IE3081 MODELLING AND DISCRETE SIMULATION

TERM PROJECT

STARBUCKS COFFEE SHOP SIMULATION

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STARBUCKS COFFEE SHOP QUEUEING MODEL SIMULATION

In this program we built a queueing simulation model of well known coffee shop and observe the outputs corresponding inputs. Time (second) based queueing system is working in FIFO manner.

Scenario

Customers arrives in the coffee shop with a defined interarrival time() and they determine their requests individually after that they include the queue of course if there is a queue and cashiers are not idle. When the queue comes to relevant customer, customer gives the order to one of the two cashiers. Order can be include either beverages, foods or both of them. In this step customers specify the payment type because it will be taken in three different way and which are directly cash, via by credit card or Starbucks online customer's account. After the giving order and payment process, customers get involved the delivery queue. The queue depends on cashiers, baristas and food server's service time distribution and necessary payment time. When the orders are ready to receive, customer takes the own order and get a table or leave the shop.

Input Variables

Customers' interarrival times, cashier1's service times and their distributions, barista1 and barista2's service times and their distributions, food server's service times and distributions, payment types service times and distributions.

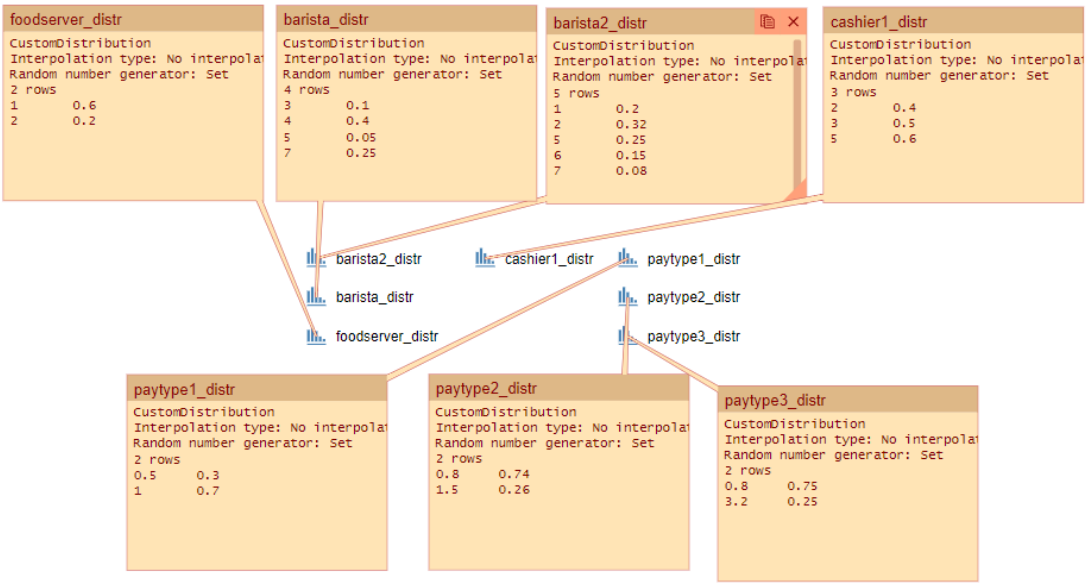
Cashier, barista 1&2 and food server's times varies by just their capabilities.

Payment times varies by type because the necessary operations can be take different times. For instance, the fastest payment type cash because customer just gives the money and get back change if it is necessary. On the other hand if the type is credit card, customers uses contactless credit card or enters the credit card pins and then wait the bank response. When customer choose the another type, Starbucks Online Account, customer just shows barcode like contactless credit card but if customer have not enough money for the orders in the account, customer charge the account and then accomplish the payment issue.

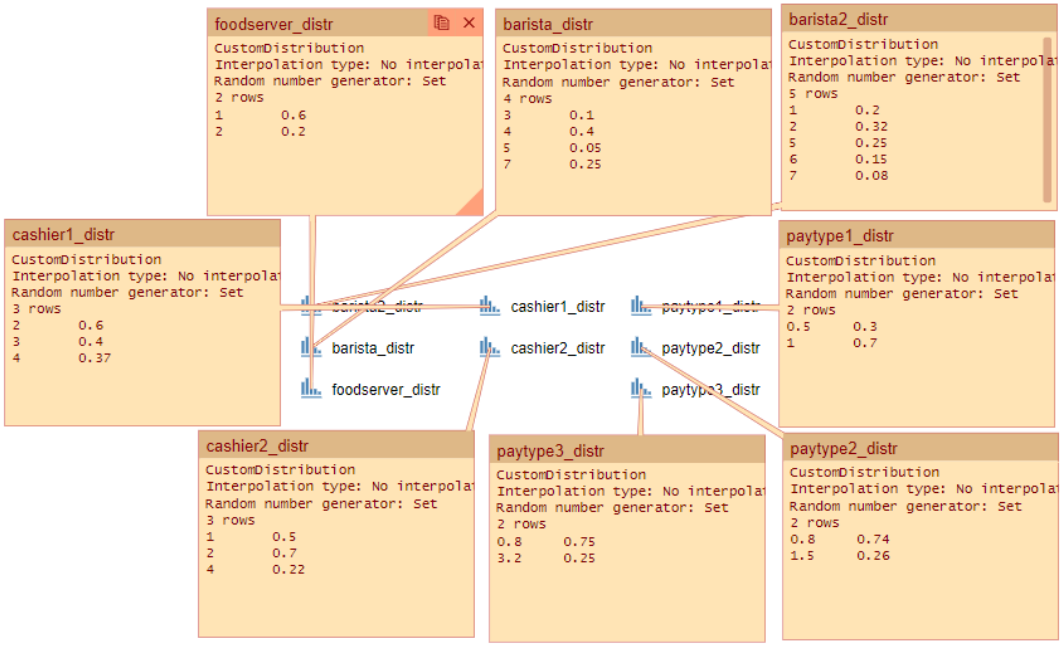
Number of arrival customers is specified in the system by hand and it is not change.

Interarrival Times (minutes)	
Minimum	0.5
Maximum	10

Distributions of the Original Model



Distributions of the Optimized Model



Output Variables

Average time that customer spent in system, number of customers wait in queue, to average waiting time, average service time.

After Running the Original System

Average Time that Customers Spent in the System:

Seed Value	Average Time that Customers Spent in the System (min)
1	5.50
8	5.45
13	5.52
17	5.46
25	5.68
Mean	**5.52**
Standard Deviation	**0.0928**
Variance	**0.00862**
Intervals(CI: 95%)	**5.522 ±0.0814**
Standard Error	**0.04152**
Replication Estimation(H=0.1, z=1.96)	**21**

Number of Customers Wait in Queue:

Seed Value	Number of Customers Wait in Queue
1	588
8	583
13	572
17	575
25	570
Mean	**577.6**
Standard Deviation	**7.6354**
Variance	**58.3**
Intervals(CI: 95%)	**577.6 ±6.693**
Standard Error	**3.4146**
Replication Estimation(H=0.1, z=1.96)	**139,978.3**

Average Waiting Time in the Queue:

Seed Value	Total Waiting Time in the Queue
1	1.01
8	1
13	0.96
17	1.01
25	0.98
Mean	**0.992**
Standard Deviation	**0.0216**
Variance	**0.00047**
Intervals(CI: 95%)	**0.992 ±0.019**
Standard Error	**0.0096**
Replication Estimation(H=0.1, z=1.96)	**2**

Average Service Time:

Seed Value	Total Waiting Time in the Queue
1	1.62
8	1.58
13	1.57
17	1.62
25	1.64
Mean	**1.60**
Standard Deviation	**0.0296**
Variance	**0.00088**
Intervals(CI: 95%)	**1.606 ±0.026**
Standard Error	**0.0132**
Replication Estimation(H=0.1, z=1.96)	**2**

After Running the Optimized System

Average Time that Customers Spent in the System:

Seed Value	Average Time that Customers Spent in the System (min)
1	5.46
8	5.46
13	5.43
17	5.31
25	5.64
Mean	**5.46**
Standard Deviation	**0.1181**
Variance	**0.01395**
Intervals(CI: 95%)	**5.46 ±0.104**
Standard Error	**0.05282**
Replication Estimation(H=0.1, z=1.96)	**34**

Number of Customers Wait in Queue:

Seed Value	Number of Customers Wait in Queue
1	578
8	576
13	585
17	597
25	576
Mean	**582.4**
Standard Deviation	**8.9610**
Variance	**80.3**
Intervals(CI: 95%)	**582.4 ±7.855**
Standard Error	**4.0074**
Replication Estimation(H=0.1, z=1.96)	**308**

Average Waiting Time in the Queue:

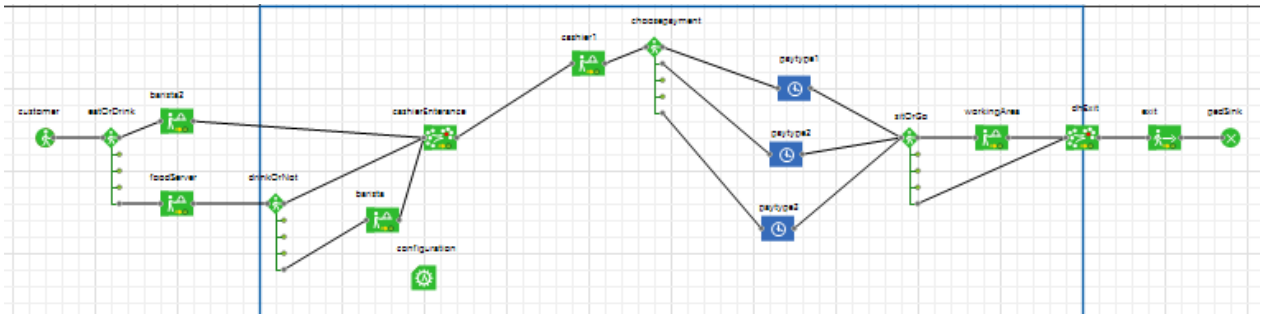
Seed Value	Total Waiting Time in the Queue
1	0.85
8	0.83
13	0.86
17	0.90
25	0.84
Mean	**0.86**
Standard Deviation	**0.0270**
Variance	**0.00073**
Intervals(CI: 95%)	**0.856 ±0.0237**
Standard Error	**0.01208**
Replication Estimation(H=0.1, z=1.96)	**2**

Average Service Time:

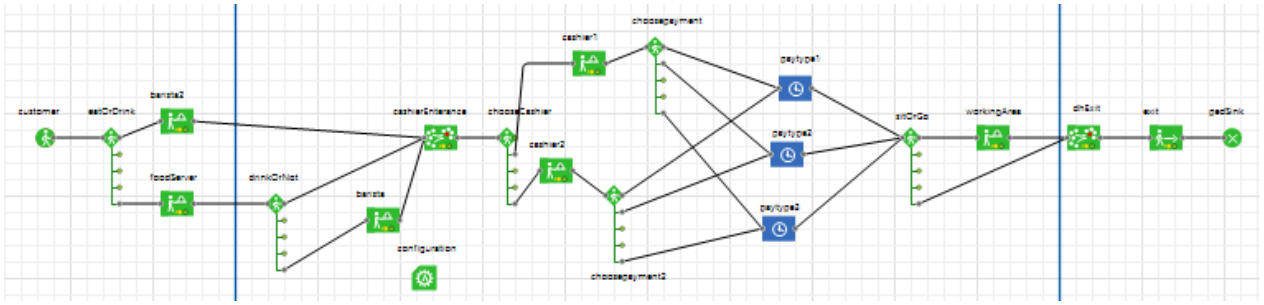
Seed Value	Total Waiting Time in the Queue
1	1.33
8	1.37
13	1.35
17	1.30
25	1.32
Mean	**1.33**
Standard Deviation	**0.0270**
Variance	**0.00073**
Intervals(CI: 95%)	**1.334 ±0.0237**
Standard Error	**0.01208**
Replication Estimation(H=0.1, z=1.96)	**2**

To optimize the system, cashier is fired because he is working slow and we hired 2 new cashiers which are faster than fired one. As we expected, average waiting time in the queue, average service time, and average time that customer spent in the system decreased. In contrast, number of customers waiting in queue is increased. That is not what we want but it is ignorable when we look at decreasing of the other performance metrics.

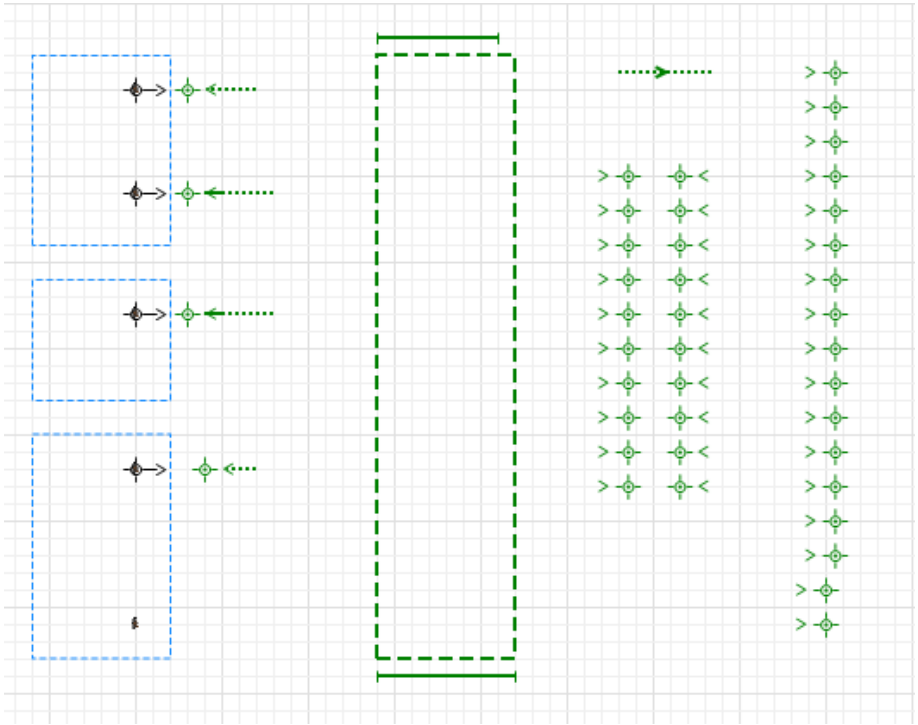
Structure of the Original Model



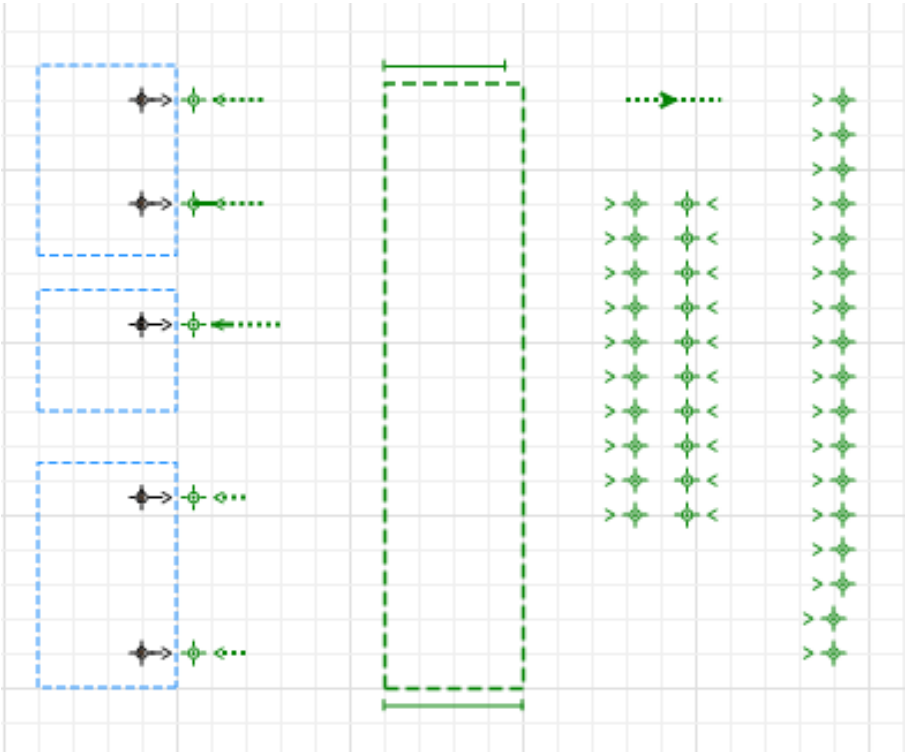
Structure of the Optimized Model



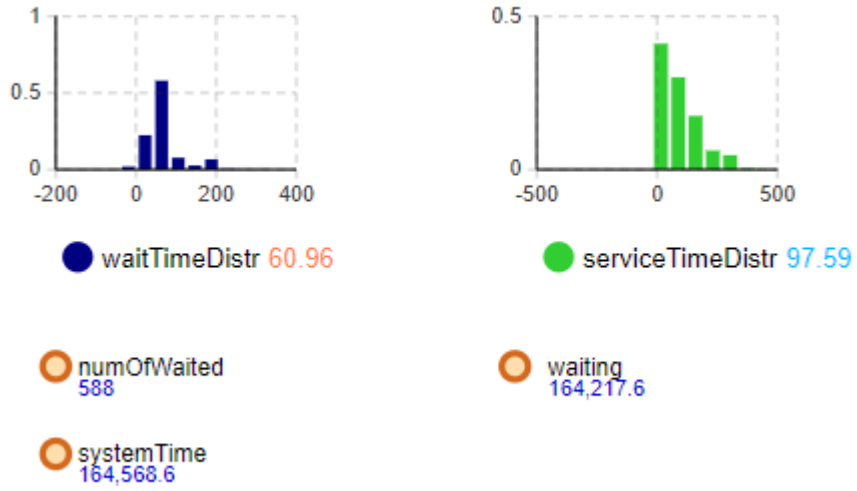
2D Animation of Original Model



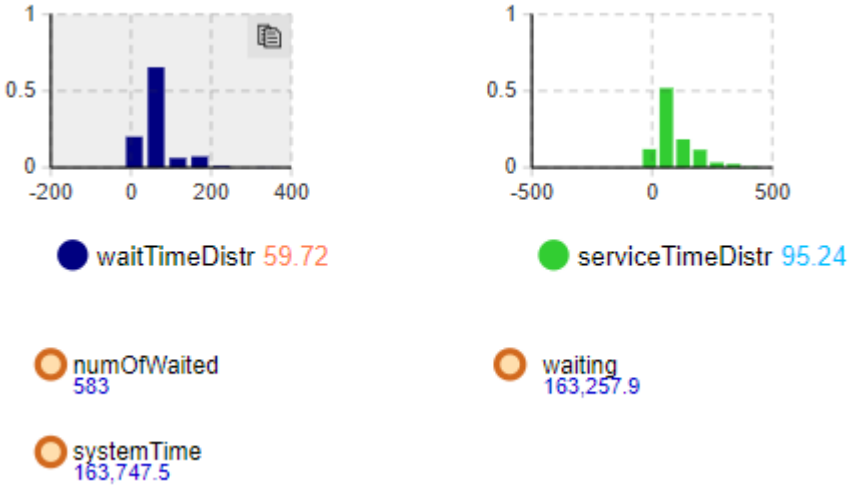
2D Animation of Optimized Model



Screenshots of Original Model's Runs



Seed Value = 1



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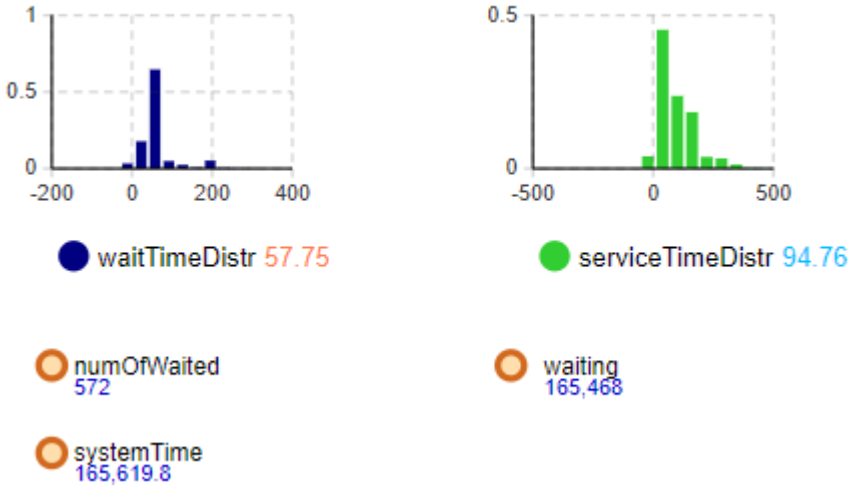
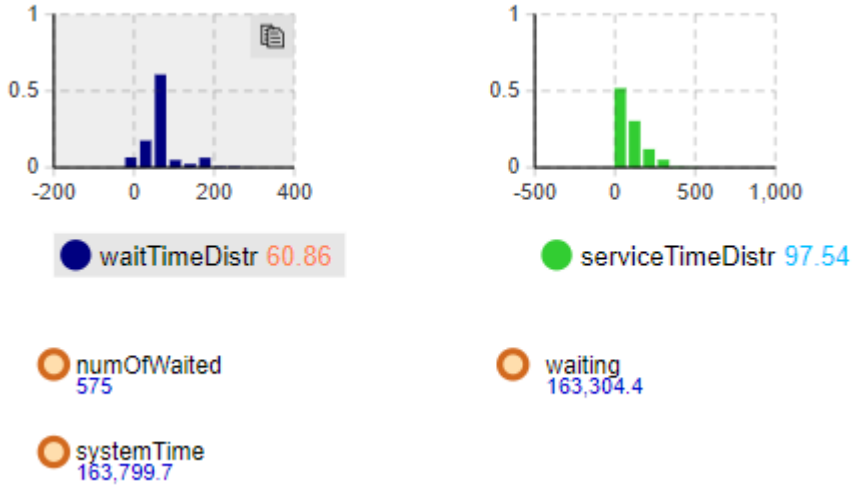
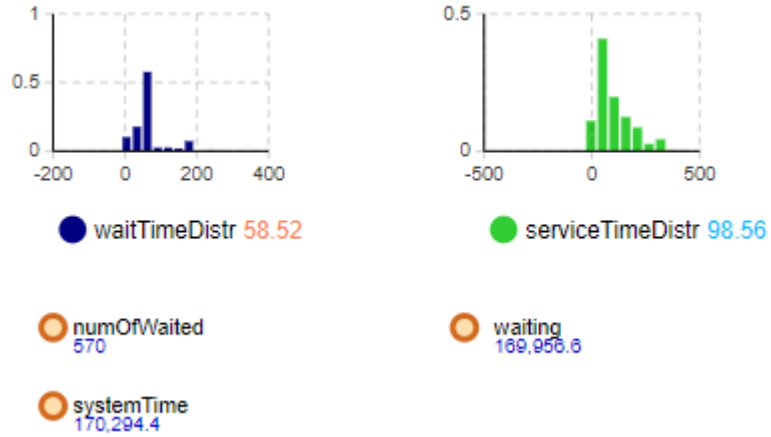


Seed Value = 13

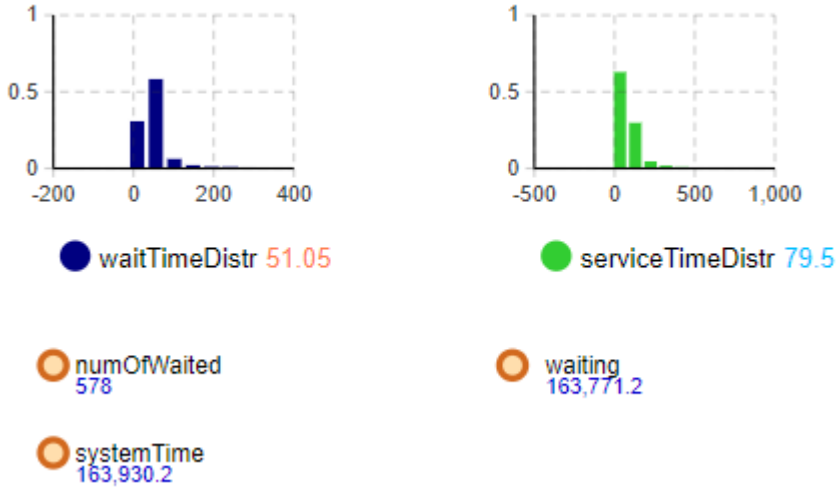


Seed Value = 17



Seed Value = 25

Screenshots of Optimized Model's Runs



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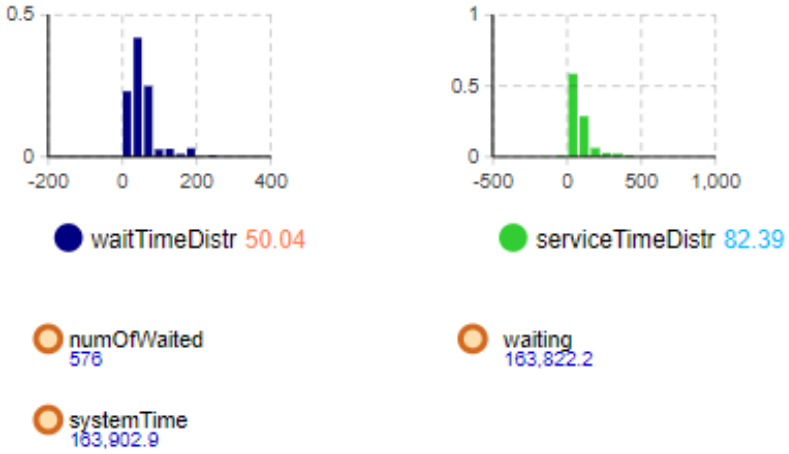
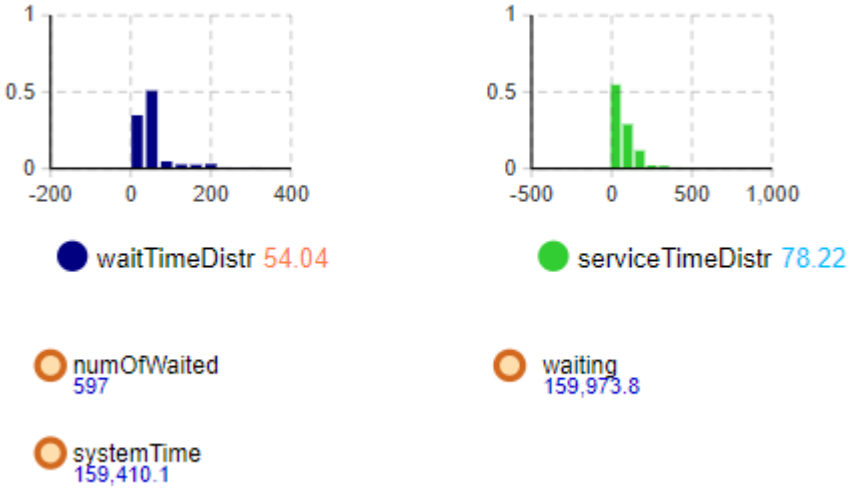
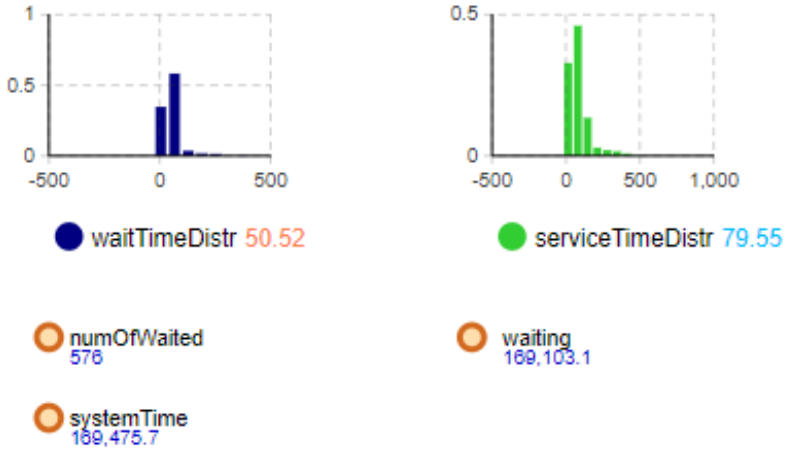


Seed Value = 8

Seed Value = 13



Seed Value = 17



Seed Value = 25