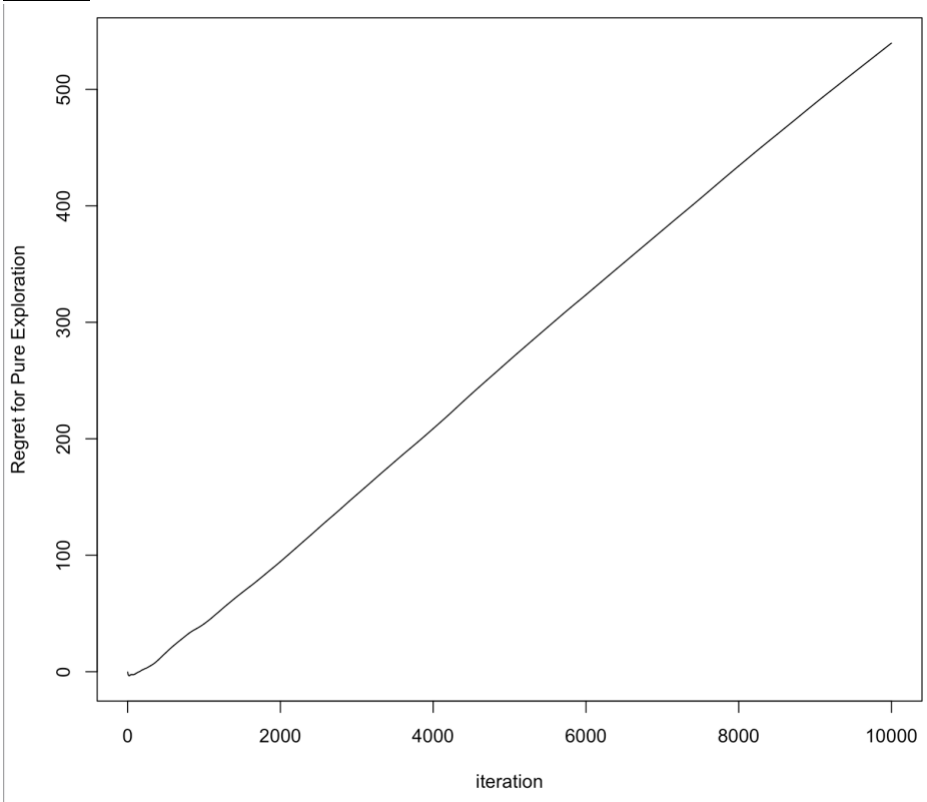
Business Analytics

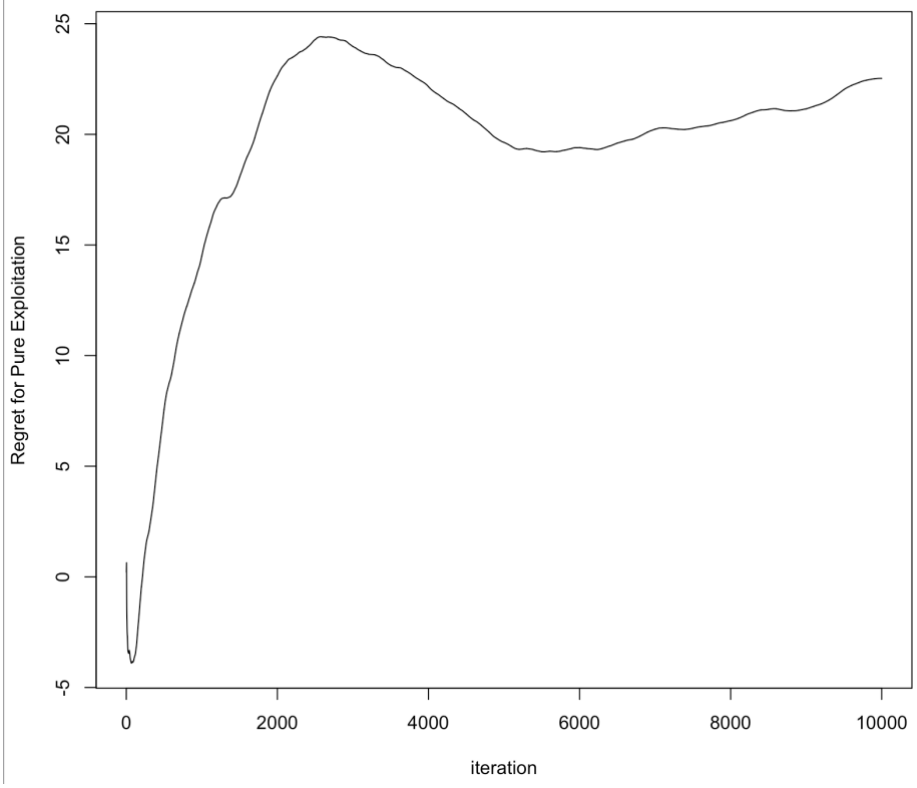
Assignment-5

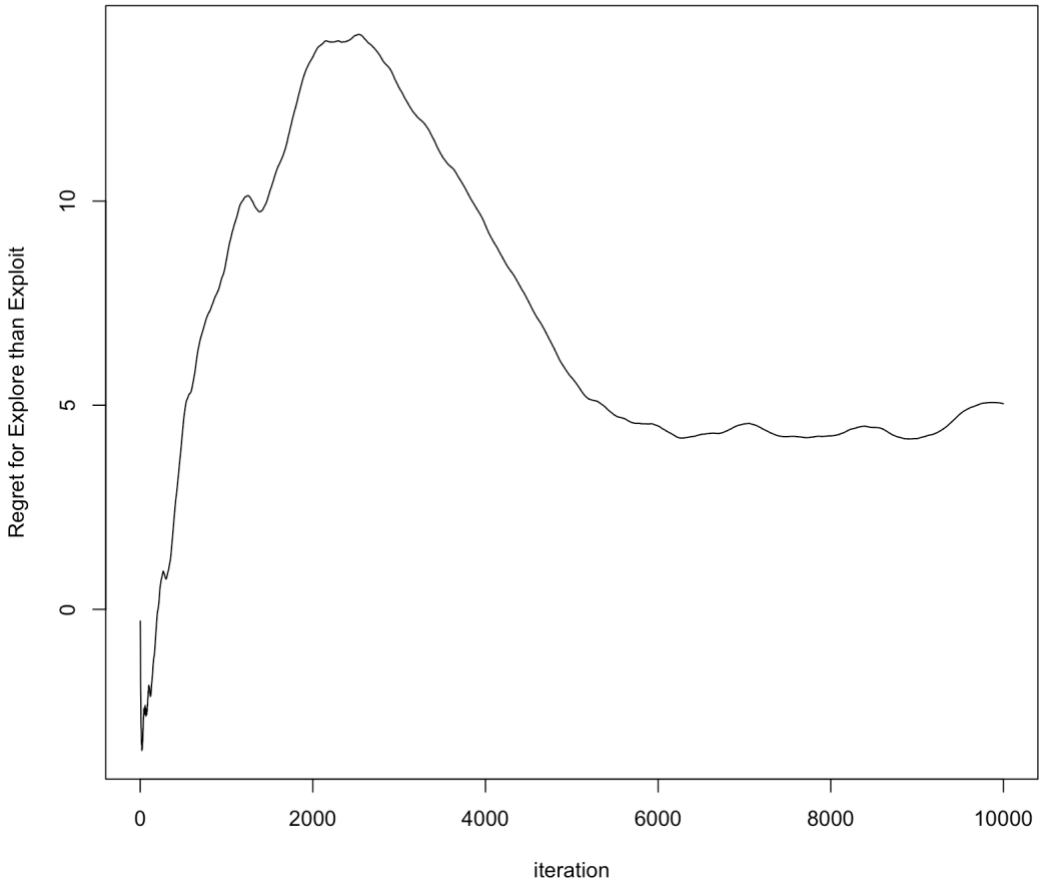
Name-Subham Kedia
UNI-sk4355

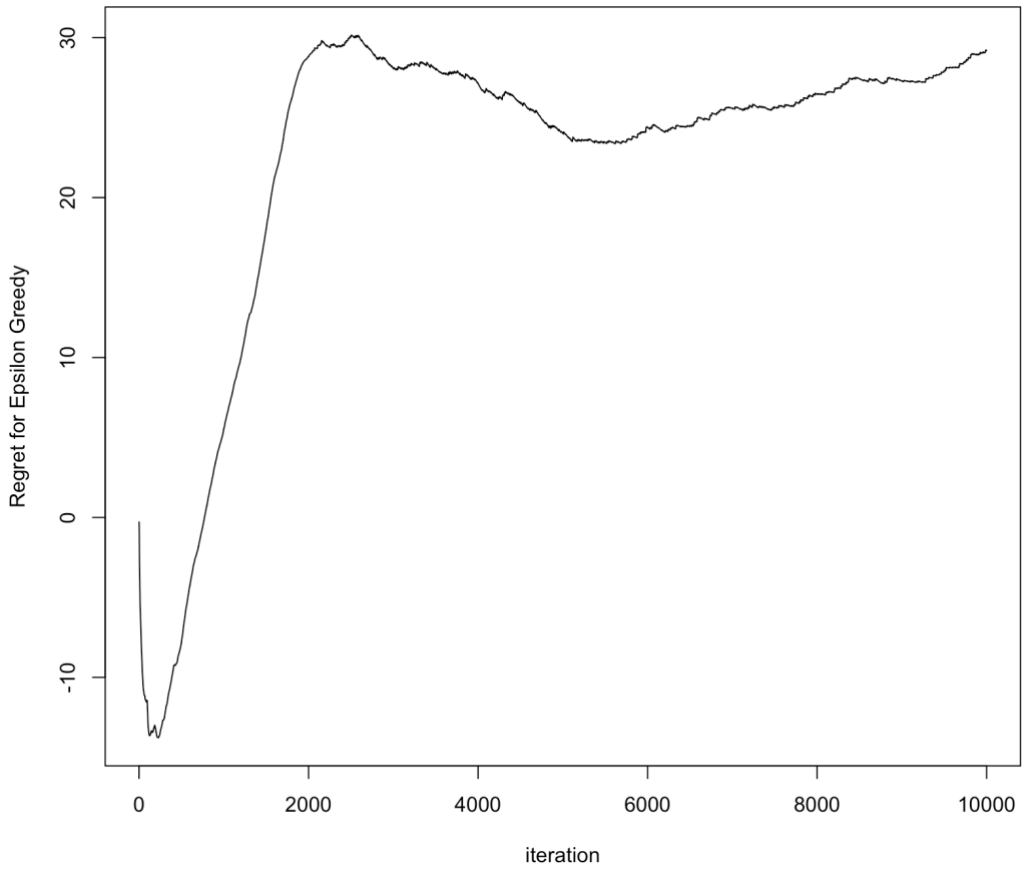
Answer 1

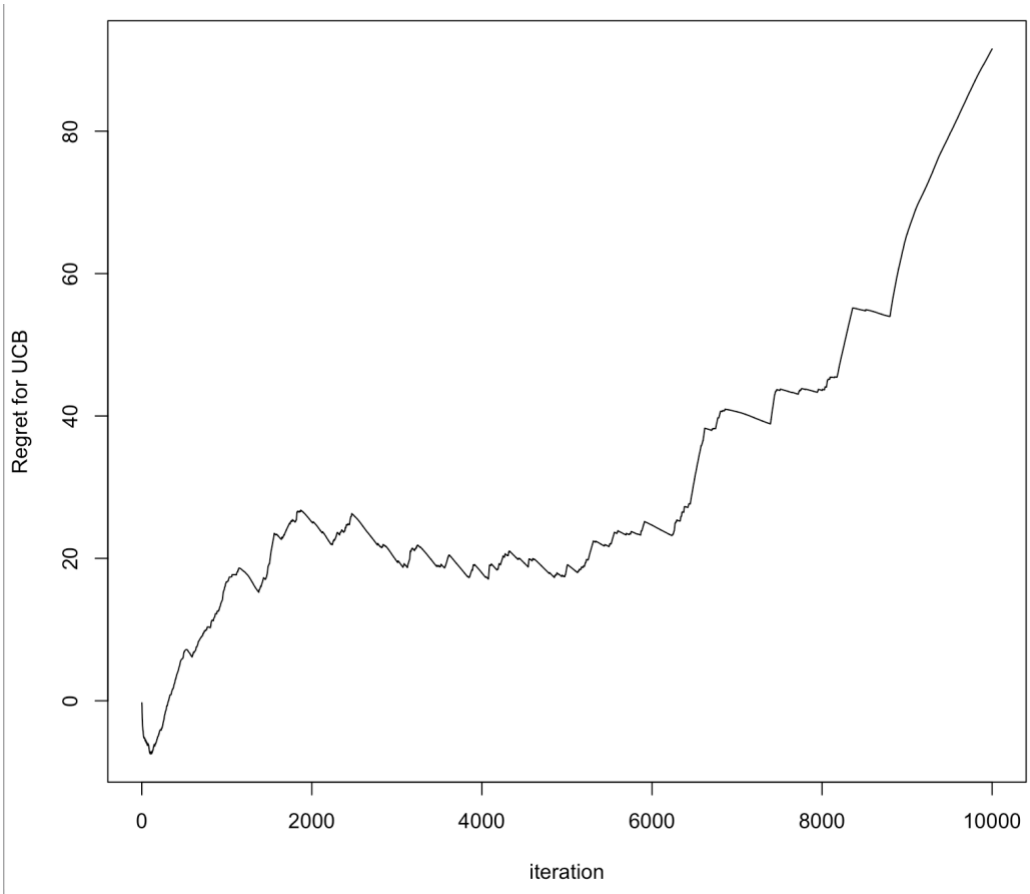
Part a.

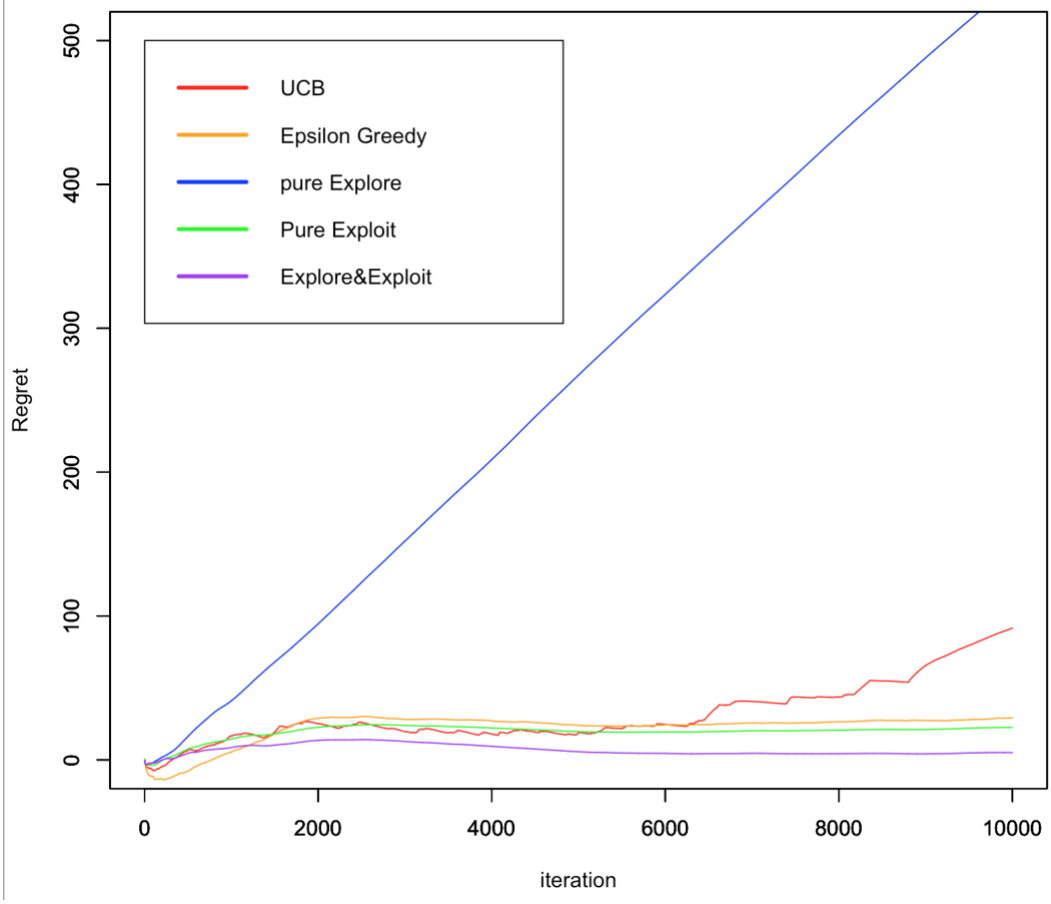




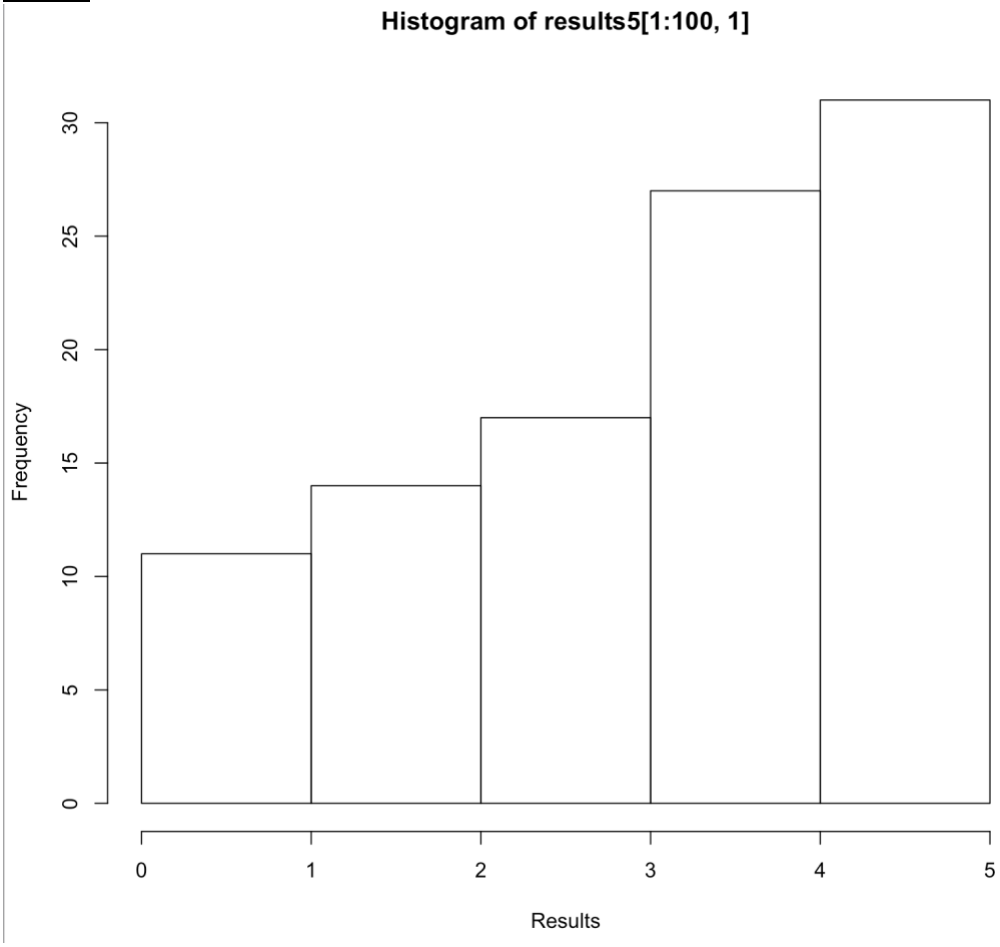

Regret for Explore than Exploit
10
5
0
0
2000
4000
6000
8000
10000
iteration

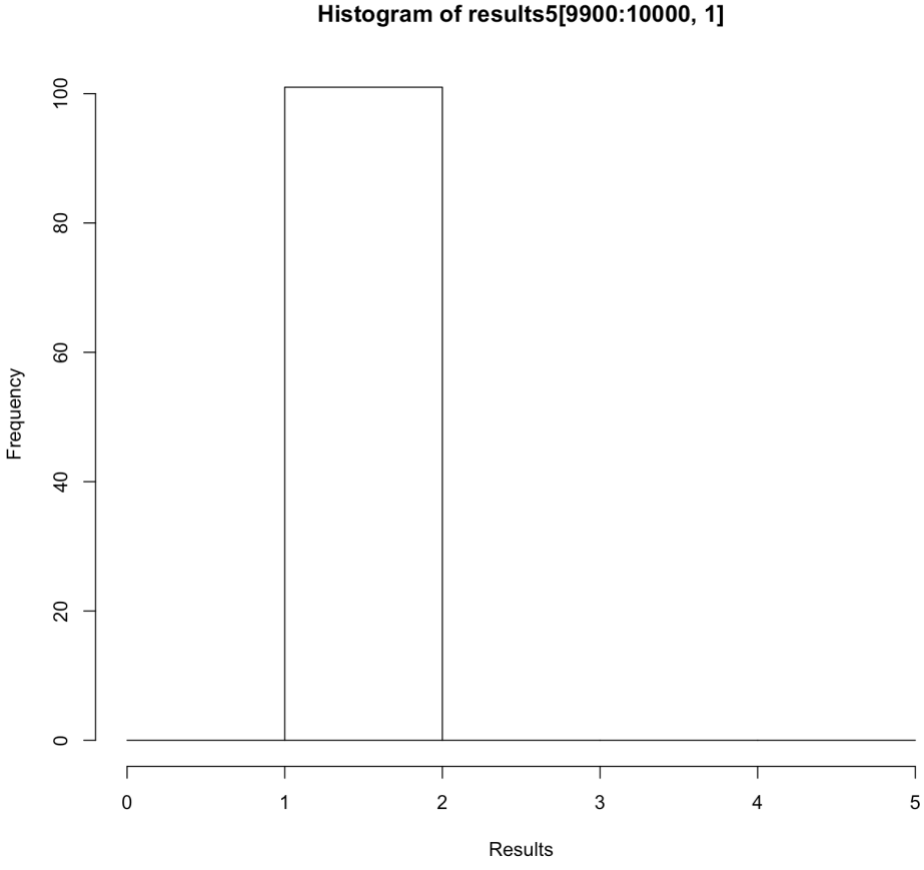

Regret for Epsilon Greedy
30
20
10
0
-10
0
2000
4000
6000
8000
10000
iteration


Regret for UCB
0
20
40
60
80
0
2000
4000
6000
8000
10000
iteration


Regret
0
100
200
300
400
500
0
2000
4000
6000
8000
10000
iteration
UCB
Epsilon Greedy
pure Explore
Pure Exploit
Explore&Exploit

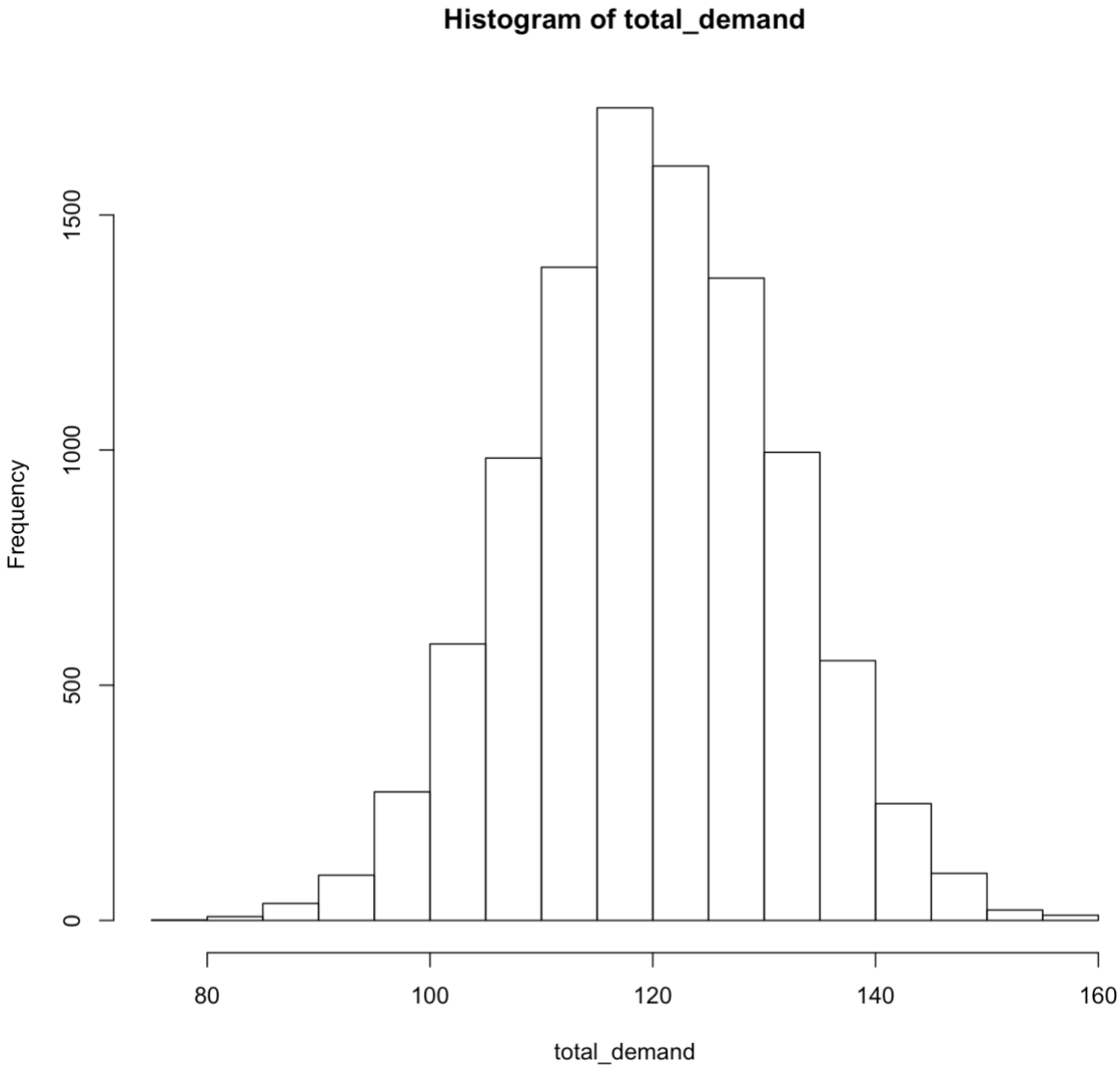
Part b.


Histogram of results5[1:100, 1]
Frequency
0
5
10
15
20
25
30
0
1
2
3
4
5
Results


Histogram of results5[9900:10000, 1]
Frequency
0
20
40
60
80
100
0
1
2
3
4
5
Results

Answer 2

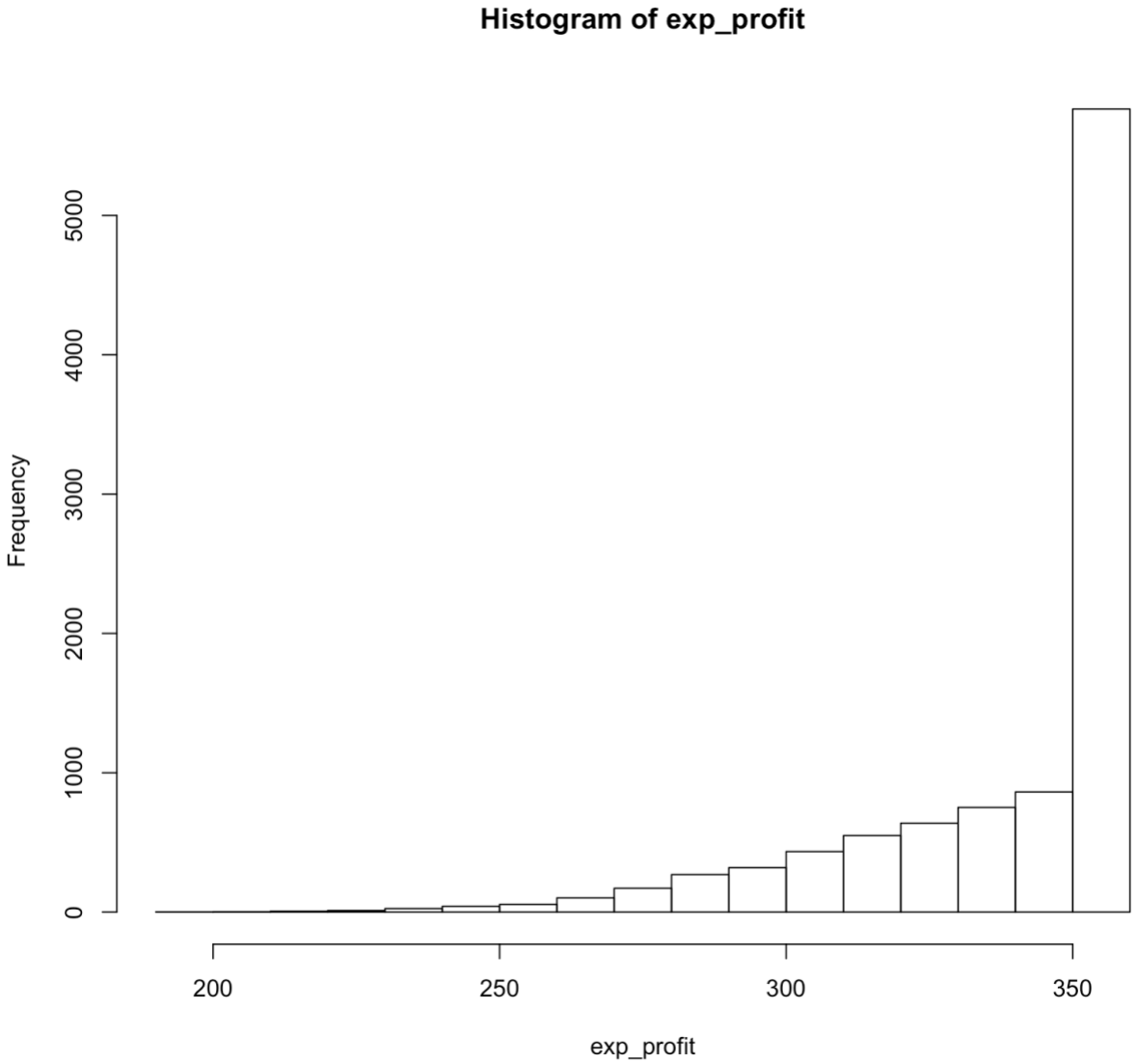
Part a.



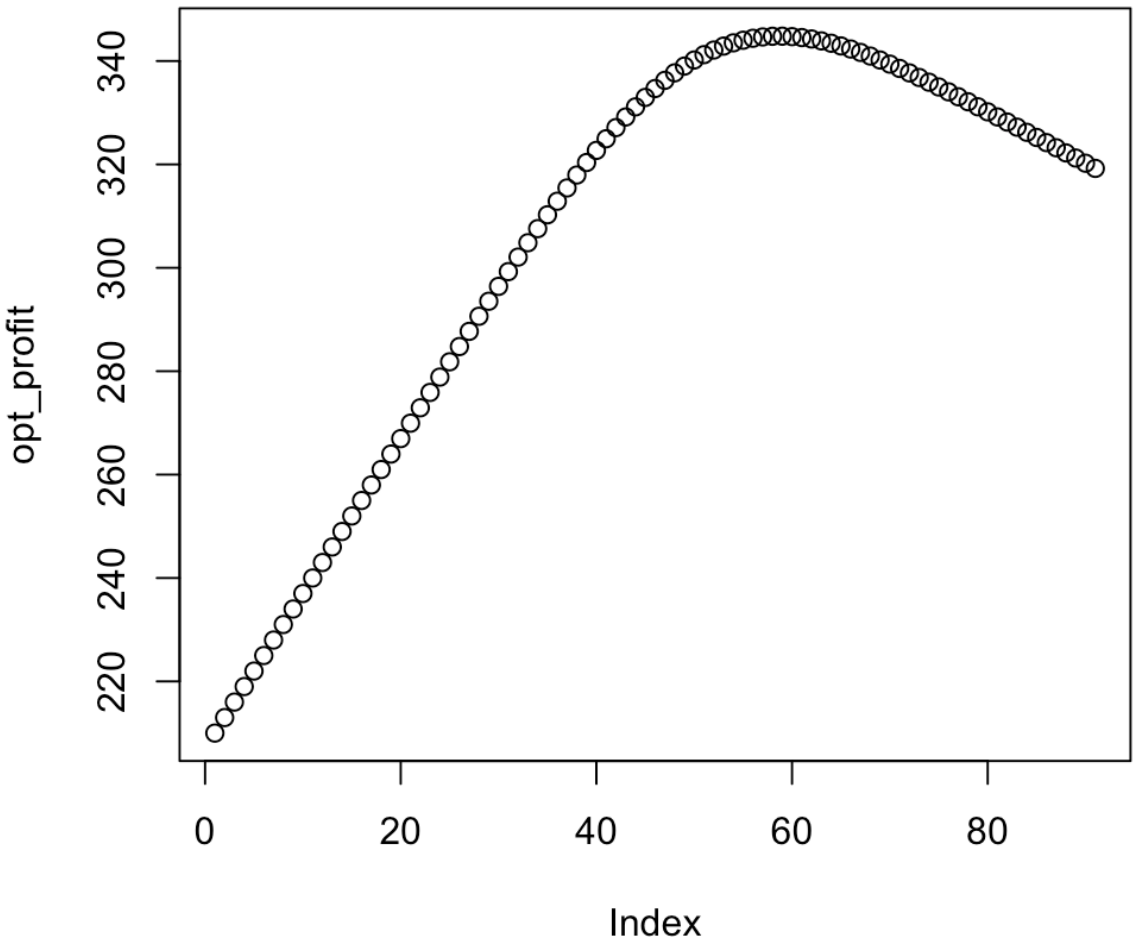

```
> quantile(total_demand, c(0.1, 0.5,0.9))
     10%      50%      90%
104.9920 119.7246 134.5866
```

Part b.

```
> expected_profit = mean(exp_profit)
> expected_profit
[1] 341.2349
```



Part c.




```
> optimal_profit = opt_profit[which.max(opt_profit)]
> optimal_profit
[1] 344.8027

> optimal_production = which.max(opt_profit) + 70
> optimal_production
[1] 129
```

Answer 3

Part a.

AAPL	GOOGL	AMZN	C	TSLA	GE	IBM	FB	
1.96%	1.92%	2.78%	-0.02%	5.68%	1.42%	-0.41%	4.52%	**AVERAGE**
0.004818	0.003831	0.007871	0.004453	0.036547	0.002778	0.002996	0.011007	**VARIANCE**
0.069415	0.061896	0.088717	0.066729	0.191173	0.052704	0.054732	0.104915	**STD DEV**

AAPL	GOOGL	AMZN	C	TSLA	GE	IBM	FB
-1.04%	-1.03%	-1.96%	1.75%	-2.28%	-0.98%	1.12%	-2.80%
10.76%	4.45%	4.66%	7.49%	14.03%	7.68%	16.00%	2.20%
-2.09%	-7.72%	-8.65%	-8.74%	-5.30%	-0.48%	6.49%	-9.23%
-9.48%	-4.06%	-15.93%	-17.60%	-26.02%	-8.00%	-8.91%	2.70%
-12.98%	0.07%	-1.11%	-4.30%	-1.45%	3.40%	-0.88%	-4.11%
-2.54%	1.53%	3.44%	1.75%	5.59%	2.11%	0.88%	-2.29%
6.38%	13.59%	19.49%	7.30%	-22.38%	13.25%	-2.96%	8.91%
-4.14%	-3.38%	-2.97%	-7.21%	-5.95%	1.10%	-1.56%	-3.99%
-8.58%	-3.39%	-7.12%	-8.50%	-12.10%	-6.32%	-7.53%	-9.39%
-5.25%	19.83%	20.73%	5.94%	-6.47%	-3.19%	0.00%	5.09%
-5.68%	-2.89%	-1.65%	2.17%	1.28%	-3.16%	-3.71%	3.79%
2.58%	-2.55%	-1.01%	1.54%	5.27%	-0.72%	0.21%	-3.98%
-1.38%	-2.99%	10.57%	3.52%	14.07%	7.73%	7.14%	-8.71%
-5.09%	-3.33%	-4.90%	-1.69%	-12.85%	-5.96%	-0.47%	-0.40%
8.12%	2.75%	4.45%	11.67%	-5.81%	8.37%	6.78%	-0.49%
4.18%	-0.62%	11.46%	-13.19%	-14.14%	-6.88%	-4.03%	-7.22%
-9.15%	-5.27%	-11.13%	0.28%	-14.72%	-5.13%	-0.65%	-4.11%
8.64%	-5.23%	8.08%	0.84%	-4.51%	1.22%	-0.27%	-0.90%
5.24%	-5.41%	-8.04%	3.34%	-6.09%	-0.68%	-12.98%	-9.64%
-3.66%	-0.88%	-7.67%	0.35%	-15.70%	-1.97%	-0.87%	1.12%
5.79%	-1.44%	5.54%	5.62%	15.10%	1.88%	1.34%	-1.53%
0.92%	-2.80%	-6.41%	3.89%	-12.66%	-5.72%	6.15%	3.45%
0.81%	0.36%	1.13%	-0.97%	9.86%	-2.51%	-1.26%	1.79%
5.91%	4.95%	-0.01%	-0.67%	-5.74%	-1.79%	-5.20%	1.37%
7.98%	-6.03%	-12.36%	0.67%	-5.95%	2.44%	2.48%	-5.28%
0.04%	-10.24%	-9.88%	-2.10%	-20.53%	0.23%	4.37%	-16.52%
3.79%	1.02%	-1.83%	2.55%	29.27%	0.82%	5.79%	4.90%
-12.73%	3.46%	-12.83%	-8.94%	14.91%	-11.76%	-5.39%	9.97%
-1.07%	3.85%	-1.46%	-1.51%	12.51%	4.57%	4.81%	11.73%
5.05%	0.89%	5.35%	8.51%	-26.10%	0.57%	1.22%	-10.89%
7.68%	15.74%	13.66%	0.60%	-22.97%	8.00%	-2.81%	-4.56%
-4.11%	1.51%	8.49%	0.40%	8.74%	2.62%	2.01%	17.13%
6.42%	-6.52%	-9.50%	-7.27%	20.17%	-6.47%	-5.67%	7.68%
12.16%	-1.08%	5.70%	8.72%	19.39%	3.67%	2.47%	43.39%
-13.79%	-0.87%	0.38%	-7.71%	4.14%	-1.18%	-7.71%	-2.34%

0.28%	3.74%	3.29%	11.47%	75.39%	3.20%	3.60%	-16.83%

EtE	AAPL	GOOGL	AMZN	C	TSLA	GE	IBM	FB
AAPL	0.168647	0.015628	0.076197	0.086599	0.039791	0.063247	0.045892	0.04144
GOOGL	0.015628	0.134089	0.136808	0.050974	0.009138	0.041617	0.005054	0.051587
AMZN	0.076197	0.136808	0.275477	0.100116	0.037608	0.095098	0.035305	0.052611
C	0.086599	0.050974	0.100116	0.155846	0.134662	0.075674	0.064454	0.028777
TSLA	0.039791	0.009138	0.037608	0.134662	1.279146	0.042697	0.104415	0.100021
GE	0.063247	0.041617	0.095098	0.075674	0.042697	0.097221	0.048988	0.009088
IBM	0.045892	0.005054	0.035305	0.064454	0.104415	0.048988	0.104847	0.008697
FB	0.04144	0.051587	0.052611	0.028777	0.100021	0.009088	0.008697	0.385247

Covariance Matrix	AAPL	GOOGL	AMZN	C	TSLA	GE	IBM	FB
AAPL	0.004685	0.000434	0.002117	0.002406	0.001105	0.001757	0.001275	0.001151
GOOGL	0.000434	0.003725	0.0038	0.001416	0.000254	0.001156	0.00014	0.001433
AMZN	0.002117	0.0038	0.007652	0.002781	0.001045	0.002642	0.000981	0.001461
C	0.002406	0.001416	0.002781	0.004329	0.003741	0.002102	0.00179	0.000799
TSLA	0.001105	0.000254	0.001045	0.003741	0.035532	0.001186	0.0029	0.002778
GE	0.001757	0.001156	0.002642	0.002102	0.001186	0.002701	0.001361	0.000252
IBM	0.001275	0.00014	0.000981	0.00179	0.0029	0.001361	0.002912	0.000242
FB	0.001151	0.001433	0.001461	0.000799	0.002778	0.000252	0.000242	0.010701

Part b.

	AAPL	GOOGL	AMZN	C	TSLA	GE	IBM	FB
AAPL	0.00468464							
GOOGL	0.00043412	0.0037247						
AMZN	0.0021166	0.00380022	0.00765214					
C	0.00240553	0.00141594	0.00278099	0.00432905				
TSLA	0.0011053	0.00025384	0.00104468	0.00374062	0.03553183			
GE	0.00175685	0.00115604	0.0026416	0.00210204	0.00118602	0.00270058		
IBM	0.00127477	0.00014039	0.0009807	0.0017904	0.00290042	0.00136078	0.00291241	
FB	0.00115111	0.00143298	0.00146142	0.00079937	0.00277837	0.00025246	0.00024159	0.01070131

Covariance Matrix	AAPL	GOOGL	AMZN	C	TSLA	GE	IBM	FB
AAPL	0.00468464	0.00043412	0.0021166	0.00240553	0.0011053	0.00175685	0.00127477	0.00115111
GOOGL	0.00043412	0.0037247	0.00380022	0.00141594	0.00025384	0.00115604	0.00014039	0.00143298
AMZN	0.0021166	0.00380022	0.00765214	0.00278099	0.00104468	0.0026416	0.0009807	0.00146142
C	0.00240553	0.00141594	0.00278099	0.00432905	0.00374062	0.00210204	0.0017904	0.00079937
TSLA	0.0011053	0.00025384	0.00104468	0.00374062	0.03553183	0.00118602	0.00290042	0.00277837
GE	0.00175685	0.00115604	0.0026416	0.00210204	0.00118602	0.00270058	0.00136078	0.00025246
IBM	0.00127477	0.00014039	0.0009807	0.0017904	0.00290042	0.00136078	0.00291241	0.00024159
FB	0.00115111	0.00143298	0.00146142	0.00079937	0.00277837	0.00025246	0.00024159	0.01070131

STOCKS	AAPL	GOOGL	AMZN	C	TSLA	GE	IBM	FB
AVERAGE	0.01957596	0.01919933	0.02777978	-0.00022848	0.05681693	0.01417941	-0.00414766	0.04517238

Portfolio	weight 1	weight 2	weight 3	weight 4	weight 5	weight 6	weight 7	weight 8	EXPECTED RETURN	STD	SUM OF WEIGHTS
MIN-RISK	0.11088176	0.29119696	0	0	0	0.1595541	0.36335502	0.07501215	0.011905191	0.03841498	1

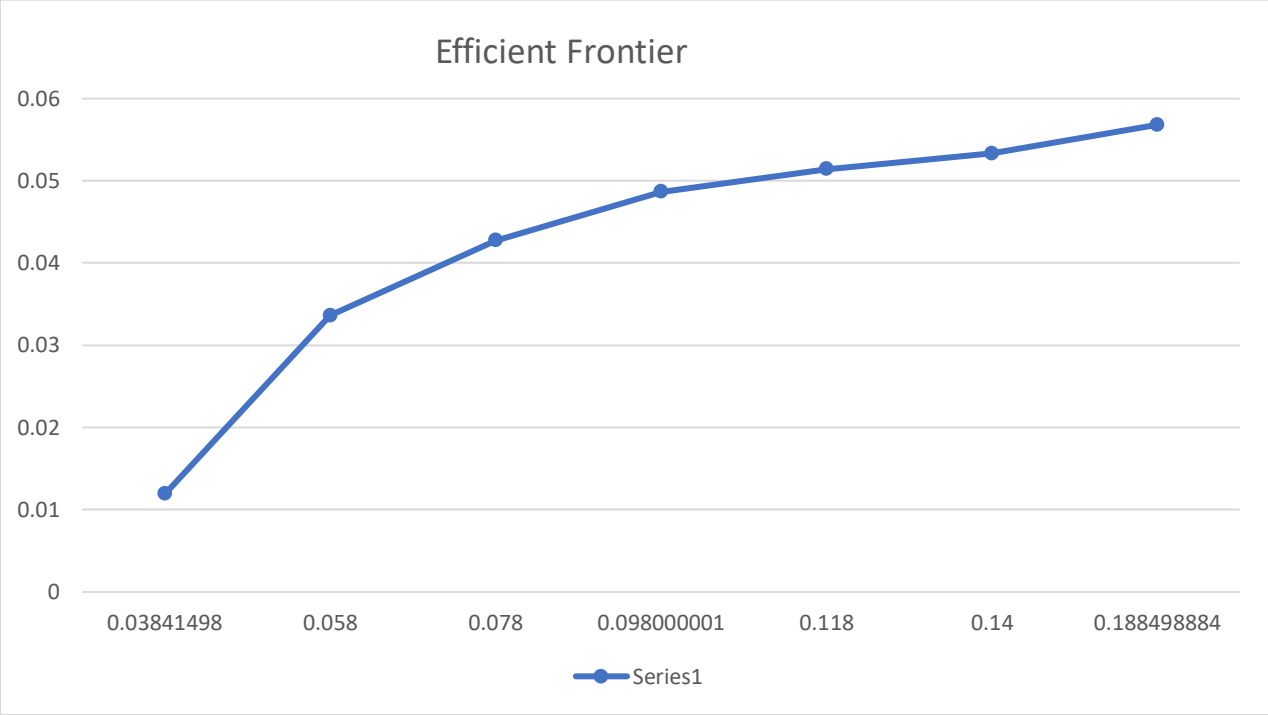
Part c.

Portfolio	weight 1	weight 2	weight 3	weight 4	weight 5	weight 6	weight 7	weight 8	EXPECTED RETURN	STD	SUM OF WEIGHTS
MAX-RETURN	0	0	0	0	1	0	0	0	0.056816931	0.18849888	1

Part d.

Portfolio	weight 1	weight 2	weight 3	weight 4	weight 5	weight 6	weight 7	weight 8	EXPECTED RETURN	STD	SUM OF WEIGHTS
MAX-RETURN	0	0	0	0	1	0	0	0	0.056816931	0.18849888	1
MIN-RISK	0.11088176	0.29119696	0	0	0	0.1595541	0.36335502	0.07501215	0.011905191	0.03841498	1
	0.18518135	0.18210812	0.11324927	0	0.12824284	0.05172529	0	0.33949313	0.033623007	0.058	1
	0.00133661	0	0.27233119	0	0.20199917	0	0	0.52433303	0.042753809	0.078	1
	0	0	0.00470061	0	0.30683982	0	0	0.68845956	0.048663635	0.098	1
	0	0	0	0	0.53707602	0	0	0.46292398	0.051426388	0.118	1
	0	0	0	0	0.70144247	0	0	0.29855753	0.053340362	0.14	1

Table for Efficient Frontier	
Expected Return	**Risk**
0.011905191	0.03841498
0.033623007	0.058
0.042753809	0.078
0.048663635	0.098
0.051426388	0.118
0.053340362	0.14
0.056816931	0.18849888



Answer 4

Part a.

x1 = units of standard laptops manufactured by the manufacturer
x2 = units of customized laptops manufactured by the manufacturer
x3 = units of standard desktops manufactured by the manufacturer
x4 = units of customized desktops manufactured by the manufacturer

```
maximize
        120 x1 + 200 x2 + 170 x3 + 400 x4
subject to
        x1 + x2 <= 1500
        x3 + x4 <= 1000
        x2 + x4 <= 500
bounds
        x1 <= 1300
        x2 <= 1000
        x3 <= 700
        x4 <= 400
        x1 >= 0
        x2 >= 0
        x3 >= 0
        x4 >= 0
end
```

The mathematical formulation given above to optimize the total net profit is linear.

Part b.

Solution using Gurobi

```
# Objective value (Net Profit) = 438000
x1 1300
x2 100
x3 600
x4 400
```

Optimal Strategy

Manufacture 1300 units of standard laptops, 100 units of customized laptops, 600 units of standard desktops and 400 units of customized desktops.

Part c.

```
maximize
        120 x1 + 200 x2 + 170 x3 + 400 x4
subject to
        x1 + x2 <= 1500
        x3 + x4 <= 1000
        x2 + x4 <= 700
bounds
        x1 <= 1300
        x2 <= 1000
        x3 <= 700
        x4 <= 400
        x1 >= 0
        x2 >= 0
        x3 >= 0
        x4 >= 0
end

# Objective value (Net Profit) = 466000
x1 1200
x2 300
x3 600
x4 400
```

We are able to increase our profits from 438000 to 466000 if we can customize 200 more machines.

Part d.

```
maximize
        120 x1 + 200 x2 + 170 x3 + 400 x4
subject to
        x1 + x2 <= 1500
        x3 + x4 <= 1300
        x2 + x4 <= 500
bounds
        x1 <= 1300
        x2 <= 1000
        x3 <= 700
        x4 <= 400
        x1 >= 0
        x2 >= 0
        x3 >= 0
        x4 >= 0
end

# Objective value (Net Profit) = 455000
```

x1 1300
x2 100
x3 700
x4 400

We are able to increase our profits (objective value) from 438000 to 455000 if we can sell 300 more desktops.

Part e.

```
maximize
        120 x1 + 200 x2 + 170 x3 + 400 x4
subject to
        x1 + x2 <= 1400
        x3 + x4 <= 1000
        x2 + x4 <= 500
bounds
        x1 <= 1300
        x2 <= 1000
        x3 <= 700
        x4 <= 400
        x1 >= 0
        x2 >= 0
        x3 >= 0
        x4 >= 0
end

# Objective value = 438000
x1 1300
x2 100
x3 600
x4 400
```

There is no change in profits (objective value) if we manufacture 100 less laptops because the constraint was not tight.