Part 1

- Problem:
  The problem here for that project it's for determining the average waiting time before and after adding additional teller to serve the distinguished customers only to make all customers satisfied.

- objective:
  Determining if the bank should add additional teller to serve the distinguished customers only or leave everything as it is.

Part 2

- System Components

System	Entity	Attributes	Activities	Events	States
Banking	customers	-Customer type. -Customer's arrival time. -Customer's service start time. -Customer's completion time.	Waiting time.	-Inter-arrival time. -Service time.	-teller idle. -teller busy. -no.of customers in the ordinary queue. -no.of customers in the distinguished queue.

- System analysis

Ordinary Customer

Time between Arrivals (Minutes)	Probabilities	Cumulative Probabilities	Service Time (Minutes)	Probabilities	Cumulative Probabilities
0	**0.09**	**0.09**	**1**	**0.20**	**0.2**
1	**0.17**	**0.26**	**2**	**0.40**	**0.6**
2	**0.27**	**0.53**	**3**	**0.28**	**0.88**

3	0.20	0.73	4	0.12	1
4	0.15	0.88			
5	0.12	1			

theoretical AVG IAT = 2.5
theoretical AVG ST = 2.5

Distinguished Customer

Time between Arrivals (Minutes)	Probabilities	Cumulative Probabilities	Service Time (Minutes)	Probabilities	Cumulative Probabilities
1	0.1	0.1	1	0.10	0.1
2	0.2	0.3	2	0.30	0.4
3	0.3	0.6	3	0.38	0.78
4	0.4	1	4	0.22	1

theoretical AVG IAT = 2.5
theoretical AVG ST = 2.5

Ordinary Customer	Distinguished Customer

IAT	AT	ST	SST	WT	CT	TIS	IAT	AT	ST	SST	WT	CT	TIS
1	1	2	4	3	6	5	1	1	3	1	0	4	3
5	6	2	31	25	33	27	4	5	3	6	1	9	4
4	10	2	33	23	35	25	1	6	3	9	3	12	6
5	15	3	35	20	38	23	2	8	2	12	4	14	6
4	19	2	38	19	40	21	3	11	2	14	3	16	5
5	24	2	40	16	42	18	4	15	4	16	1	20	5
3	27	3	42	15	45	18	3	18	3	20	2	23	5

4	**31**	**1**	**45**	**14**	**46**	**15**	**2**	**20**	**4**	**23**	**3**	**27**	**7**
1	**32**	**3**	**46**	**14**	**49**	**17**	**2**	**22**	**1**	**27**	**5**	**28**	**6**
2	**34**	**2**	**49**	**15**	**51**	**17**	**4**	**26**	**3**	**28**	**2**	**31**	**5**

Part 3

- Experimental Design Parameters : Inter-arrival time \ Service time
- Justification of experiment parameters values :
    1. Ordinary customer inter-arrival time range [0,1,2,3,4,5] follows cumulative distribution.
    2. Distinguished customer inter-arrival time range [1,2,3,4] follows cumulative distribution.
    3. Ordinary customer service time range [1,2,3,4] follows cumulative distribution.
    4. Distinguished customer service time range [1,2,3,4]follows cumulative distribution.

Part 4

- Results Analysis:

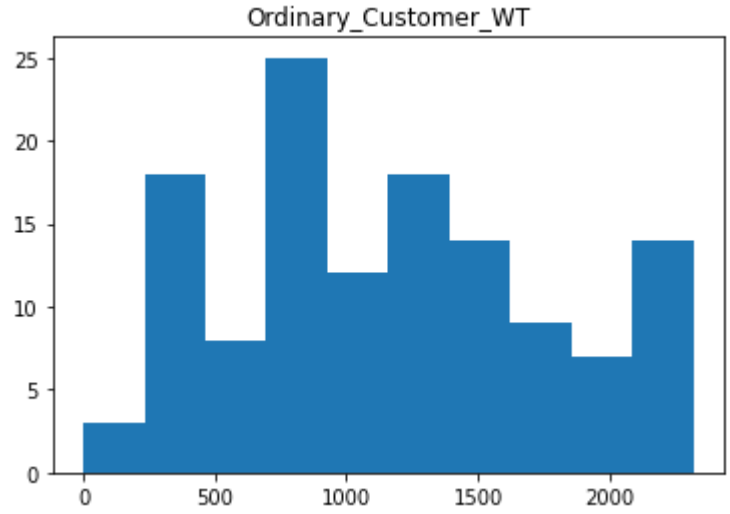
  The system runed for 1000 times and I got these results:

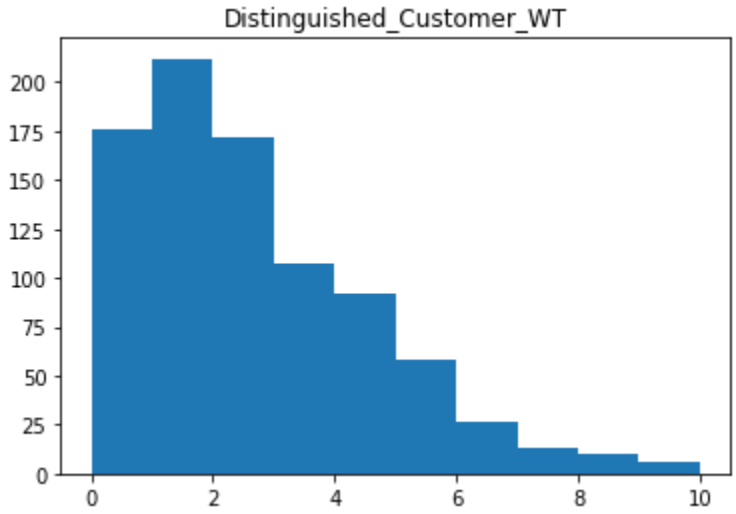
  ☐ One teller for both types of customers

    1. The average service time of the teller :**2.636**
    2. average waiting time in the ordinary customers queue: **1157.22**
    3. average waiting time in the distinguished customers queue: **2.19**
    4. The maximum ordinary customers queue length:**879**
    5. The maximum distinguished customers queue length:**4**
    6. The probability that an ordinary customer wait in the queue: **0.99**

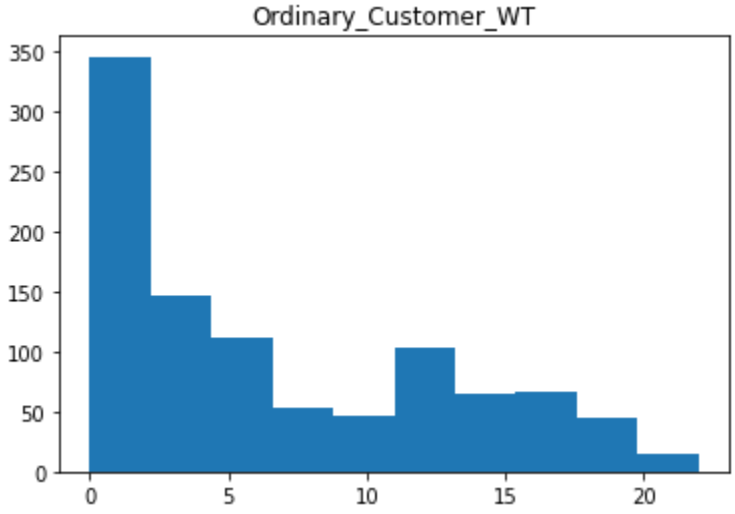
7. The probability that an distinguished customer wait in the queue: **0.79**

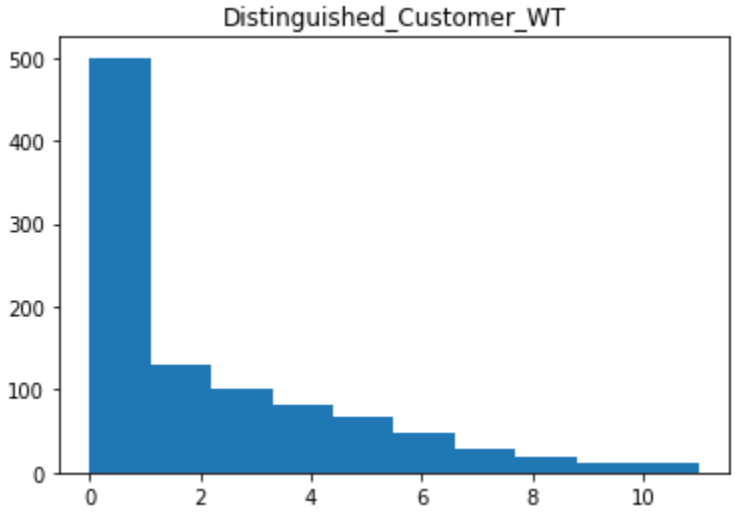
	ordinary customers	distinguished customer
Inter-arrival time	Theoretical average: 2.5 Experimental average: 2.47	Theoretical average: 2.5 Experimental average: 2.47
Service time	Theoretical average: 2.5 Experimental average: 2.63	Theoretical average: 2.5 Experimental average: 2.56





- ☐ Teller for each type of customers
    1. average waiting time in the ordinary customers queue : **6.65**
    2. average waiting time in the distinguished customers queue: **2.24**





- Conclusion : according to the previous results the bank should add additional teller to serve the distinguished customers only.