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 ***
---
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.

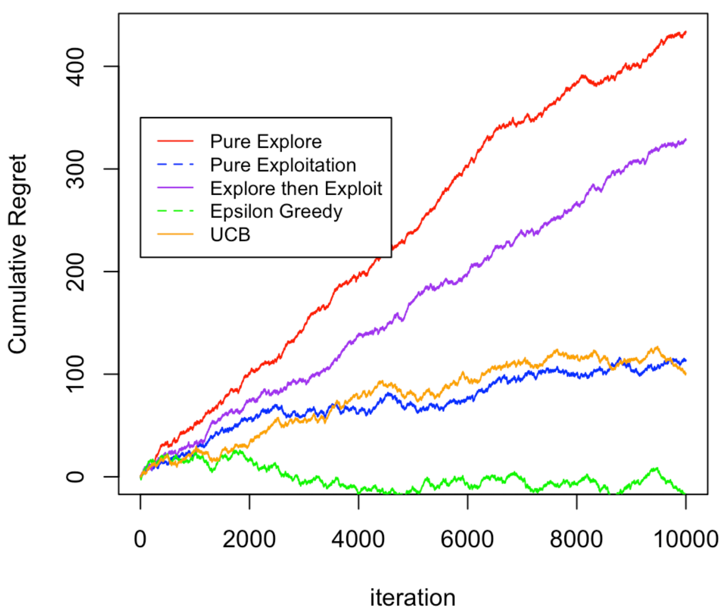
```
> linReg2 = lm(sales_change~Affected)
> summary(linReg2)

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 .  
---
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 integre programming so it’s linear and discrete.

	laptop		desktop	
Supply	1500		1000	
	std.	cust.	std.	cust.
	x_1	x_2	y_1	y_2
demand	1300	1000.	700	400
Net pft.	120.	200.	170.	400

$$\max \ prof = 120x_1 + 200x_2 + 170y_1 + 400y_2$$

s.t.

$$\left.\begin{array}{l} x_1 + x_2 \le 1{,}500 \\ y_1 + y_2 \le 1000 \end{array}\right\} \text{supply const}$$

$$\left.\begin{array}{l} y_1 \le 700 \\ y_2 \le 400 \\ x_1 \le 1300 \\ x_2 \le 1000 \end{array}\right\} \text{Demand const}$$

$$x_2 + y_2 \le 500 \quad \} \text{ labor const.}$$

(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	x1 + x2	1400	<=	1500
c2	y1 + y2	1000	<=	1000
c3	y1	600	<=	700
c4	y2	400	<=	400
c5	x1	1300	<=	1300
c6	x2	100	<=	1000
c7	x2 + y2	500	<=	500

(c) If there are 200 more machines could be customized, the c7 becomes x2+y2<=700. Then the maximum profit is 466000, the extra benefit = 466000 – 438000 = 28000.

x1	x2	y1	y2	
1200	300	600	400	
max	466000			
c1	x1 + x2	1500	<=	1500
c2	y1 + y2	1000	<=	1000
c3	y1	600	<=	700
c4	y2	400	<=	400
c5	x1	1200	<=	1300
c6	x2	300	<=	1000
c7	x2 + y2	700	<=	700

(d) If there are 300 more demands from standardized desktops, then C3 becomes y1<=1000. Then the maximum profit is 438000, the extra benefit = 0;

x1	x2	y1	y2	
1300	100	600	400	
max	438000			
c1	x1 + x2	1400	<=	1500
c2	y1 + y2	1000	<=	1000
c3	y1	600	<=	1000
c4	y2	400	<=	400
c5	x1	1300	<=	1300
c6	x2	100	<=	1000
c7	x2 + y2	500	<=	500

If there are 300 more demands from customized desktops, then C4 becomes y2<=700. Then the maximum profit is 441000, the extra benefit =3000;

x1	x2	y1	y2	
1300	0	500	500	
max	441000			
c1	x1 + x2	1300	<=	1500
c2	y1 + y2	1000	<=	1000
c3	y1	500	<=	700
c4	y2	500	<=	700
c5	x1	1300	<=	1300
c6	x2	0	<=	1000
c7	x2 + y2	500	<=	500

Thus if there are 300 more demands from desktops (no matter standard ones or customized ones), the extra benefit will range from 0 to 3000.

(e) c1 becomes x1+x2<=1400. The optimal strategy and maximum net profit remains the same.

x1	x2	y1	y2	
1300	100	600	400	
max	438000			
c1	x1 + x2	1400	<=	1400
c2	y1 + y2	1000	<=	1000
c3	y1	600	<=	700
c4	y2	400	<=	400
c5	x1	1300	<=	1300
c6	x2	100	<=	1000
c7	x2 + y2	500	<=	500