

1.

(a) The average percent change for stores in USA is -10.17%, the average percent change for stores in Canada is -15.90%.

```
> mean(bm_sale_usa_change$sales_change)
[1] -0.101665
> mean(bm_sale_can_change$sales_change)
[1] -0.1590504
```

(b) The coefficient of affected (whether involved in BOPS program) is 0.05739, and stand error is 0.01566. Because the P value is 0.000439 so it's significant. Thus BOPS has positive influence on sales.

```
> linReg1 = lm(sales_change~Affected)
> summary(linReg1)
```

Call:

```
lm(formula = sales_change ~ Affected)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.134281	-0.037914	-0.004034	0.034551	0.115439

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-0.15905	0.01399	-11.371	< 2e-16 ***
Affected	0.05739	0.01566	3.664	0.000439 ***

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Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.05767 on 82 degrees of freedom

Multiple R-squared: 0.1407, Adjusted R-squared: 0.1302

F-statistic: 13.43 on 1 and 82 DF, p-value: 0.0004389

(c) The average sales percent change for DMAs close to stores with BOPS is -19.65%.

```
> mean(online_sale_close_change$sales_change)
[1] -0.1964794
```

(d) The coefficient of affected (whether involved in BOPS program) is -0.0267, and stand error is 0.014. Because the P value is 0.0594 so it's not significant.

```
> linReg2 = lm(sales_change~Affected)
> summary(linReg2)
```

Call:

```
lm(formula = sales_change ~ Affected)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.21518	-0.07304	-0.01619	0.06832	0.34975

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-0.169760	0.009775	-17.367	<2e-16 ***
Affected	-0.026719	0.014095	-1.896	0.0594 .

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Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1021 on 208 degrees of freedom

Multiple R-squared: 0.01698, Adjusted R-squared: 0.01226

F-statistic: 3.593 on 1 and 208 DF, p-value: 0.05939

(e) After using 13 months data, the coefficient of affected (whether involved in BOPS program) is -0.0387, and stand error is 0.0265. Because the P value is 0.147 so it's still not significant.

```
> linReg3 = lm(sales_change~Affected)
> summary(linReg3)
```

Call:  
lm(formula = sales\_change ~ Affected)

Residuals:

Min	1Q	Median	3Q	Max
-0.43835	-0.12077	-0.01014	0.10747	0.75385

Coefficients:

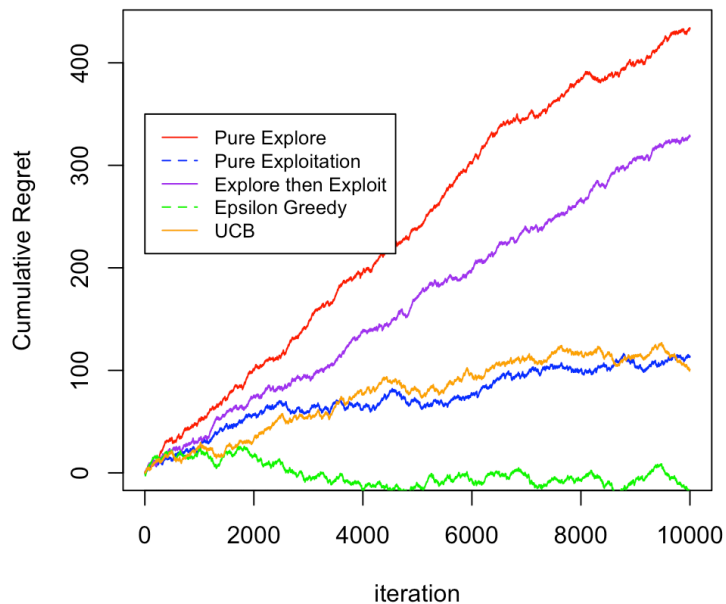
	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	0.15768	0.01841	8.566	2.41e-15 ***
Affected	-0.03865	0.02654	-1.456	0.147

---  
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1922 on 208 degrees of freedom  
Multiple R-squared: 0.01009, Adjusted R-squared: 0.005333  
F-statistic: 2.121 on 1 and 208 DF, p-value: 0.1468

2.

(a) Below is the plot for all five algorithms.



(b) The distribution of first 100 customers are 0.11, 0.14, 0.17, 0.27, 0.31; the distribution of last 100 customers are 0.15, 0.23, 0.18, 0.23, 0.21

```
> dist1 = (UCB(emaildata[1:100,], 0.75)[[2]] - 1)/100
> dist2 = (UCB(emaildata[(nrow(emaildata)-99):nrow(emaildata)], 0.75)[[2]] - 1)/100
> dist1; dist2
```

[1]	0.11	0.14	0.17	0.27	0.31
[1]	0.15	0.23	0.18	0.23	0.21

3.

(a) The mathematical formulation is listed below. It's integer programming so it's linear and discrete.

	laptop		desktop	
Supply	std.	cust.	std.	cust.
	$x_1$	$x_2$	$y_1$	$y_2$
demand	1300	1000	700	400
net pft.	120	200	170	400

$$\max \text{ profit} = 120x_1 + 200x_2 + 170y_1 + 400y_2$$
  

$$\text{s.t.} \quad \begin{aligned} x_1 + x_2 &\leq 1500 \\ y_1 + y_2 &\leq 1000 \end{aligned} \quad \left. \vphantom{\begin{aligned} x_1 + x_2 &\leq 1500 \\ y_1 + y_2 &\leq 1000 \end{aligned}} \right\} \text{supply const}$$
  

$$\begin{aligned} y_1 &\leq 700 \\ y_2 &\leq 400 \\ x_1 &\leq 1300 \\ x_2 &\leq 1000 \end{aligned} \quad \left. \vphantom{\begin{aligned} y_1 &\leq 700 \\ y_2 &\leq 400 \\ x_1 &\leq 1300 \\ x_2 &\leq 1000 \end{aligned}} \right\} \text{Demand const}$$
  

$$x_2 + y_2 \leq 500 \quad \left. \vphantom{x_2 + y_2 \leq 500} \right\} \text{labor const.}$$

(b)

The optimal strategy is to produce 1300 standardized laptops, 100 customized laptops, 600 standardized desktops, and 400 customized desktops.

The maximum net profit is 438000.

x1	x2	y1	y2	
1300	100	600	400	
max	438000			
c1	$x_1 + x_2$	1400	$\leq$	1500
c2	$y_1 + y_2$	1000	$\leq$	1000
c3	$y_1$	600	$\leq$	700
c4	$y_2$	400	$\leq$	400
c5	$x_1$	1300	$\leq$	1300
c6	$x_2$	100	$\leq$	1000
c7	$x_2 + y_2$	500	$\leq$	500

(c) If there are 200 more machines could be customized, the c7 becomes  $x_2 + y_2 \leq 700$ . Then the maximum profit is 466000, the extra benefit =  $466000 - 438000 = 28000$ .

x1	x2	y1	y2	
1200	300	600	400	
max	466000			
c1	$x_1 + x_2$	1500	$\leq$	1500
c2	$y_1 + y_2$	1000	$\leq$	1000
c3	$y_1$	600	$\leq$	700
c4	$y_2$	400	$\leq$	400
c5	$x_1$	1200	$\leq$	1300
c6	$x_2$	300	$\leq$	1000
c7	$x_2 + y_2$	700	$\leq$	700

(d) c2 becomes  $y_1 + y_2 \leq 1300$ . Then the maximum profit is 455000, the extra benefit =  $455000 - 438000 = 17000$

x1	x2	y1	y2	
1300	100	700	400	
max	455000			
c1	$x_1 + x_2$	1400	$\leq$	1500
c2	$y_1 + y_2$	1100	$\leq$	1300
c3	$y_1$	700	$\leq$	700
c4	$y_2$	400	$\leq$	400
c5	$x_1$	1300	$\leq$	1300
c6	$x_2$	100	$\leq$	1000
c7	$x_2 + y_2$	500	$\leq$	500

(e) c1 becomes  $x_1 + x_2 \leq 1400$ . The optimal strategy and maximum net profit remains the same.

x1	x2	y1	y2	
1300	100	600	400	
max	438000			
c1	$x_1 + x_2$	1400	$\leq$	1400
c2	$y_1 + y_2$	1000	$\leq$	1000
c3	$y_1$	600	$\leq$	700
c4	$y_2$	400	$\leq$	400
c5	$x_1$	1300	$\leq$	1300
c6	$x_2$	100	$\leq$	1000
c7	$x_2 + y_2$	500	$\leq$	500