Faculty of Computers and Artificial Intelligence – Cairo University

Problem I [Bank Multi-Channel Queue]

Part 1

- **Problem formulation & Objective**
  - Bank has two types of customers (ordinary – distinguished), each type has one queue
  - If a distinguished customer came before ordinary customer or when ordinary customer waiting, the teller would serve him first. It means that the distinguished customer has a higher priority to be served.
  - If distinguished customer came when one process still running, he couldn't interrupt it.

  - **Our objective function** for this problem is to answer the following questions:
    1. The average service time of the teller.
    2. The average waiting time in the ordinary customers queue and the distinguished customers' queue.
    3. The maximum ordinary customers queue length and the distinguished customers queue length.
    4. The probability that an ordinary customer waits in the queue, and the probability that a distinguished customer waits in the queue.
    5. The portion of idle time of the teller.

    6. 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?

Part 2

- **System Components.**
  - Entity: Customers (Ordinary & distinguished)
  - Attribute: Type – Account - Balance
  - Activity: Making deposits
  - State: Number of customers (Ordinary & distinguished)
  - Event: Arrival, departure of customers.

- **System analysis including cumulative distribution tables, calendar table.**

For ordinary Customers

IAT	Com IAT	Random digit
0	0.09	1-9
1	0.26	10-26
2	0.53	27-53
3	0.73	54-73
4	0.88	74-88
5	1	89-00

ST	Com ST	Random digit
1	0.2	1-20
2	0.6	21-60
3	0.88	61-88
4	1	89-00

For Distinguished Customers

IAT	Com IAT	Random digit
1	0.1	1-10
2	0.3	11-30
3	0.6	31-60
4	1	61-00

ST	Com ST	Random digit
1	0.10	1-10
2	0.4	11-40
3	0.78	41-78
4	1	79-00

Random table for ordinary Customers

#	Random digit	IAT	AT	Random digit for ST	ST
1				5	1
2	55	3	3	18	1
3	73	3	6	94	4
4	25	1	7	93	4
5	77	4	11	66	3
6	90	5	16	25	2
7	13	1	17	77	3
8	5	0	17	65	3
9	80	4	21	9	1
10	83	2	23	28	2

Random table for distinguished Customer

#	Random digit	IAT	AT	Random digit for ST	ST
1				40	2
2	70	4	4	17	2
3	13	2	6	55	3
4	55	3	9	9	1
5	3	1	10	16	2
6	33	3	13	49	3
7	90	4	17	70	3
8	9	1	18	85	4
9	40	3	21	90	4
10	10	1	22	11	2

Calendar Table

#	Type	IAT	AT	ST	SST	WT	CT	TIS	Idle
1	D	0	0	2	0	0	2	2	0
2	O	0	0	1	2	2	3	3	0
3	O	3	3	1	3	0	4	1	0
4	D	4	4	2	4	0	6	2	0
5	D	2	6	3	6	0	9	3	0
6	D	3	9	1	9	0	10	1	0
7	D	1	10	2	10	0	12	2	0
8	O	3	6	4	12	6	16	10	0
9	D	3	13	3	16	3	19	6	0
10	D	4	17	3	19	2	22	5	0

If arrival time for Distinguished customer (less than the completion time for previous one or equal) **or** (less than or equal the arrival time for the next ordinary customer)

Part 3

- Experimental Design Parameters: parameters that affects results of the output of our program.
  - Inter arrival time
  - Arrival time
  - Service
  - Waiting time
  - Completion time
- **Justification of experiment parameters values**
  When we run 1 trail for 1000 customers using one teller, we find that:
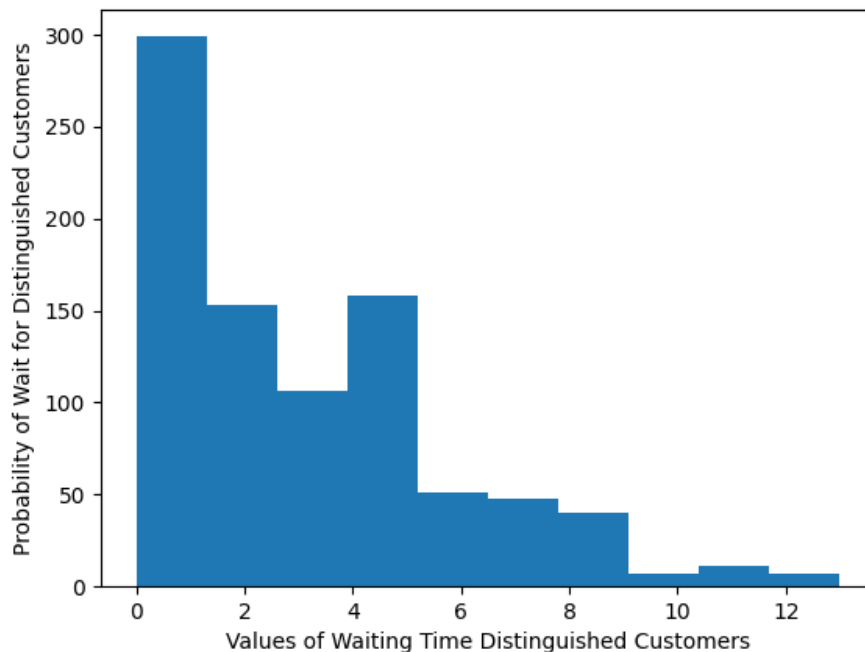 1. The average service time is 2.669
  2. The average waiting time for ordinary customers is 1235.0166666666667 & the average waiting time for distinguished customers is 3.1159090909090907
  3. Max Queue Length, for ordinary customers= 120   and for distinguished customers= 880
  4. Probability of wait for ordinary customers = 1.0 & probability of wait for distinguished customers = 0.835
  5. Portion Of Idle Time= 0.0074878322725557095 & Probability of Idle= 0.001

Results Analysis: Using graphs & discussions

- **Blot for average waiting time for ordinary customers**
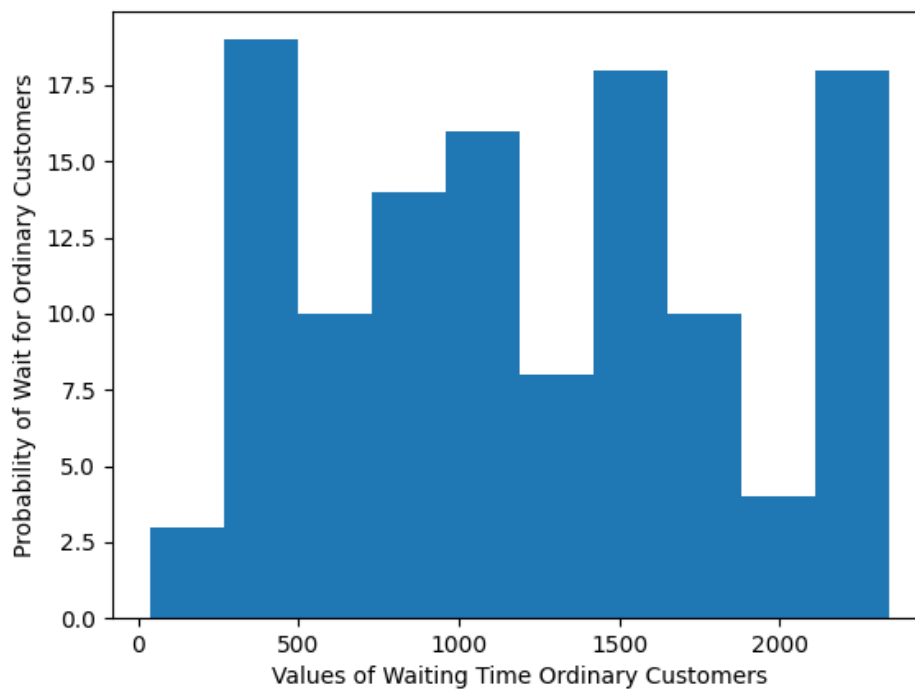
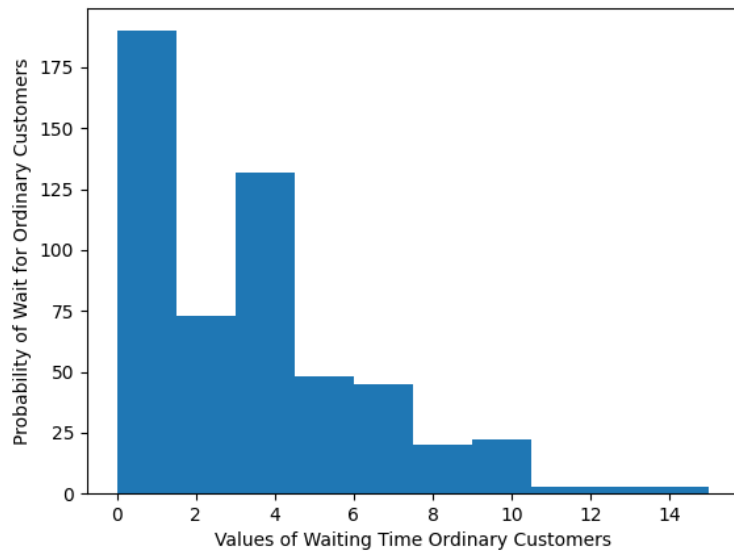- **Blot for average waiting time for distinguished customers**

- **Conclusion**

With more trials of runs and increasing number of customers by using **one teller**, this covers the greatest number of probabilities of our experiment to be near to the real-life values but using **two tellers** each one for each type of customers affects the results of the problem by decreasing the average waiting time for the tow type of customers and allowing to serve more ordinary customers.

Here are the results of using two tellers:

1. Average Service Time= 2.5
2. For ordinary customers, average waiting time= 3.0871985157699444 and for distinguished customers, average waiting time= 3.378260869565217
3. Max queue length, for ordinary customers (539) and for distinguished customers (461)
4. Probability of wait for ordinary customers = 0.7421150278293135and probability of wait for distinguished customers = 0.6746203904555315
5. Portion Of Idle Time= 0.823404255319149
6. Probability of Idle= 0.273

- **Blot for average waiting time for ordinary customers**

- **Blot for average waiting time for distinguished customers**