Group Assignment 3 - MAB

(Due Sunday, 17 November, at 23:59)

The maximum length of the report is 4 pages, not including possible appendices. The analysis can be done by Python or R. Submit the report and the estimation file by LumiNUS, one submission per group. Please have the names and the student numbers on the cover page. You may assume any data if required. Please clearly state any such assumptions in your submission.

1. In the class, we discussed the case study of Obama's fundraising campaign. This question is loosely based on that article. Similar to Obama's campaign, suppose the combination of the 6 images and 4 buttons has the following sign-up rates:

	Image1	Image 2	Image 3	Image 4	Image 5	Image 6
Button 1	0.102	0.103	0.078	0.088	0.076	0.074
Button 2	0.0923	**0.116**	0.0903	0.0877	0.0864	0.085
Button 3	0.063	0.098	0.087	***0.0826***	0.100	0.091
Button 4	0.056	0.077	0.075	0.055	0.051	0.094

Assume the following parameter

a) The target population of the campaign to be 100,000,000.
b) The campaign team likes 'button 3' and 'Image 4' combination
c) In A/B testing, the team targeted 13000 instances for every variant at the very beginning
d) After A/B testing the best variant was used till the end of the campaign
e) Each sign-up results in $21 donations

For this part, do the following

(a) Implement UCB1 and try to dynamically learn the best arm.
(b) Implement Thomson sampling and compare the results with the UCB1 implementation in step1. How do these results generalize?
(c) A/B testing resulted in saving of $60 million as per the authors of the original Obama's campaign article. How does the analogous number look for UCB1 and Thompson sampling?

2. The company ForeverProfit is a one-stop-shop for various types of products. It wants to roll out 6 products and has identified 4 types of customers. An example of customer types could be based on age- less than 30, 30-45, 46-60, greater than 60. Examples of products could be fitness products, holiday-package, health insurance cover, etc. ForeverProfit seeks your assistance to study which of these products it should roll out to which customer. Each of the customers either chooses to purchase or ignore the product. For each customer type, the probabilities of purchasing each of the products are given below (we have re-used the probabilities):

	P1	P2	P3	P4	P5	P6
Customer C1	0.102	**0.103**	0.078	0.088	0.076	0.074
C2	0.0923	**0.116**	0.0903	0.0877	0.0864	0.085
C3	0.063	0.098	0.087	0.0826	**0.100**	0.091
C4	0.056	0.077	0.075	0.055	0.051	**0.094**

Assume the number of visitors to the website to be 4,00,000 equally distributed between the four types. Implement either UCB1 or Thompson sampling to estimate the conversion rate.

Hints and notes for the assignment

- Both the exercises require you to simulate “coin” tosses; as discussed in class, this is easily accomplished in R by the function ‘rbinom’. The function rbinom(t,n,p) takes three parameter inputs as follows:
    - The input ‘t’ denotes the desired number of trials
    - The next input ‘n’ denotes the desired number of coin tosses per trial
    - The last input ‘p’ is the desired bias of the coin
    - Therefore, to simulate exactly one coin toss with bias 0.116, you can invoke the call to rbinom(1,1,0.116)
- Another useful function that you will need when you implement Thompson sampling is rbeta. The function rbeta(n,shape1, shape2) takes inputs as follows
    - The first parameter ‘n’ denotes the desired number of trials
    - The second parameter ‘shape1’ is the alpha parameter. It represents the total number of successes seen so far + 1.
    - The third parameter ‘shape2’ is the beta parameter. It represents the total number of failures+1
    - Therefore, for an arm with prior B(4,5) which has seen 3 successes, 4 failures and totally 7 pulls, a sample is simulated by the call rbeta(1, 4, 5)