

**Cairo University**

**Faculty of Computers and Artificial intelligence**

**DS331/DS241 -** **Systems Modeling & Simulation**

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**PROBLEM 1**

**Formulation :**

In this task we have a mission to make the simulation for a bank teller that serve for 2 queue (distinguished and ordinary ) in the system there are some conditions :  
 that the distinguished have high priority from the ordinary customer

And then must make a statistics and make notice what must happen :

1. Add one teller to separate the 2 queues
2. Or make any recommendation

**Objectives :**

need to eliminate the waiting time and make a good serve for both

ordinary and distinguished customers .

**System components :**

1. Entity : customer – teller
2. Attribute : VIP customer – Ordinary customer
3. Activity: service time – account bank operations
4. State : (VIP / ordinary ) queue busy or without customers

Or ( system idle or in work ).

1. Event : (distinguished and ordinary) customer arrival – customer leave

Table distribution:

**Tables distribution : (for ordinary customer )**

|  |  |  |  |
| --- | --- | --- | --- |
| Time between arrival (IAT) | probability | Cumulative | Random assignment |
| 0 | 0.09 | 0.09 | 1-9 |
| 1 | 0.17 | 0.26 | 10-26 |
| 2 | 0.27 | 0.53 | 27-53 |
| 3 | 0.20 | 0.73 | 54-73 |
| 4 | 0.15 | 0.88 | 74-88 |
| 5 | 0.12 | 1 | 89-00 |

|  |  |  |  |
| --- | --- | --- | --- |
| Service time (ST) | probability | Cumulative | Random assignment |
| 1 | 0.20 | 0.20 | 1-20 |
| 2 | 0.40 | 0.60 | 21-60 |
| 3 | 0.28 | 0.88 | 61-88 |
| 4 | 0.12 | 1 | 89-00 |

**Tables for (distinguished customer ) :**

|  |  |  |  |
| --- | --- | --- | --- |
| Time between arrival (IAT) | probability | Cumulative | Random assignment |
| 1 | 0.1 | 0.1 | 1-10 |
| 2 | 0.2 | 0.3 | 11-30 |
| 3 | 0.3 | 0.6 | 31-60 |
| 4 | 0.4 | 1 | 61-00 |

|  |  |  |  |
| --- | --- | --- | --- |
| Service time | probability | Cumulative | Random assignment |
| 1 | 0.10 | 0.10 | 1-10 |
| 2 | 0.30 | 0.40 | 11-40 |
| 3 | 0.38 | 0.78 | 41-78 |
| 4 | 0.22 | 1 | 79-00 |

**The Calendar :**

Guide to understand the calendar :

**IAt** : inter arrival time **CT** : compilation time

**ART** : Arrival time **TIS** : time in system

**SST** : Service Start Time

**WT** : waiting time

**ST** : Service time

Case 1(One Teller):

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Customar** | IAt (vip) | Art (vip) | SST (vip) | WT (vip) | ST (vip) | CT (vip) | TIS(vip) |
| 1 | 3 | 3 | 3 | 0 | 3 | 6 | 3 |
| 2 | 2 | 5 | 6 | 1 | 3 | 9 | 4 |
| 3 | 2 | 10 | 13 | 3 | 2 | 15 | 5 |
| 4 | 3 | 15 | 15 | 0 | 2 | 17 | 2 |
| 5 | 3 | 18 | 21 | 3 | 3 | 24 | 6 |
| 6 | 4 | 27 | 27 | 0 | 4 | 31 | 4 |
| 7 | 2 | 34 | 36 | 2 | 1 | 37 | 3 |
| 8 | 3 | 38 | 39 | 1 | 4 | 43 | 5 |
| 9 | 2 | 40 | 43 | 3 | 4 | 47 | 7 |
| 10 | 3 | 43 | 47 | 4 | 3 | 50 | 4 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Customar** | IAt (ord) | Art (ord) | SST (ord) | WT (ord) | ST (ord) | CT (ord) | TIS(ord) |
| 1 | 0 | 0 | 0 | 0 | 2 | 2 | 2 |
| 2 | 3 | 8 | 9 | 1 | 4 | 13 | 5 |
| 3 | 2 | 10 | 17 | 7 | 4 | 21 | 11 |
| 4 | 2 | 12 | 24 | 12 | 3 | 27 | 15 |
| 5 | 5 | 23 | 31 | 8 | 2 | 33 | 10 |
| 6 | 5 | 32 | 33 | 1 | 3 | 36 | 4 |
| 7 | 2 | 34 | 37 | 3 | 2 | 39 | 5 |
| 8 | 1 | 35 | 50 | 15 | 1 | 51 | 16 |
| 9 | 2 | 40 | 51 | 11 | 1 | 52 | 12 |
| 10 | 5 | 48 | 52 | 4 | 3 | 55 | 7 |

**Experimental design & justification :**

1. Probabilistic parameters :
   1. Distinguished / ordinary (interarrival time )
   2. Distinguished / ordinary (service time )
2. Controllable parameter

( number of customer per one run in the simulation project ) .

1. The average service time of the teller ordinary = (55 – 1)/10 = 5.4
2. The average waiting time in the ordinary customers queue = 62/10 = 6.2

and the distinguished customers queue = 17/10 = 1.7

1. The maximum ordinary customers queue length = 3

and the distinguished customers queue length = 1

1. The probability that an ordinary customer wait in the queue = 9/10 =0.9

and the probability that a distinguished customer wait in the queue = 0.7

1. The portion of idle time of the teller ordinary =1 and average = 1/20 = 0.05

Moreover, the policy maker requires answers for the following questions:

1. Does the theoretical average service time of the service time distribution match with the experimental one for both types of customers

Ordinary:

* theoretical average = 0.58
* the experimental average = 2.6
* the theoretical average service time of the service time distribution not match the experimental one for ordinary customer

Distinguished:

* theoretical average = 0.68
* the experimental average = 2.2
* the theoretical average service time of the service time distribution not match the experimental one for Distinguished customer.

1. Does the theoretical average inter-arrival time of the inter-arrival time distribution match with the experimental one for both types of customers?

Case 2 (Two Teller):

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Customar** | IAt (vip) | Art (vip) | SST (vip) | WT (vip) | ST (vip) | CT (vip) | TIS(vip) |
| 1 | 3 | 3 | 3 | 0 | 2 | 5 | 2 |
| 2 | 2 | 5 | 5 | 0 | 3 | 8 | 3 |
| 3 | 1 | 6 | 8 | 2 | 2 | 10 | 4 |
| 4 | 4 | 10 | 10 | 0 | 2 | 12 | 2 |
| 5 | 3 | 13 | 13 | 0 | 3 | 16 | 3 |
| 6 | 2 | 15 | 16 | 1 | 3 | 19 | 4 |
| 7 | 1 | 16 | 19 | 3 | 2 | 21 | 5 |
| 8 | 3 | 19 | 21 | 2 | 2 | 23 | 4 |
| 9 | 3 | 22 | 23 | 1 | 2 | 25 | 3 |
| 10 | 4 | 26 | 26 | 0 | 1 | 27 | 1 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Customar** | IAt (ord) | Art (ord) | SST (ord) | WT (ord) | ST (ord) | CT (ord) | TIS(ord) |
| 1 | 4 | 4 | 4 | 0 | 4 | 8 | 4 |
| 2 | 2 | 6 | 8 | 2 | 2 | 10 | 4 |
| 3 | 2 | 8 | 10 | 2 | 2 | 12 | 4 |
| 4 | 3 | 11 | 12 | 1 | 2 | 14 | 3 |
| 5 | 5 | 16 | 16 | 0 | 3 | 19 | 3 |
| 6 | 3 | 19 | 19 | 0 | 1 | 20 | 1 |
| 7 | 5 | 24 | 24 | 0 | 2 | 26 | 2 |
| 8 | 2 | 26 | 26 | 0 | 3 | 29 | 3 |
| 9 | 2 | 28 | 29 | 1 | 3 | 32 | 4 |
| 10 | 2 | 30 | 32 | 2 | 4 | 36 | 6 |

1. If there is an additional teller to serve the distinguished customers only, how does this affect the average waiting time in the queues of both types of customers?

Ordinary:

* New average wait = 0.8
* Decrease the average wait time in queue of ordinary customers

Distinguished:

* New average wait = 0.9
* Decrease the average wait time in queue of Distinguished customers

**Conclusion :**

After make a simulation for the teller system in bank that serve 2 queue ( one for distinguished and another for the ordinary customers )

We find that in most cases the distinguished make have very advantage than the ordinary customer .

Ordinary customers face problem with waiting for long time because the disti-nguished customers have high priority than the ordinary customers .

And when make the case that each type of customers have a teller that serve each type find the problem is solved , because each type of customer not face any priority conditions that make him waiting much time .

Mission complete .