Cairo University

Faculty of Computers and artificial intelligence

Department: Operations Research and Decision Support

Course Name: Systems Modeling and Simulation

Course Code: DS331 / DS241

Instructor: Assoc. Prof. Ayman Ghoneim

Report Documentation

For Problem I

[Supermarket Multi-Channel Queue]

BY:

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Contents

Problem formulation & Objectives.

Formulation:

A Supermarket has 2 customers express, which represents 60% of the customers, and regular, which represents the other.

The supermarket has 2 cashiers express and regular, the regular customer enters the regular cashier, and the express customer enters the express cashier if the length of the express cashier queue length less 1.5 times than the regular cashier queue length.

Objectives:

-To get the waiting time and service time for each customer and then determine if the 2 cashiers are enough or not.

-To reach the highest level of customers satisfaction.

System Components:

Entity: Customer.
Attributes: Type of customers.
Activity: Service time.
State: Number of waiting customers.
Event: Arrival time, completion time.

System Analysis:

Calendar table:

Customer	Type	IAT	Arrival time	Start Service time	Waiting time	Service Time	Regular	Express
1	Regular	0	0	0	0	5	5	0
2	Express	1	1	5	4	2	7	0
3	Regular	4	5	7	2	5	12	0
4	Express	3	8	8	0	1	12	9
5	Regular	0	8	12	4	5	17	9
6	Express	3	11	11	0	3	17	14
7	Express	1	12	14	2	3	17	17
8	Regular	2	14	17	3	5	22	17
9	Regular	3	17	22	5	7	29	17
10	Regular	1	18	29	11	7	36	17

Cumulative distribution tables:

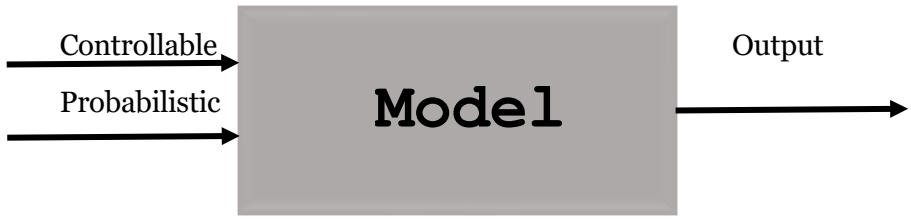
Time between Arrivals (Minutes)	
Cumulative Distribution	Time
0.16	0
0.39	1
0.69	2
0.9	3
1	4

Express Customers Service Time (Minutes)	
Cumulative Distribution	Time
0.3	1

0.7	2
1	3

Regular Customers Service Time (Minutes)	
Cumulative Distribution	Time
0.2	3
0.7	5
1	7

Experimental Design Parameters:



Controllable inputs:

- Number of Customer

Probabilistic inputs:

- Interarrival time.
- Service time for two types of customers.

Justification of experiment parameters values

Controllable inputs:

- Number of Customers = 1000.

Probabilistic inputs:

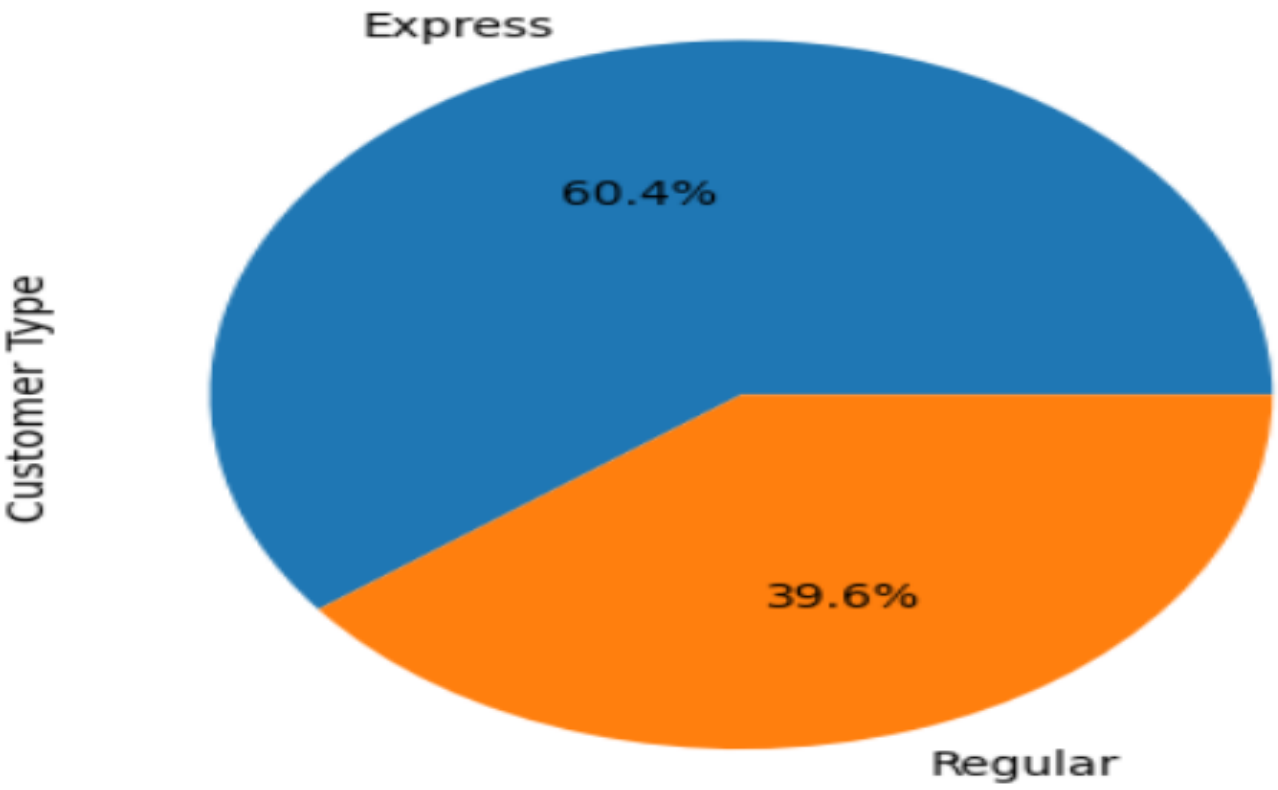
- Inter arrival time generated randomly for each customer.
- Service time for each customer type.

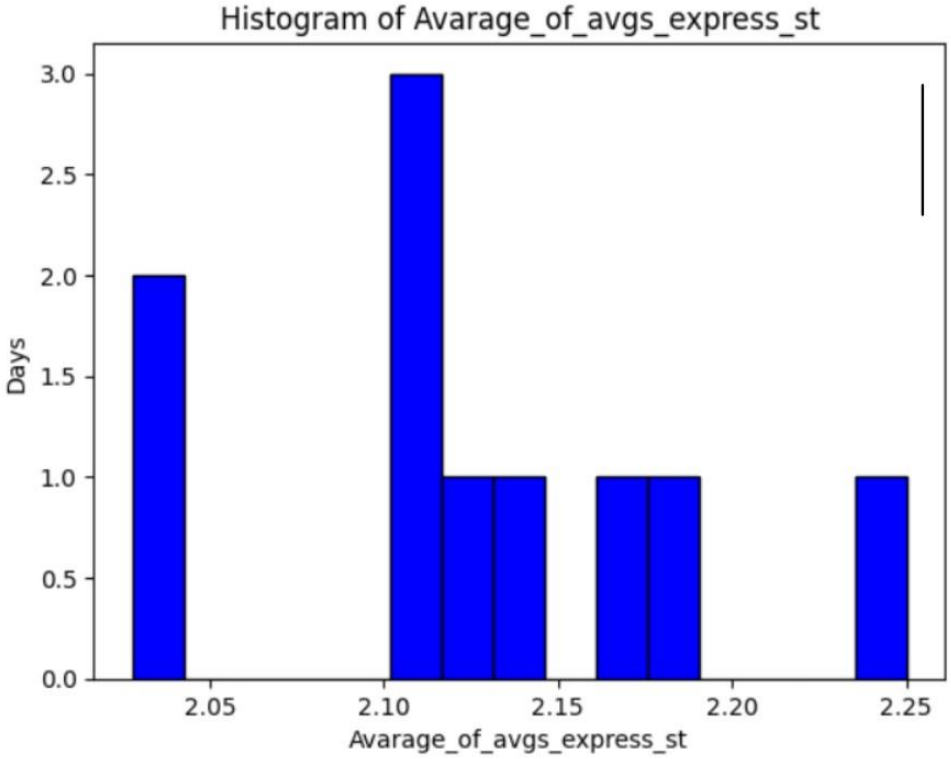
Result analysis:

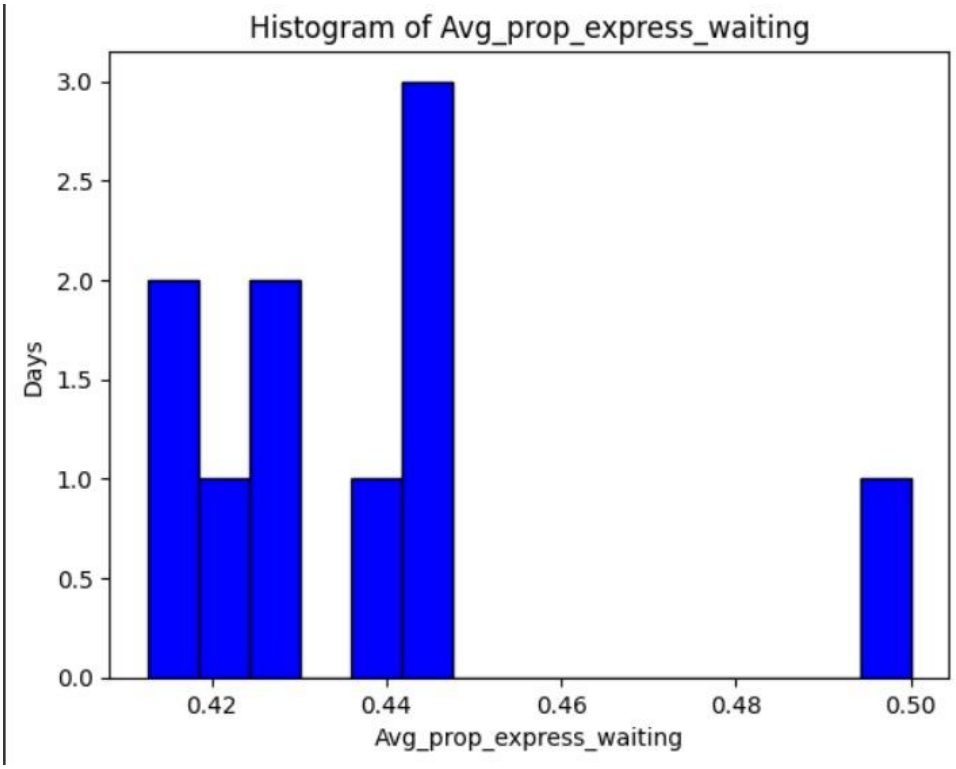
Test case1:

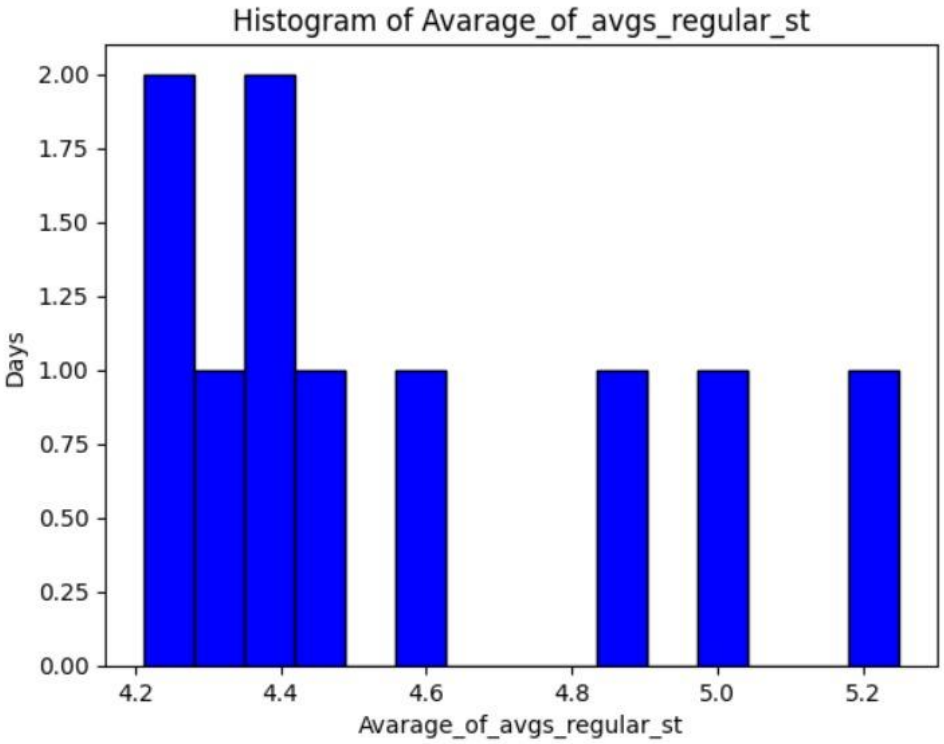
Number of customers small = 20

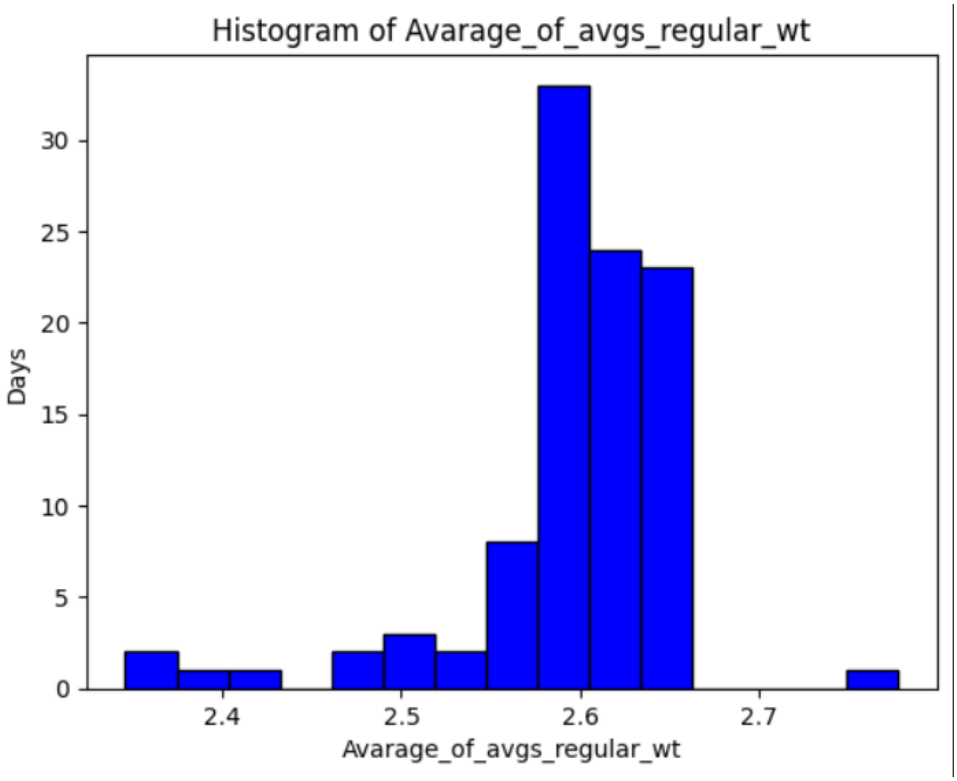
Number of repeating is 100

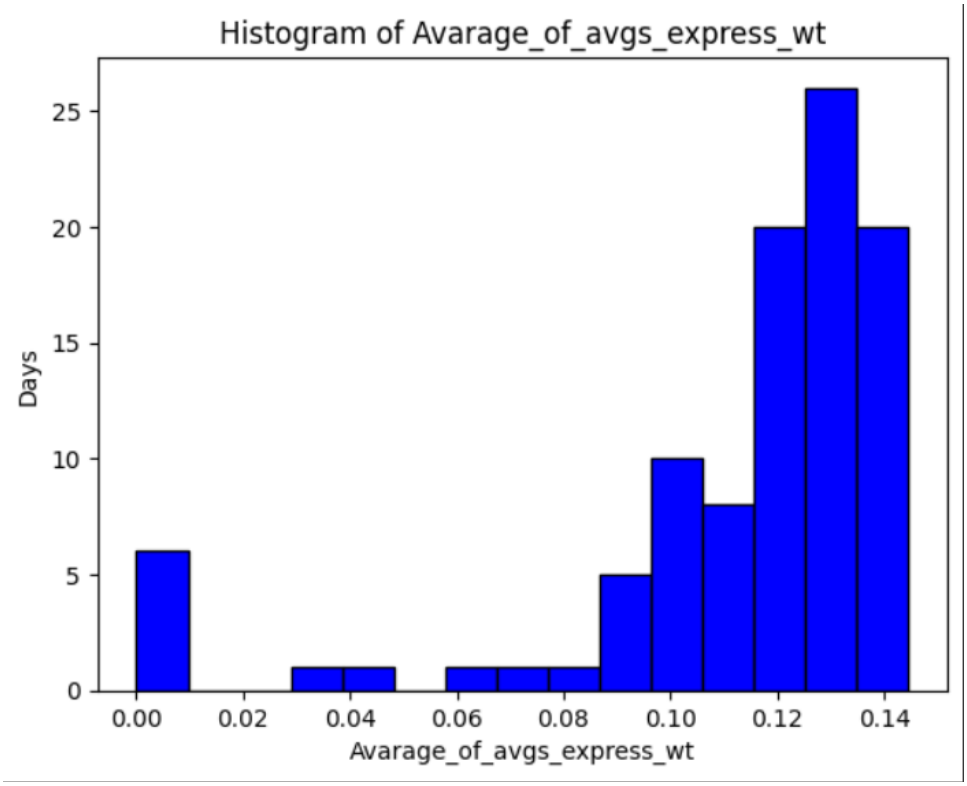


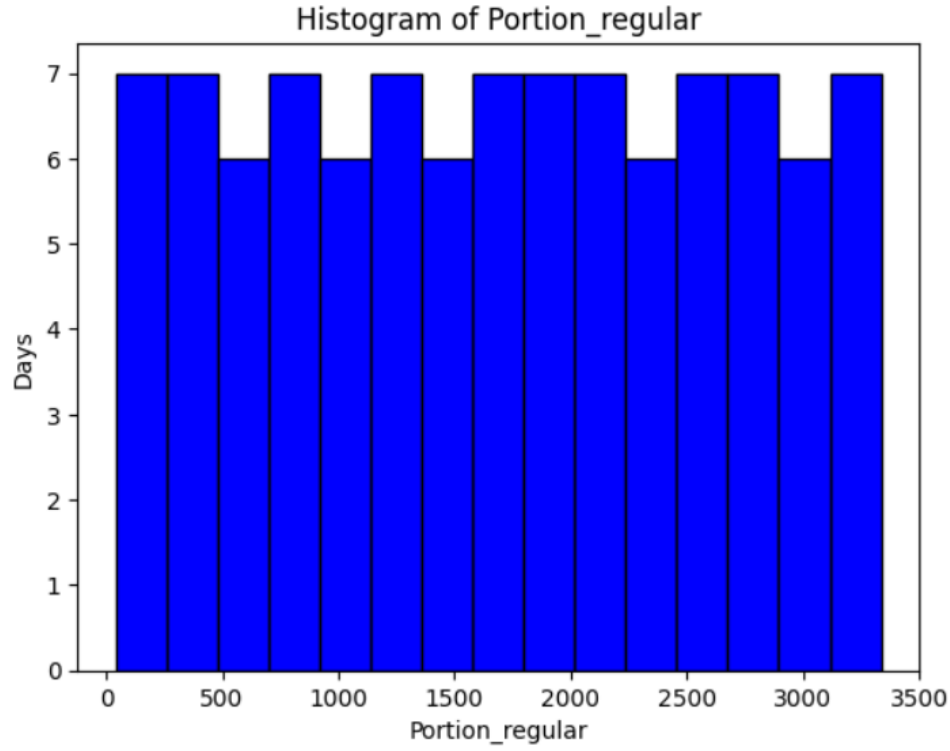

Histogram of Avarage_of_avgs_express_st
Days
Avarage_of_avgs_express_st
0.0
0.5
1.0
1.5
2.0
2.5
3.0
2.05
2.10
2.15
2.20
2.25

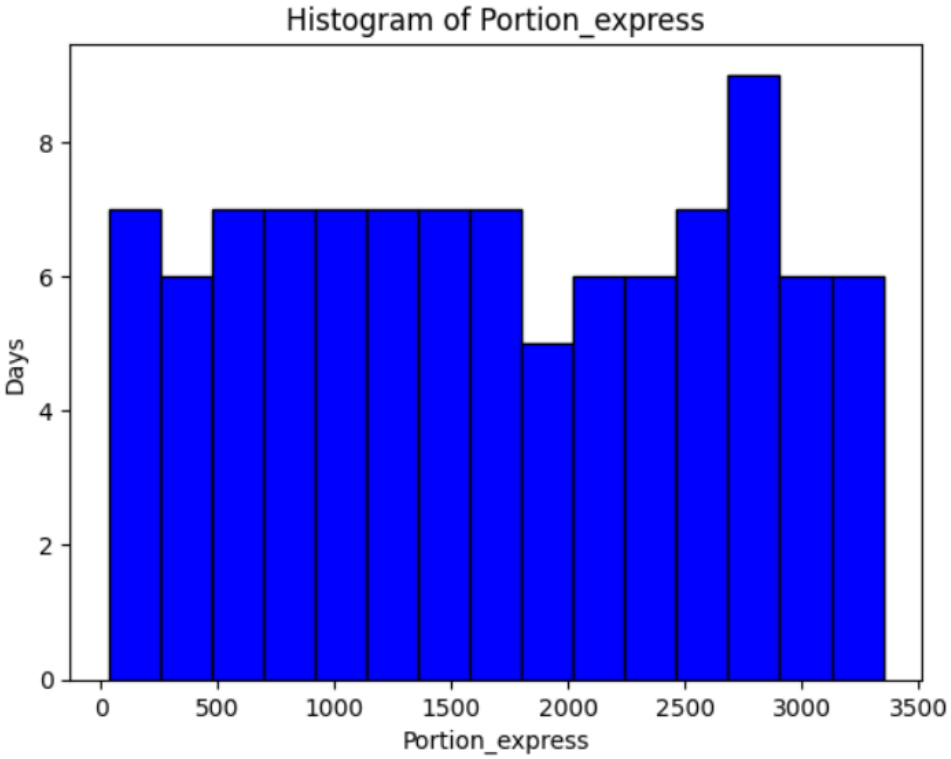

Histogram of Avg_prop_express_waiting
Days
Avg_prop_express_waiting
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0.42
0.44
0.46
0.48
0.50


Histogram of Avarage_of_avgs_regular_st
Days
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
4.2
4.4
4.6
4.8
5.0
5.2
Avarage_of_avgs_regular_st


Histogram of Avarage_of_avgs_regular_wt
Days
30
25
20
15
10
5
0
2.4
2.5
2.6
2.7
Avarage_of_avgs_regular_wt


Histogram of Avarage_of_avgs_express_wt
Days
Avarage_of_avgs_express_wt
0
5
10
15
20
25
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14


Histogram of Portion_regular
Days
Portion_regular
0
1
2
3
4
5
6
7
0
500
1000
1500
2000
2500
3000
3500



Output ‘Average of Average’:

Avarage_of_avgs_regular_stt : 3.789818533361165

Avarage_of_avgs_express_stt : 1.945435357589080 8

Avarage_of_avgs_regular_wtt : 2.5949988513668076

Avarage_of_avgs_express_wtt : 0.1120103990779833 5

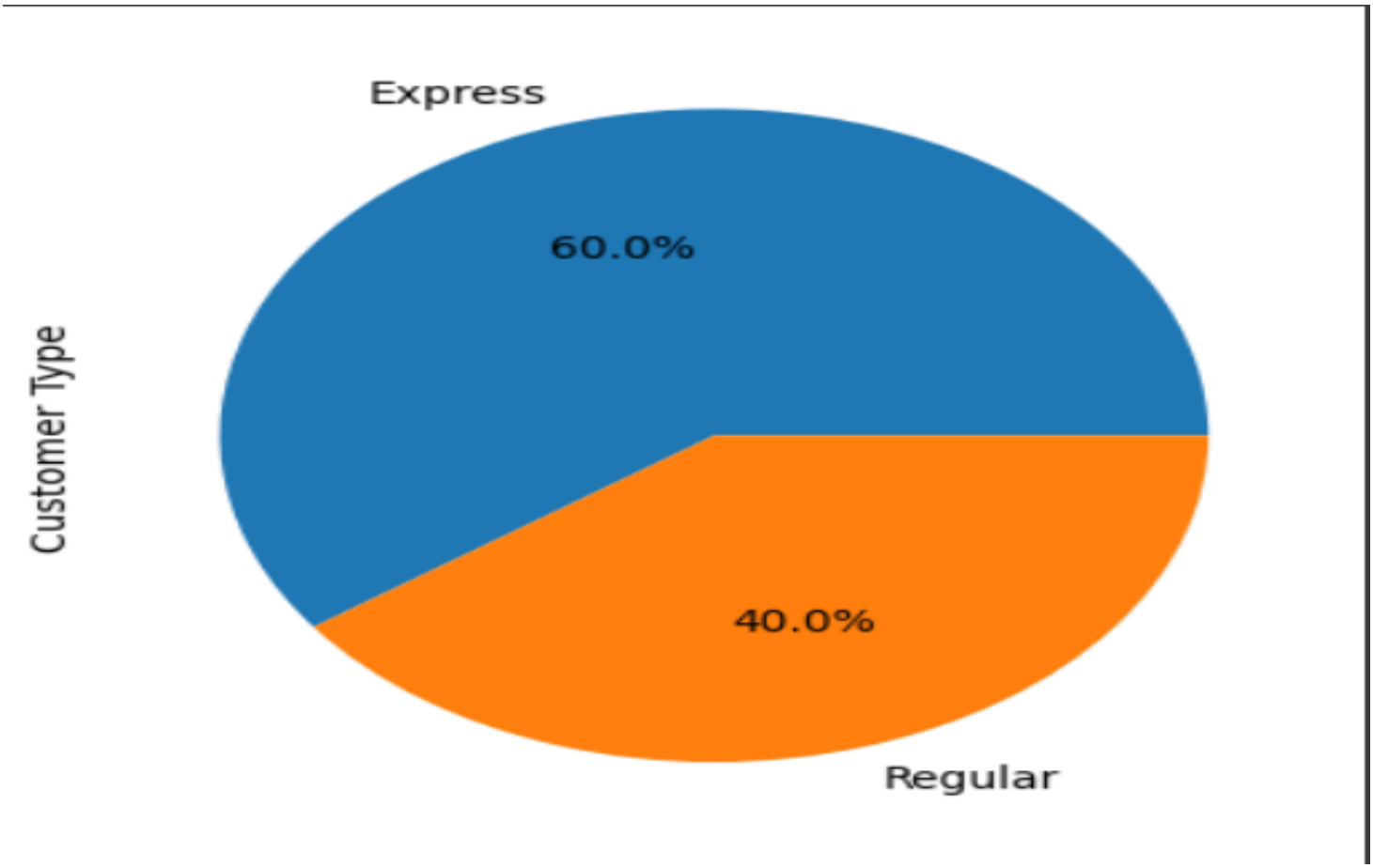
Avarage_of_max_regular_max_length : 3.0

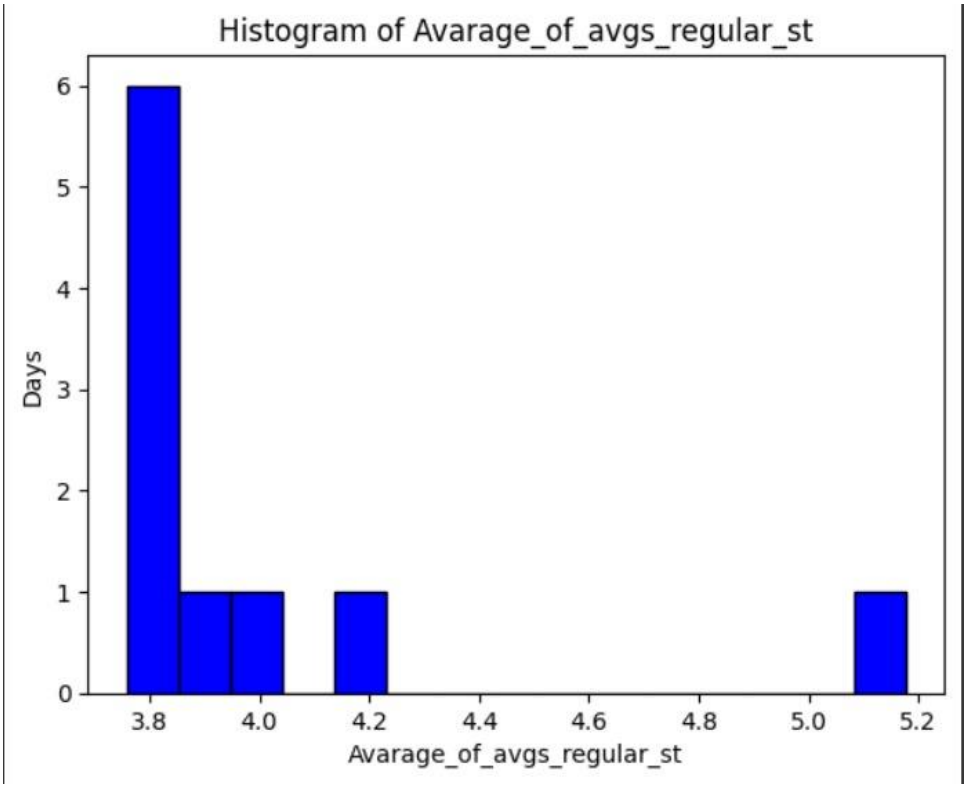
Avarage_of_max_express_max_length : 0.97

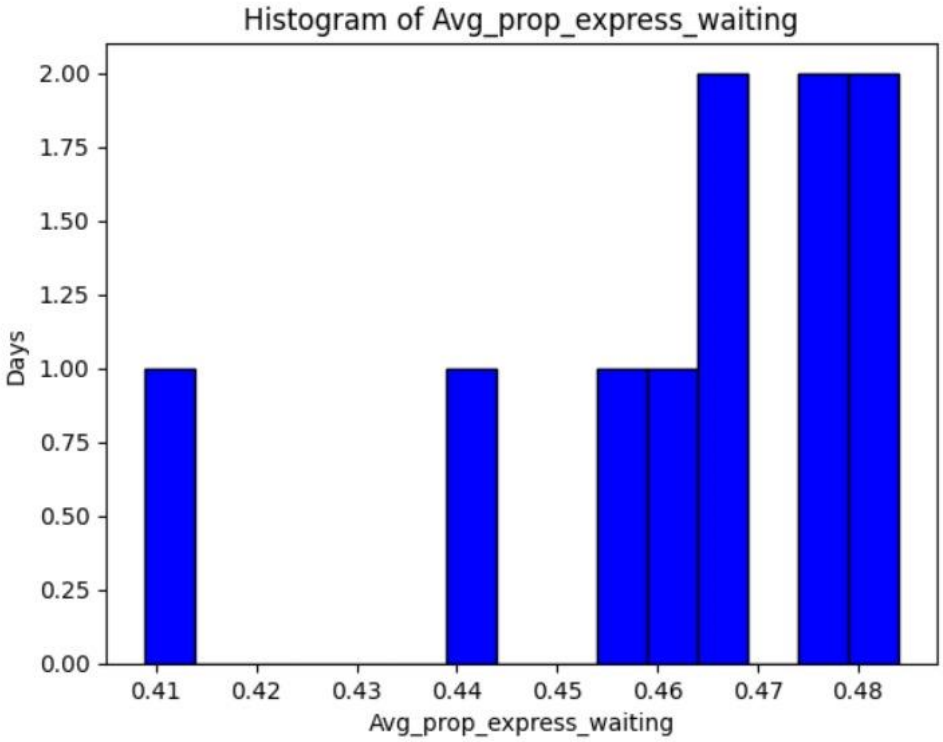
Test case2:

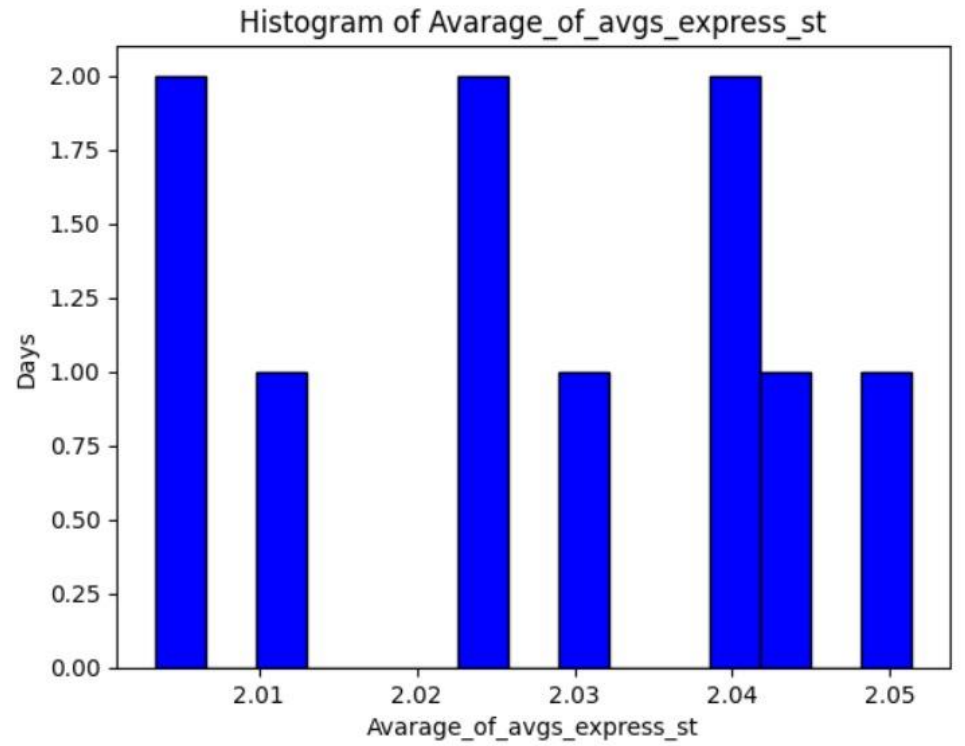
Number of customers medium = 500

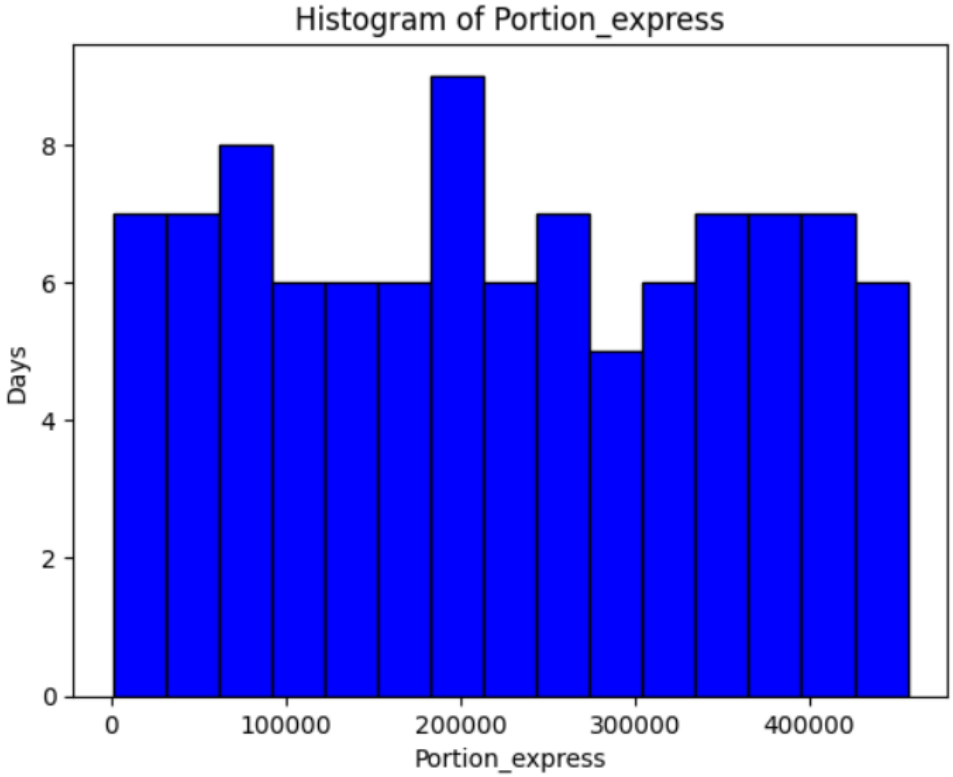
Number of repeating is 100

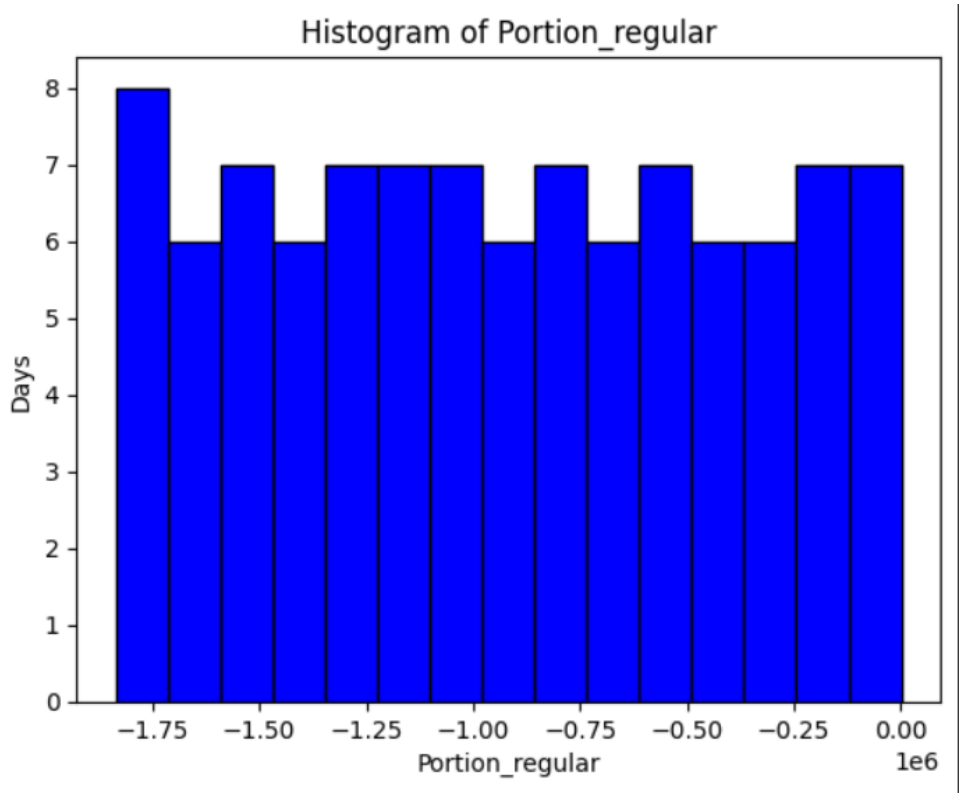


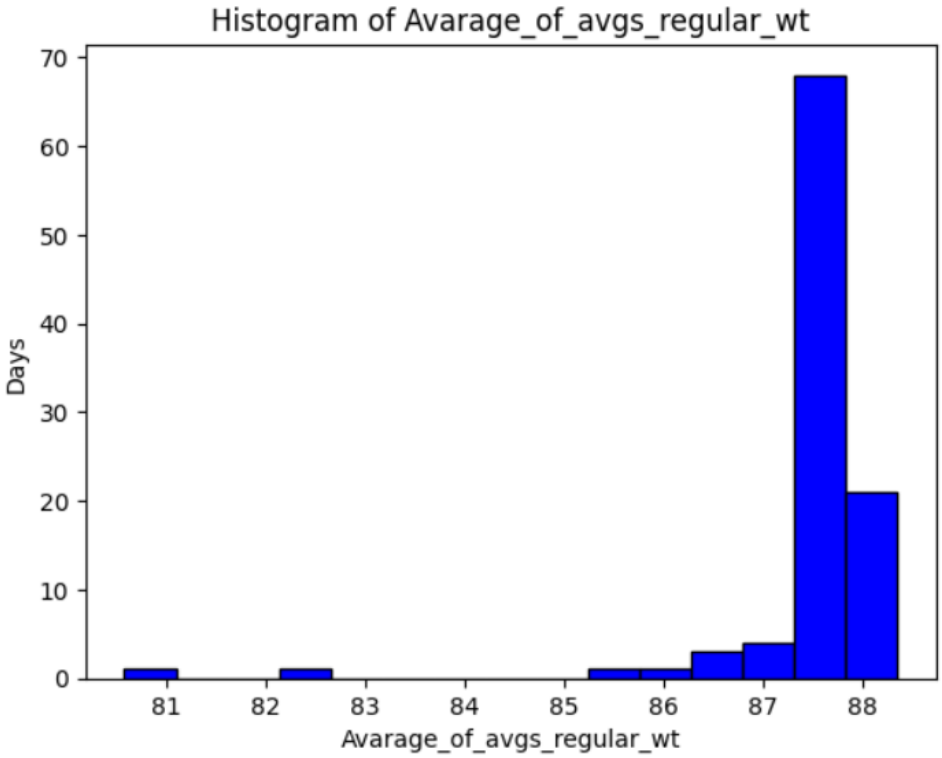

Histogram of Avarage_of_avgs_regular_st
Days
Avarage_of_avgs_regular_st
0
1
2
3
4
5
6
3.8
4.0
4.2
4.4
4.6
4.8
5.0
5.2

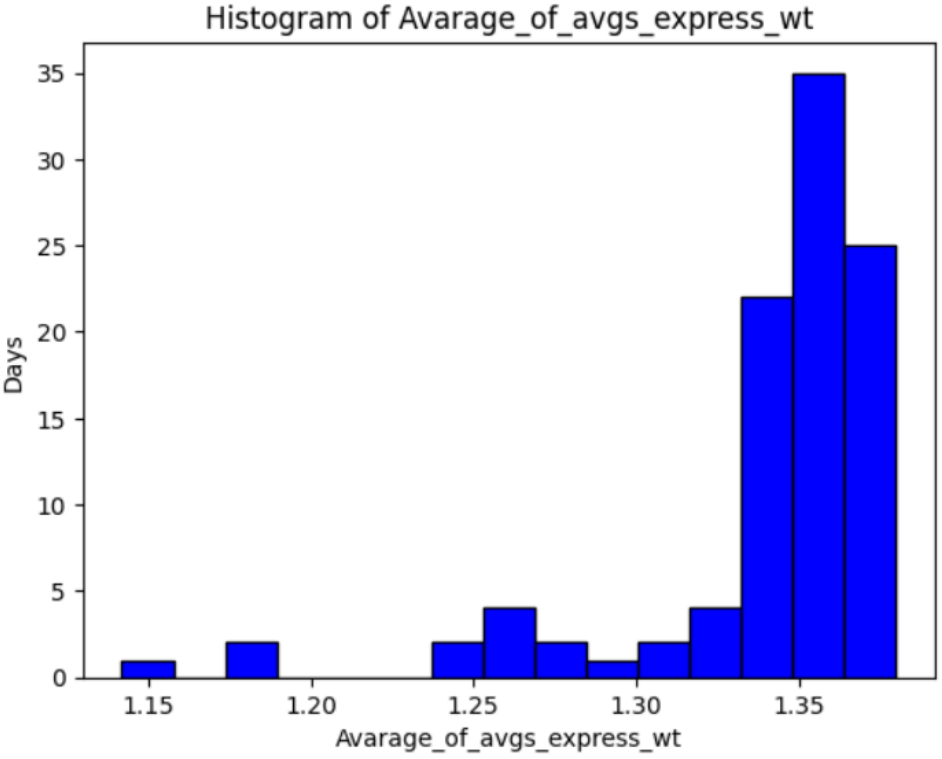

Histogram of Avg_prop_express_waiting
Days
Avg_prop_express_waiting
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
0.41
0.42
0.43
0.44
0.45
0.46
0.47
0.48


Histogram of Avarage_of_avgs_express_st
Days
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
2.01
2.02
2.03
2.04
2.05
Avarage_of_avgs_express_st


Histogram of Portion_express
Days
Portion_express
0
100000
200000
300000
400000
0
2
4
6
8


Histogram of Portion_regular
Days
Portion_regular
1e6
−1.75
−1.50
−1.25
−1.00
−0.75
−0.50
−0.25
0.00
0
1
2
3
4
5
6
7
8


Histogram of Avarage_of_avgs_regular_wt
Days
Avarage_of_avgs_regular_wt
0
10
20
30
40
50
60
70
81
82
83
84
85
86
87
88


Histogram of Avarage_of_avgs_express_wt
Days
Avarage_of_avgs_express_wt
0
5
10
15
20
25
30
35
1.15
1.20
1.25
1.30
1.35

Output ‘Average of Average’:

Avarage_of_avgs_regular_stt : 3.756151292041893 4

Avarage_of_avgs_express_stt : 2.003038463584 35

Avarage_of_avgs_regular_wtt : 87.42558955026234

Avarage_of_avgs_express_wtt : 1.3417074442642076

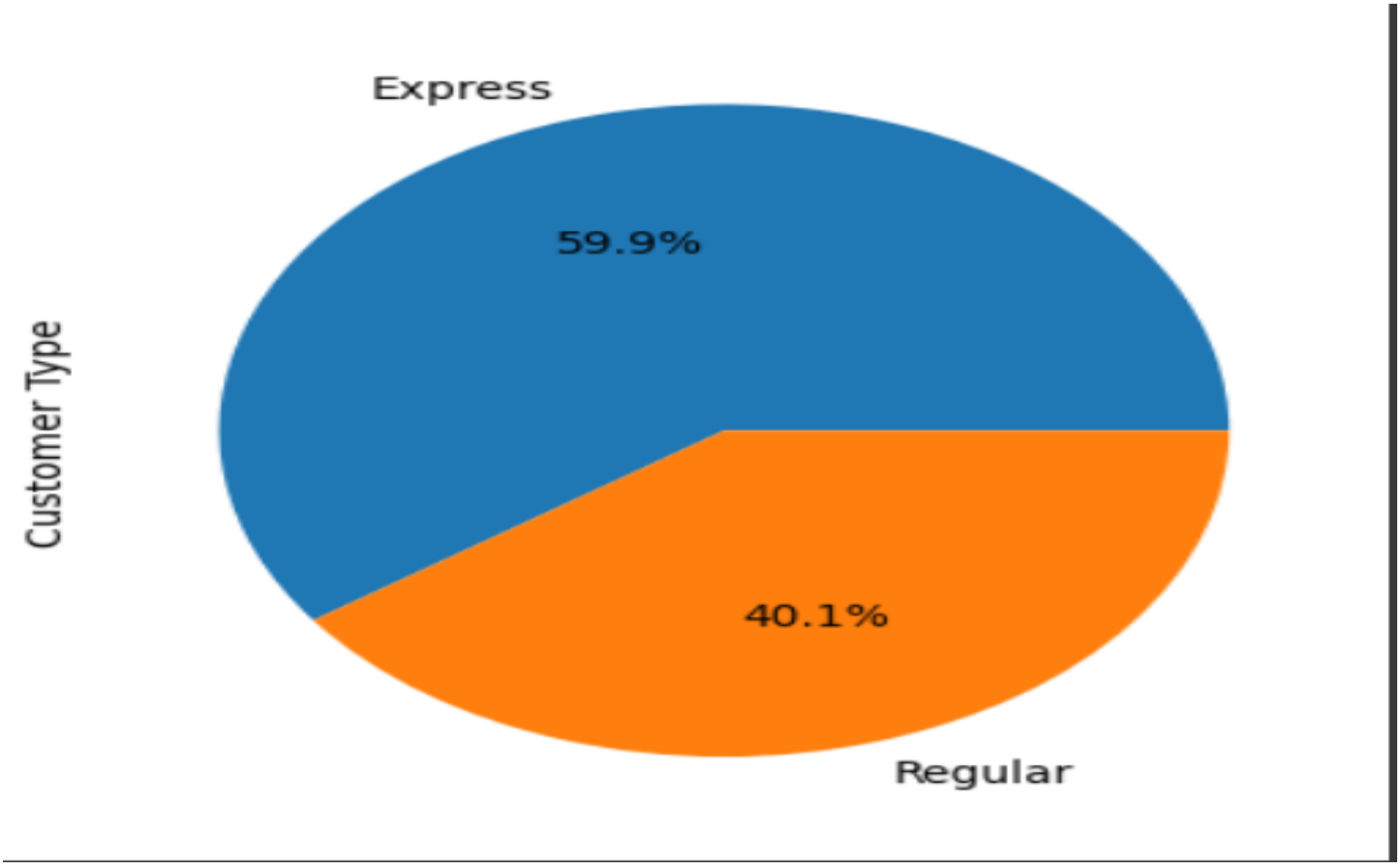
Avarage_of_max_regular_max_length : 20.67

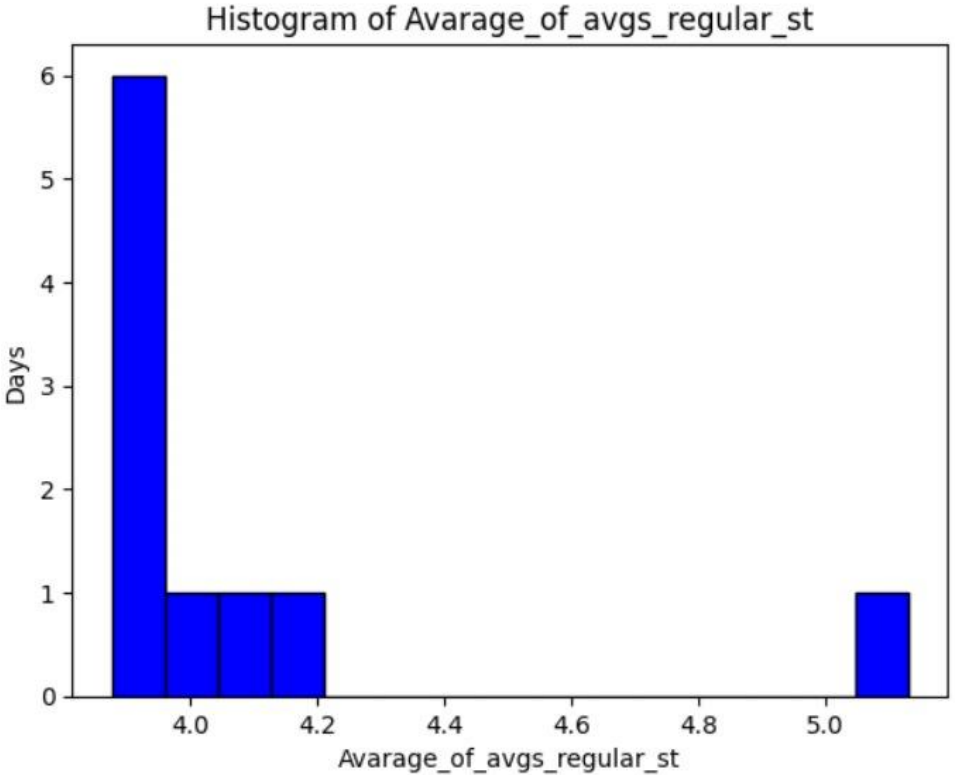
Avarage_of_max_express_max_lengthh : 19.81

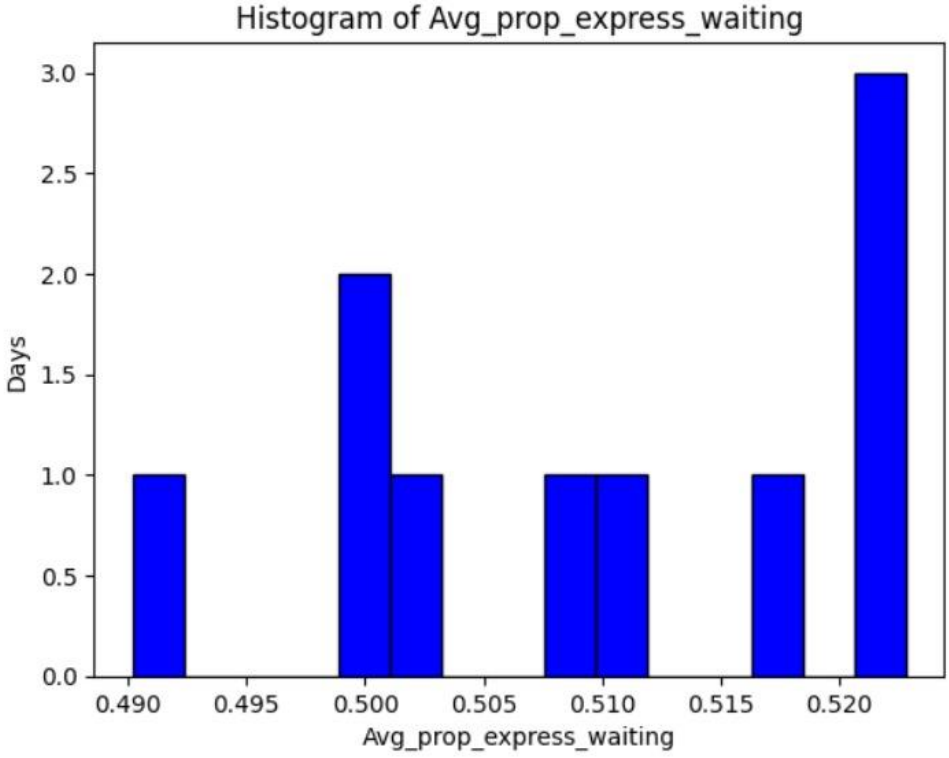
Test case2:

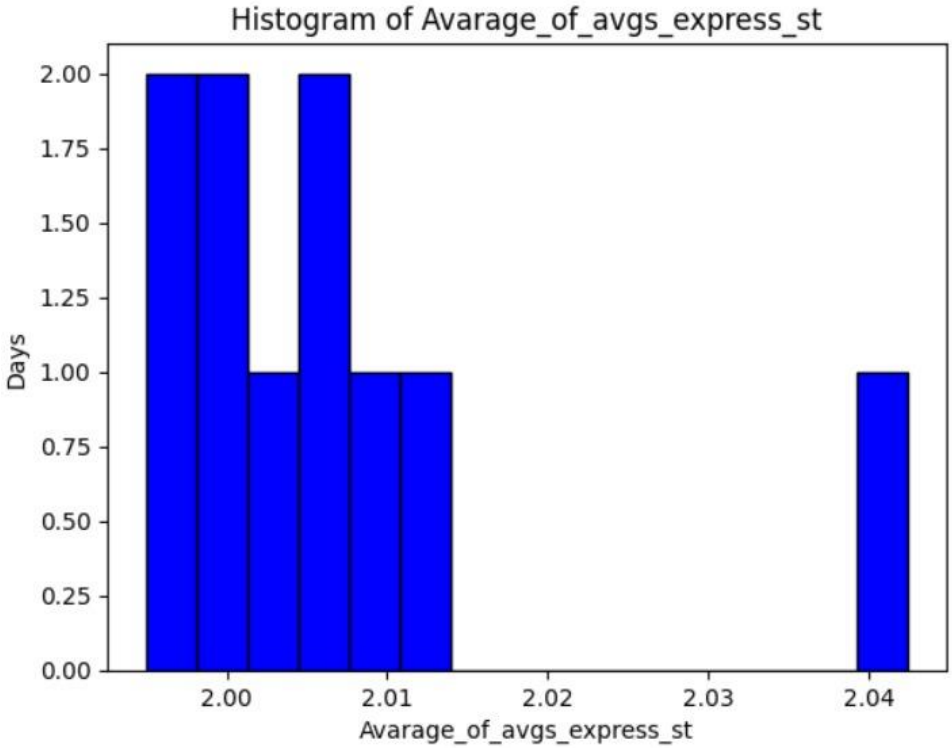
Number of customers large = 1000

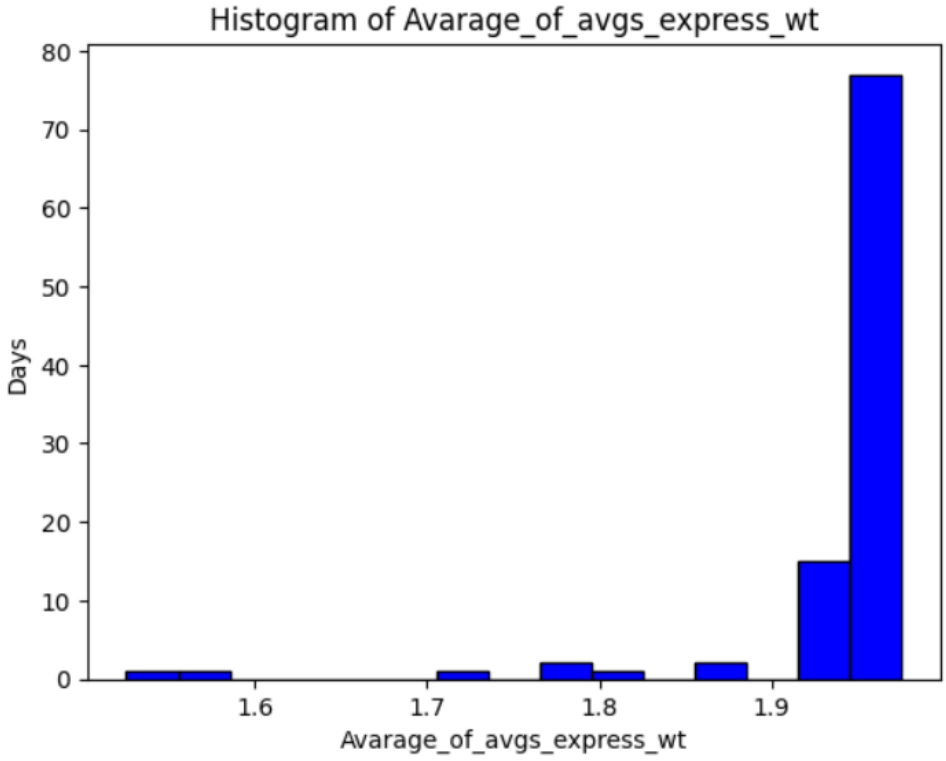
Number of repeating is 100

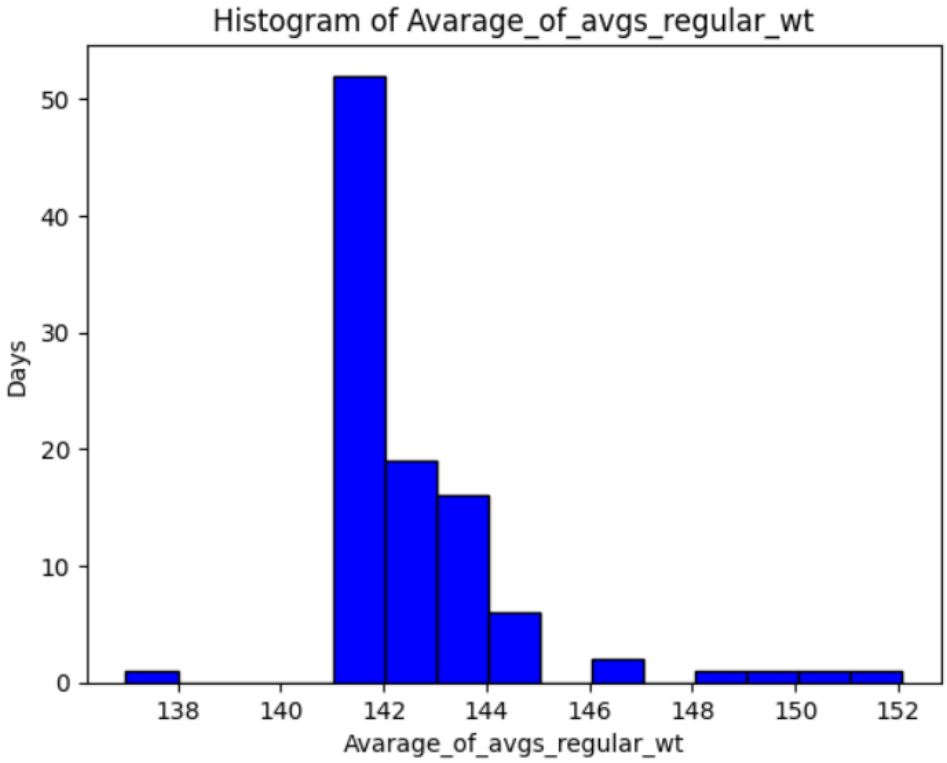


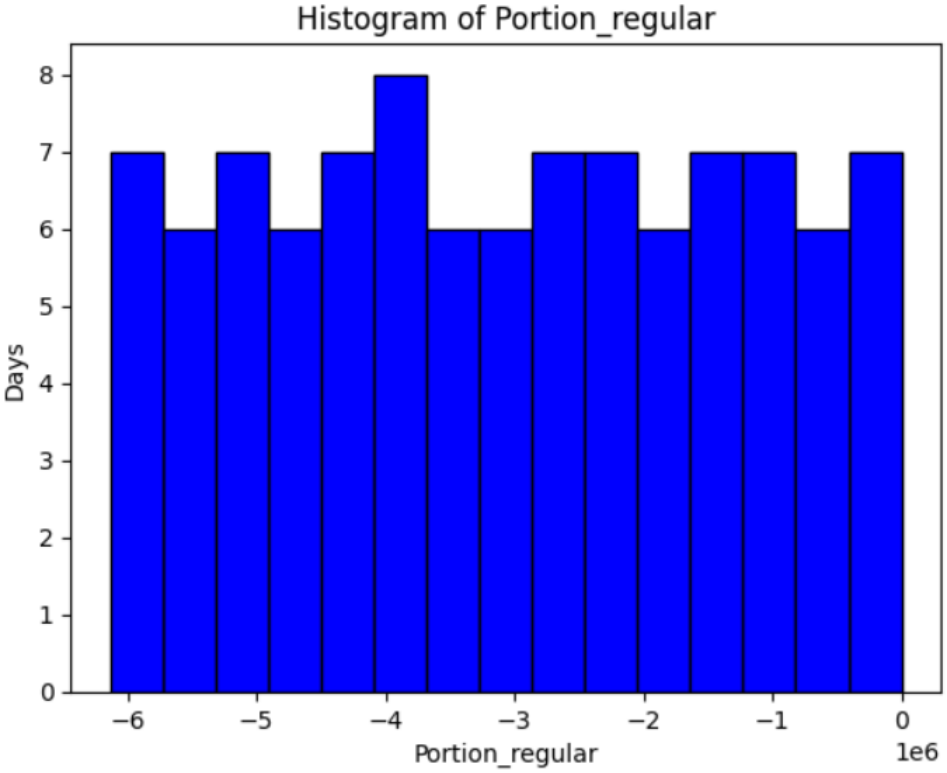

Histogram of Avarage_of_avgs_regular_st
Days
Avarage_of_avgs_regular_st
0
1
2
3
4
5
6
4.0
4.2
4.4
4.6
4.8
5.0

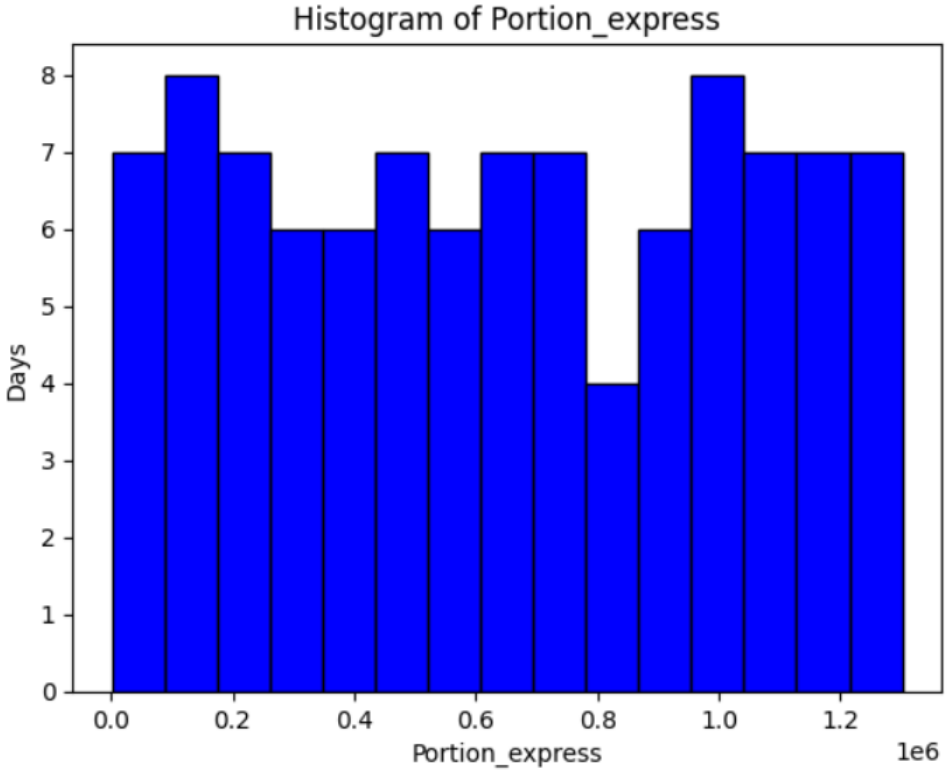

Histogram of Avg_prop_express_waiting
Days
Avg_prop_express_waiting
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0.490
0.495
0.500
0.505
0.510
0.515
0.520


Histogram of Avarage_of_avgs_express_st
Days
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
2.00
2.01
2.02
2.03
2.04
Avarage_of_avgs_express_st


Histogram of Avarage_of_avgs_express_wt
Days
80
70
60
50
40
30
20
10
0
1.6
1.7
1.8
1.9
Avarage_of_avgs_express_wt


Histogram of Avarage_of_avgs_regular_wt
Days
Avarage_of_avgs_regular_wt
0
10
20
30
40
50
138
140
142
144
146
148
150
152


Histogram of Portion_regular
Days
Portion_regular
1e6
0
1
2
3
4
5
6
7
8
−6
−5
−4
−3
−2
−1
0



Output 'Average of Average':

Avarage_of_avgs_regular_stt : 3.7866175576782606

Avarage_of_avgs_express_stt : 1.996928821535997 3

Avarage_of_avgs_regular_wtt : 142.5743068713762

Avarage_of_avgs_express_wtt : 1.9368402055711047

Avarage_of_max_regular_max_length : 31.02

Avarage_of_max_express_max_lengthh : 38.88

Conclusion

The average waiting time for a regular cashier is large and this will lead to ‘Customer dissatisfaction’.

We should minizine the relation between the regular and express cashier for the express customer.

Regarding 60% for express and 40% for regular the waiting time of the regular cashier was large so when we replace the percentages the waiting time will increase more.