Cairo University

Faculty of Computers and Artificial Intelligence

Report for problem 1 - The Bank

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Course Name: Systems Modeling and Simulation

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Contents

Problem formulation & Objectives:

System: Bank system.

Objects: Tellers, Customers.

Purpose:

1. The average service time of the drive-in teller and the inside-bank teller.
2. The average waiting time in the drive-in teller queue and the inside-bank teller queue.
3. The maximum inside-bank teller queue length.
4. The probability that a customer wait in the inside-bank teller queue.
5. The portion of idle time of the inside-bank teller.
6. Does the theoretical average service time of the service time distribution match with the experimental one?
7. Does the theoretical average inter-arrival time of the inter-arrival time distribution match with the experimental one?
8. If the drive-in teller queue can accommodate for two cars instead of one car, how does this affect the average waiting time in the drive-in teller queue and the inside-bank teller queue.

System Components:

- **Entity:** Customers.
- **Attributes:** Identity number, Balance account.
- **Activity:** Transact business.
- **State variables:**
    a. The number of busy tellers.
    b. The number clients in the bank.
- **Events:**
    a. **Exogenous event:** Arrival of customer.
    b. **Endogenous event:** Service completion of a client.

System analysis including cumulative distribution tables, calendar table (for 10 customers).

Time between arrivals	Probability	Cumulative probability	Intervals
0	0.09	0.09	1-9
1	0.19	0.28	10-28
2	0.30	0.58	29-58
3	0.21	0.79	59-79
4	0.12	0.91	80-91
5	0.09	1	92-100

customers	Random digit	Time between arrivals
1	-	-
2	59	3
3	44	2
4	91	4
5	91	4
6	99	5
7	87	4
8	38	2
9	32	2
10	41	2

Service time	Probability	Cumulative probability	Intervals
1	0.20	0.20	1-20
2	0.40	0.6	20-60
3	0.28	0.88	60-88
4	0.12	1	88-100

customers	Random digit	Service time
1	42	2
2	12	1
3	8	1
4	81	3
5	59	2
6	48	2
7	68	3
8	52	2
9	68	3
10	38	2

customers	Time since last arrival	Arrival time	Service time	Time service begin	Waiting time(teller)	Waiting time(drive-in teller)	Time service ends	Time in system	Idle of drive-in teller	Idle of teller
1	-	0	2	0	0	0	2	2	0	0
2	3	3	1	3	0	0	4	1	1	3
3	2	5	1	5	0	0	6	1	1	2
4	4	9	3	9	0	0	12	3	3	4
5	4	13	2	13	0	0	15	2	1	4
6	5	18	2	18	0	0	20	2	3	5
7	4	22	3	22	0	0	25	3	2	4
8	2	24	2	25	0	1	27	3	0	2
9	2	26	3	27	0	1	30	4	0	2
10	2	28	2	30	0	2	32	4	0	2

1- The average service time = 21/10 = 2.1 min

2- Average waiting time in the drive-in teller = 4/10 = 0.4 min

3- Average waiting time inside the bank teller = 0

4- Maximum inside bank teller queue length = 0

5- Probability that a customer waits inside bank teller = 0

6- The portion of idle time of the inside bank teller = 28

Experimental Design Parameters

customers = 500

Time between arrivals is a random value

Service time is a random value

Justification of experiment parameters values

Customers = 500 to test every case in the problem (service in drive-in teller – waiting in drive-in teller queue – service inside bank teller – waiting inside the bank teller queue).
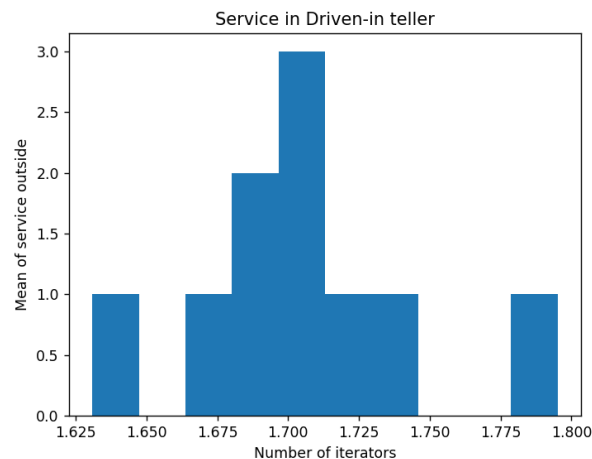
Time between arrivals is a random value because no specific arrival time for the customers.
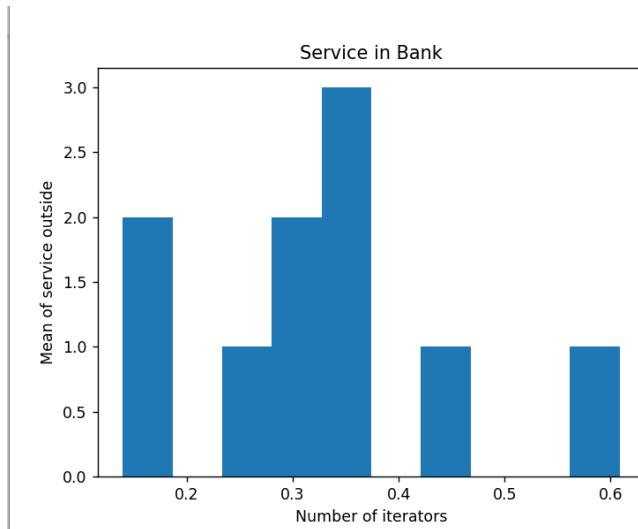
Service time is random because people take different time to complete their activity.
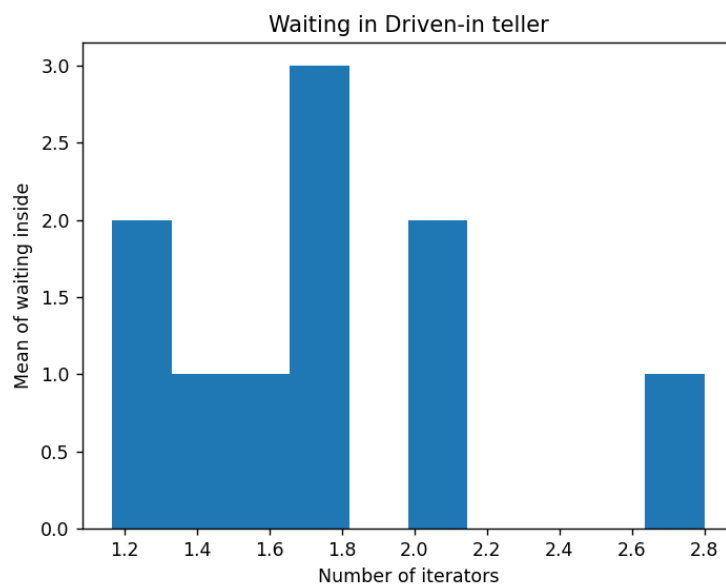
Results Analysis

- The theoretical average service time = 2.1 and the experimental = 1.9
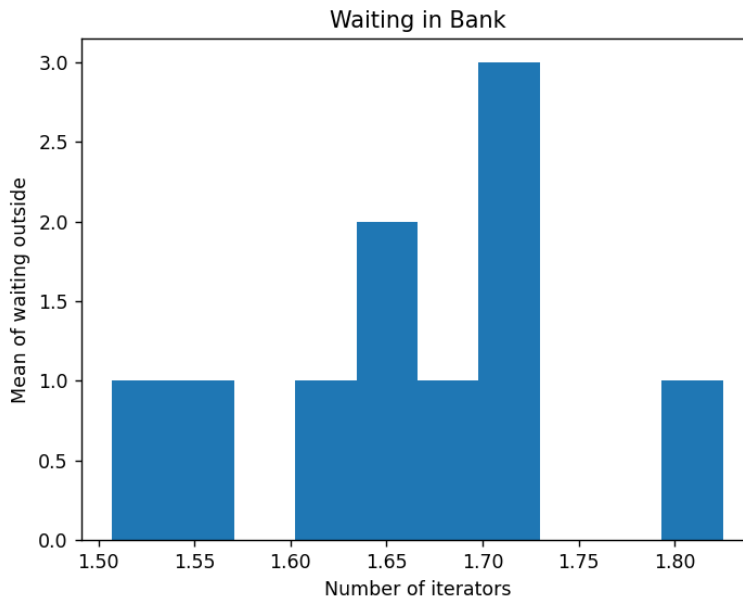
   The two results aren't the same but close.

Service in Bank

- The theoretical average waiting time in drive-in teller = 0.4 and the experimental one = 1.8
- The theoretical average waiting time inside bank teller = 0 and the experimental one = 1.6

Waiting in Driven-in teller

Waiting in Bank

- The theoretical maximum inside bank teller length = 0 and the experimental one = 1
- The theoretical probability that a customer waits inside bank teller = 0 and the experimental one = 0.018
- The theoretical portion of idle time of the inside bank teller = 28 and the experimental one = 1027
- The average inter-arrival time of the inter-arrival time distribution match with the experimental one because they follow the same table.
- If the drive-in teller queue can accommodate for two cars instead of one car in theoretical it's effect won't be significant but in the experimental one the average waiting time inside the bank will decrease almost nonexistent but the average waiting time in drive-in teller will increase.

Conclusion

In the simulation model we will find the experimental is with more accuracy than the theoretical because we trace with large number but in theoretical, we trace with small number so the result of experimental is the best one.