TMA 1301 - Computational Method
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Report for Queueing System Simulation

TC03

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1. Details of Simulation

Firstly, get some information needed to be used as parameters. The informations needed are number of servers, number of customers, type of random number generator to be used, number of product available, minimum price of the product, maximum price of the product, and how much a customer can buy (the maximum limit a customer can buy).

Next, generate the table of products. There are two columns, the first for product number or ID, second for the price. Each column is a matrix, the size is (1, number of product). The price is randomly generated, the range of it is determined by the minimum price and maximum price.

Next, generate the tables for the servers. All servers has the same columns or attributes, Interarrival time, probability, cdf, and the range (1 - 100). The service time for later servers are longer than its' previous. Each column is a matrix, the size is (number of servers, number of interarrival time).

Next, generate the interarrival time table. It has four columns, first being interarrival time, probability, cdf, and range.

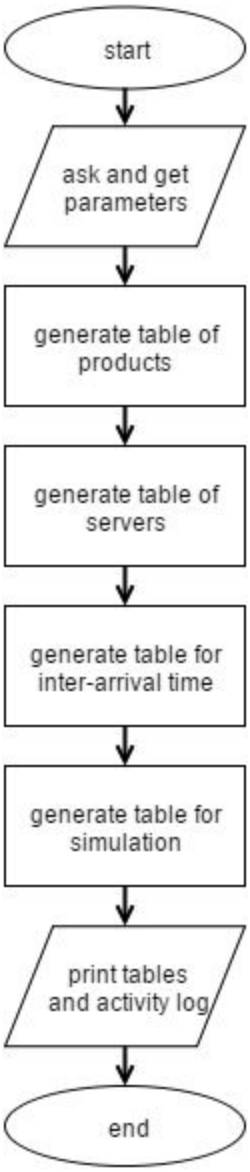
Next, generate the simulation. A server activity is used to keep track of simulation activity (which server will serve the customer). It is done by a 1 x number of servers matrix. Initially the matrix will be [0 0 0]. When a customer arrives. By default, the first server will serve the customer since all are 0. Next, the get the service end of the first customer and update the service activity so the matrix now becomes [n 0 0]. It repeats the similar process for all the customers. It gets the arrival time of the customer compare it with the matrix, if any is smaller than the arrival time, use that server. If all is higher than the arrival time, a wait time is introduced, and choose the server that will complete its' current activity first.

Next, just print print all the matrix into a table format.

After printing the tables, print the activity log based on the same matrix.

Finally, draw a conclusion by getting the average of certain matrix such as wait time, sum of service duration for the servers and so on.

2. Flowcharts and Diagrams



3. Outputs, tables and results from Freemat

```
--> main
-- SIMULATOR --
-----------------------------------------------------------------
Enter number of servers 1 - 3.
-----------------------------------------------------------------
3


-----------------------------------------------------------------
Enter number of customers.
-----------------------------------------------------------------
6
```

```
Enter type for number generator:
1. Additive Congruential Generator
2. Linear Congruential Generator
3. Multiplicative Congruential Generator
4. Random Exponential Distribution
5. Random Uniform Distribution
-----------------------------------------------------------------
Enter 1 - 5.
-----------------------------------------------------------------
4


-----------------------------------------------------------------
Enter number of products available.
-----------------------------------------------------------------
4


-----------------------------------------------------------------
What is the minimum price of a product?
-----------------------------------------------------------------
20


-----------------------------------------------------------------
What is the maximum price of a product?
-----------------------------------------------------------------
40


-----------------------------------------------------------------
How much can a customer buy?
-----------------------------------------------------------------
3
```

Results:

Table of Products

Product no.	Product Price
1	20.08
2	20.03
3	20.74
4	20.23

Server 1 Service Time

Service Time	Probability	CDF	Random No Range
6	0.65	0.65	0 - 65
7	0.05	0.70	66 - 69
8	0.23	0.93	70 - 93
9	0.02	0.95	94 - 95
10	0.05	1.00	96 - 100

Server 2 Service Time

Service Time	Probability	CDF	Random No Range
7	0.07	0.07	0 - 6
8	0.11	0.18	7 - 17
9	0.24	0.42	18 - 41
10	0.03	0.45	42 - 44
11	0.55	1.00	45 - 100

Server 3 Service Time

Service Time	Probability	CDF	Random No Range
8	0.05	0.05	0 - 4
9	0.46	0.51	5 - 50
10	0.01	0.52	51 - 51
11	0.31	0.83	52 - 83
12	0.17	1.00	84 - 100

Interarrival Time	Probability	CDF F(X)	Random No Range
1	0.06	0.06	0 - 5
2	0.01	0.07	6 - 7
3	0.03	0.10	8 - 9
4	0.35	0.45	10 - 45
5	0.17	0.62	46 - 61
6	0.08	0.70	62 - 70
7	0.14	0.84	71 - 83
8	0.16	1.00	84 - 100

Cust no.	Interarrival Time	Arrival Time	Wait Time	Server Number	Service Starts	Service Duration	Service Ends
1	0	0	0	1	0	6	6
2	4	4	0	2	4	9	13
3	4	8	0	1	8	6	14
4	4	12	0	3	12	9	21
5	4	16	0	1	16	6	22
6	1	17	0	2	17	7	24

ACTIVITY LOG

```
Customer 1 arrives at minute 0 and queues at Server 1
Service Duration is 6 minutes and Service starts at minute 0
Customer 1 departs at minute 6

Customer 2 arrives at minute 4 and queues at Server 2
Service Duration is 9 minutes and Service starts at minute 4
Customer 2 departs at minute 13

Customer 3 arrives at minute 8 and queues at Server 1
Service Duration is 6 minutes and Service starts at minute 8
Customer 3 departs at minute 14

Customer 4 arrives at minute 12 and queues at Server 3
Service Duration is 9 minutes and Service starts at minute 12
Customer 4 departs at minute 21

Customer 5 arrives at minute 16 and queues at Server 1
Service Duration is 6 minutes and Service starts at minute 16
Customer 5 departs at minute 22

Customer 6 arrives at minute 17 and queues at Server 2
Service Duration is 7 minutes and Service starts at minute 17
Customer 6 departs at minute 24
```

```
|=============================================================================
|                                  END OF ACTIVITY LOG
|=============================================================================



Server 1 spent a total of 18 minutes serving a total of 3 customers.
Percentage of Server 1 being used is 41.86 percent.

Server 2 spent a total of 16 minutes serving a total of 2 customers.
Percentage of Server 2 being used is 37.21 percent.

Server 3 spent a total of 9 minutes serving a total of 1 customers.
Percentage of Server 3 being used is 20.93 percent.

0.00 percent of customers have spent time queueing up
Average waiting time:  0.00
Average service time:  7.17
Average interarrival time:  2.83
Average time spent per customer:  7.17


Conclusion drawn:
Customers have a low chance of waiting in queue.
-->
```

END OF REPORT######