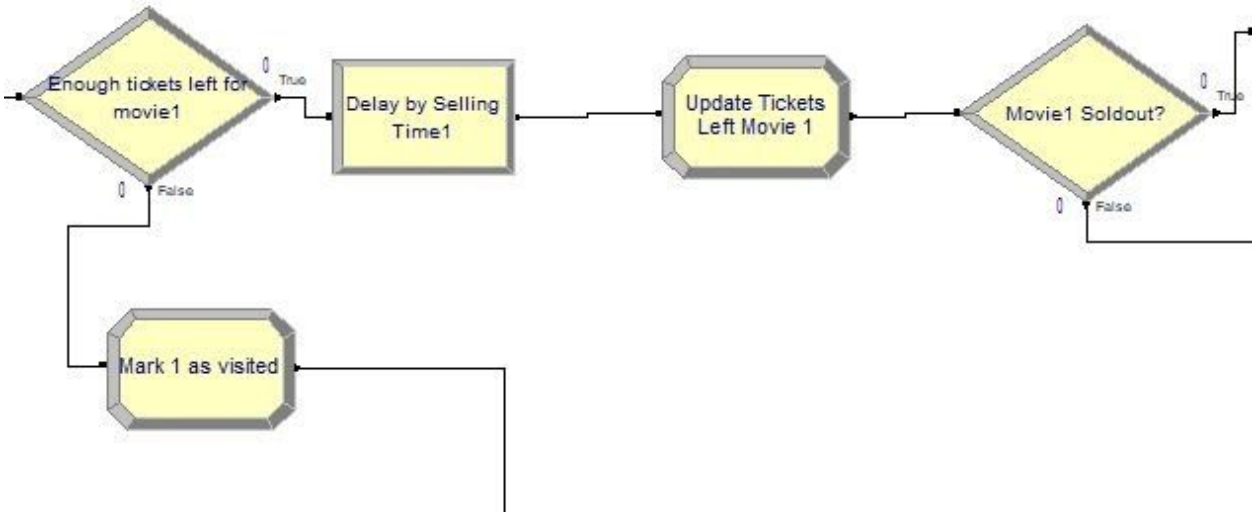

Figure 3

Then the simulation checks if there are enough tickets left as much as the moviegoer wants. If there are enough tickets, the moviegoer argues with the seller for a minute. Then the moviegoer buys the tickets and the number of tickets left is updated. After that, the simulation checks if the tickets of that movie are sold out. If there are not enough tickets, the moviegoer is redirected to another path.

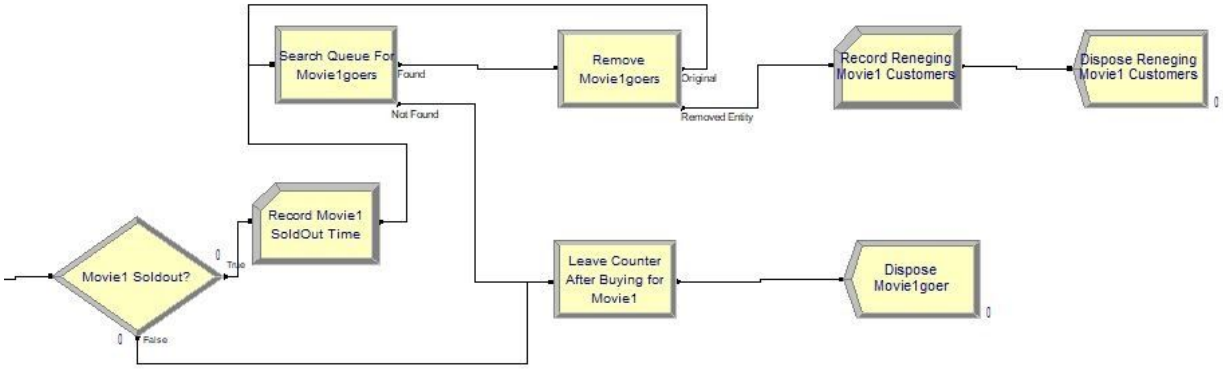

Figure 4

If the tickets of the movie are sold out after the moviegoer buys tickets, the simulation records the time of sold out and other moviegoers waiting for that

movie renege. They are recorded as reneged customers. Then the last moviegoer who bought the last tickets leaves the counter with his/her tickets.

If there are enough tickets for other moviegoers after the moviegoer buys tickets then nobody reneges and the moviegoer leaves the counter.

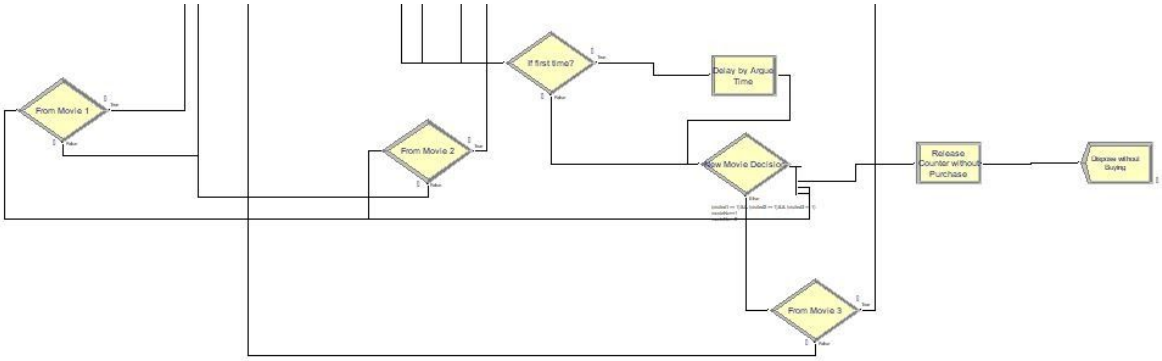

Figure 5

If there are not enough tickets left for the moviegoer then the simulation redirects the moviegoer to this part. In this part, if it is the first time of deciding for another movie then the moviegoer thinks which movie to go for a minute. Then the simulation separates the paths according to the first movie that the moviegoer wanted to go. So that the moviegoer is not redirected to that movie again. Then the moviegoer chooses a new movie to watch with a 50% chance. Then the moviegoer returns to the part in Figure 3. If it is not the first time of deciding another movie then the moviegoer chooses a new movie with a 50% chance with no delay. If the moviegoer can not find any ticket for any movie then the moviegoer leaves the counter without buying tickets.

3 Counter

In this part, the differences from 1 Counter System is mentioned.

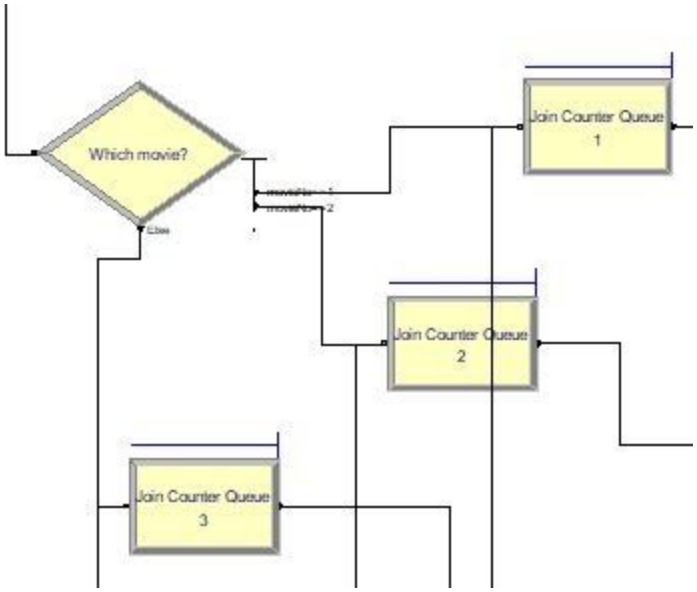

Figure 6

The difference from the 1 Counter System is that there are 3 queues for 3 counters. The simulation divides the moviegoers to different queues according to their movie numbers.

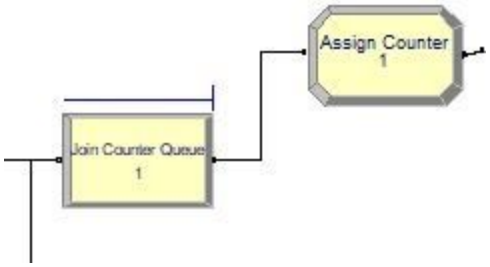

Figure 7

Because there are 3 different counters there are assign blocks for each counter that assigns a counter for a moviegoer.

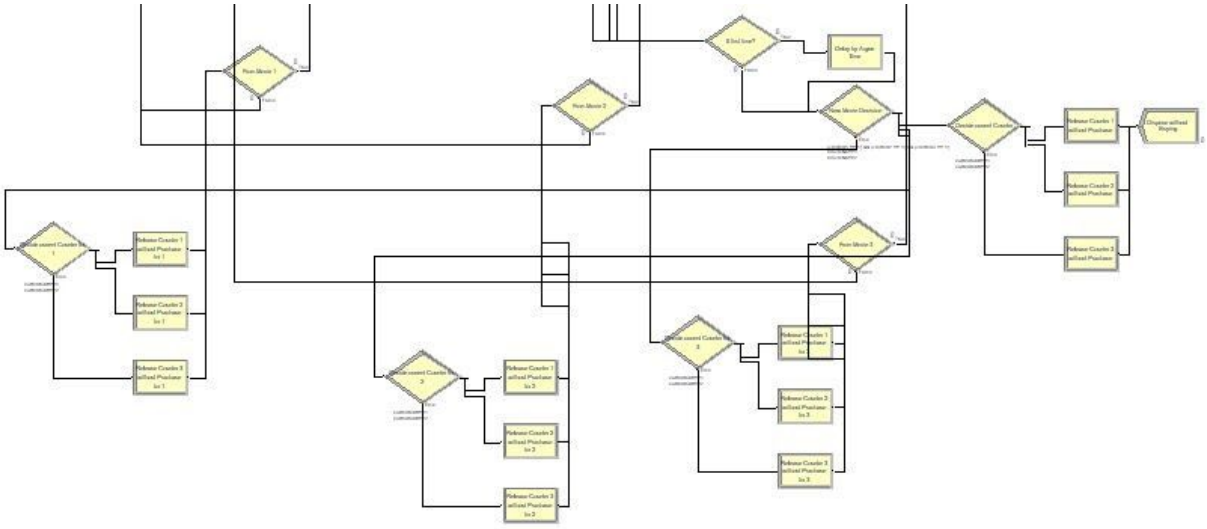

Figure 8

When a moviegoer does not find enough ticket he/she is redirected to this part. In this part the simulation releases the current counter to redirect the moviegoer to another queue. If the moviegoer does not find any ticket from any movie the simulation releases the current counter and the moviegoer leaves.

➢ Output Analysis

Single Counter StandardAR 120 mins Summary

Stat	Mean	HalfWidth	Lower	Higher
Movie 1 Soldout Time	**82.78362850279116**	**6.088191465896643**	**76.69543703689452**	**88.8718199686878**
Movie 2 Soldout Time	**88.15482402332655**	**5.433339952260664**	**82.72148407106589**	**93.58816397558722**
Movie 3 Soldout Time	**83.67577600539654**	**6.309194013188756**	**77.36658199220778**	**89.9849700185853**
Reneging Movie 1 Customer	**0.41379310344827586**	**0.25952856635540994**	**0.15426453709286592**	**0.6733216698036858**
Reneging Movie 2 Customer	**0.17241379310344483**	**0.14622778138591112**	**0.026186011717537094**	**0.3186415744893595**
Reneging Movie 3 Customer	**0.24137931034482768**	**0.16565312311053393**	**0.07572618723428828**	**0.4070324334553669**
Counter Utilization	**0.43133868808801370**	**0.00820179377207887**7	**0.42313689431593480**	**0.4395404818600925**4

Single Counter IncreasedAR 120 mins Summary

Stat	Mean	HalfWidth	Lower	Higher
Movie 1 Soldout Time	**49.92960030255678**	**3.0939727415588534**	**46.83562756099793**	**53.02357304411563**
Movie 2 Soldout Time	**50.69759002747413**	**2.120020226380051**	**48.57756980109408**	**52.81761025385418**
Movie 3 Soldout Time	**49.317404765419134**	**2.5479325627815235**	**46.769472202637761**	**51.865337328200066**
Reneging Movie 1 Customer	**2.7586206896551726**	**0.9016062388488814**	**1.8570144508062914**	**3.6602269285040054**
Reneging Movie 2 Customer	**3.0689655172413794**	**1.0755448456728243**	**1.9934206715685552**	**4.1445103629142040**
Reneging Movie 3 Customer	**2.8620689655172415**	**1.0101013222479072**	**1.8519676432693344**	**3.8721702877651487**
Counter Utilization	**0.43419540229885056**	**0.009928375009666972**	**0.4242670272891836**	**0.4441237773085175****4**

Single Counter IncreasedAR 60 mins Summary

Stat	Mean	HalfWidth	Lower	Higher
Movie 1 Soldout Time	47.73833461194578	2.601686684868 1994	45.13664792707 758	50.34002129681 398
Movie 2 Soldout Time	49.85680874626 711	1.884126394087 1633	47.97268235217 995	51.74093514035 4274
Movie 3 Soldout Time	48.90360887034 771	2.497489069120 9612	46.40611980122 675	51.40109793946 867
Reneging Movie 1 Customer	2.517241379310 3448	0.924054683280 106	1.593186696030 2388	3.441296062590 4505
Reneging Movie 2 Customer	3.034482758620 6895	1.087735511991 4045	1.946747246629 285	4.122218270612 094
Reneging Movie 3 Customer	2.827586206896 5516	1.022026542608 3066	1.805559664288 245	3.849612749504 858
Counter Utilization	0.857134385873 6291	0.015869360582 149467	0.841265025291 4796	0.873003746455 7786

3 Counters StandartAR 120 mins Summary

Stat	Mean	HalfWidth	Lower	Higher
Movie 1 Soldout Time	82.2920159562873	6.163280991195868	76.12873496509144	88.45529694748316
Movie 2 Soldout Time	87.55147144103067	5.692594831072767	81.85887660995 79	93.24406627210344
Movie 3 Soldout Time	82.7717869961107	6.384764793846701	76.387022202264	89.1565517899574
Reneging Movie 1 Customer	0.20689655172413793	0.15681182562677698	0.05008472609736095	0.3637083773509149
Reneging Movie 2 Customer	0.17241379310344483	0.14622778138591112	0.02618601171753 7094	0.3186415744893595
Reneging Movie 3 Customer	0.20689655172413793	0.15681182562677703	0.05008472609736089	0.363708377350915
Counter 1 Utilization	0.14091149676278528	0.006229924418579163	0.134681572344 2061	0.14714142118136445
Counter 2 Utilization	0.14243868557810194	0.006133943981794608	0.13630474159630732	0.14857262955989656
Counter 3 Utilization	0.14770114942528 74	0.006276890482 3494115	0.14142425894293797	0.153978039907 6368

3 Counters IncreasedAR 120 mins Summary

Stat	Mean	HalfWidth	Lower	Higher
Movie 1 Soldout Time	**44.62026923960907**	**4.73181853187541**	**39.88845070773366**	**49.35208777148 4484**
Movie 2 Soldout Time	**46.24536566951753**	**3.179153437456 1983**	**43.06621223206 133**	**49.42451910697 373**
Movie 3 Soldout Time	**44.47902230835389**	**3.255877834362 5274**	**41.22314447399 136**	**47.73490014271 642**
Reneging Movie 1 Customer	**0.413793103448 27586,**	**0.278729228305 0582**	**0.135063875143 21766**	**0.692522331753 334**
Reneging Movie 2 Customer	**0.551724137931 0345**	**0.297888638258 5616**	**0.253835499672 4729**	**0.849612776189 5961**
Reneging Movie 3 Customer	**0.517241379310 3449**	**0.261580207502 3006**	**0.255661171808 04426**	**0.778821586812 6455**
Counter 1 Utilization	**0.144252873563 21834**	**0.008560363828 507373**	**0.135692509734 71098**	**0.152813237391 7257**
Counter 2 Utilization	**0.143390804597 70118**	**0.006131290684 021494**	**0.137259513913 6797**	**0.149522095281 72267**
Counter 3 Utilization	**0.154310344827 58624**	**0.010397150593 800985**	**0.143913194233 78526**	**0.164707495421 3872**

3 Counters IncreasedAR 60 mins Summary

Stat	Mean	HalfWidth	Lower	Higher
Movie 1 Soldout Time	**40.74452278614618**	**3.1082930549581076**	**37.63622973118807**	**43.85281584110429**
Movie 2 Soldout Time	**45.12681355590425**	**2.9698769952473145**	**42.15693656065694**	**48.09669055115156**
Movie 3 Soldout Time	**43.860460353340734**	**3.117111022748322**	**40.74334933059241**	**46.97757137608906**
Reneging Movie 1 Customer	**0.41379310344827586**	**0.2787292283050582**	**0.13506387514321766**	**0.6925223317533334**
Reneging Movie 2 Customer	**0.5172413793103449**	**0.2984862088456086**	**0.21875517046473625**	**0.8157275881559535**
Reneging Movie 3 Customer	**0.4827586206896552**	**0.2615802075023007 7**	**0.2211784131873544 3**	**0.7443388281919 56**
Counter 1 Utilization	**0.2776494574341666**	**0.009448852109227981**	**0.2682006053249386**	**0.2870983095433945 5**
Counter 2 Utilization	**0.2857573109110436**	**0.0122766153310466 3**	**0.2734806955799 97**	**0.2980339262420 9024**
Counter 3 Utilization	**0.3021952901760293**	**0.0177382961268 67375**	**0.2844569940491619**	**0.3199335863028967**

Analysis Observations:

- Doubling the arrival rate led to a significance decrease in average movie sold out times in both cases for all movies.
- Doubling the arrival rate led to an increase in average number of reneging customers for all movies in both cases.
- Making the counter stay open for 60 minutes instead of 120 minutes increased the average counter utilization but did not significantly affect the movie sold out times and average number of reneging customers.