Project 1

MGMT 237G
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You will need to write codes for all the parts of the project. Make sure the codes work properly and understand the ideas behind each problem below. You may be asked to demonstrate how the codes work, by running them, and interpret the results. Code quality, speed, and accuracy will determine the grades.

Due date: by Noon on next Wednesday

1. Use the Random Number generators discussed in the class to do the following:

   (a) Using LGM method generate 10,000 Uniformly distributed random numbers on [0,1] and compute the empirical mean and the standard deviation of the sequence.

   (b) Now use built-in functions of whatever software you are using to do the same thing as in (a).

   (c) Compare your findings in (a) and (b) and comment (be short but precise).

2. Use the numbers of part (a) of question 1 to do the following:

   (a) Generate 10,000 random numbers with the following distribution:

$$X = \begin{cases} -1 \ \ with \ \ probability \ \ 0.30 \\ 0 \ \ with \ \ probability \ \ 0.35 \\ 1 \ \ with \ \ probability \ \ 0.20 \\ 2 \ \ with \ \ probability \ \ 0.15 \end{cases}$$

   (b) Draw the histogram and compute the empirical mean and the standard deviation of the sequence of 10,000 numbers generated above in part (a).

3. Use the idea of part (a) of Question 1 to do the following:

   (a) Generate 1,000 random numbers with Binomial distribution with $n = 44$ and $p = 0.64$. (*Hint*: A random variable with Binomial distribution (n, p) is a sum of n Bernoulli (p) distributed random variables, so you will need to generate 44,000 Uniformly distributed random numbers, to start with).

   (b) Draw the histogram. Compute the probability that the random variable X that has Binomial (44, 0.64) distribution, is at least 40: $P(X \geq 40)$. Use any statistics textbook or online resources for the exact number for the above probability and compare it with your finding and comment.

4. Use the numbers of part (a) of question 1 to do the following:

   (a) Generate 10,000 Exponentially distributed random numbers with parameter $\lambda = 1.5$.

   (b) Compute $P(X \geq 1)$ and $P(X \geq 4)$.

(c) Compute the empirical mean and the standard deviation of the sequence of 10,000 numbers generated above in part (a). Draw the histogram by using the 10,000 numbers of part (a).

5. Use the idea of part (a) of Question 1 to do the following:

   (a) Generate 5,000 Uniformly distributed random numbers on [0,1].

   (b) Generate 5,000 Normally distributed random numbers with mean 0 and variance 1, by **Box-Muller** Method.

   (c) Compute the empirical mean and the standard deviation of the sequence of numbers generated above of part (b).

   (d) Now use the **Polar-Marsaglia** method to do the same as in (b).
   Note: Here you will not have the same number of random variables as in (b).

   (e) Compute the empirical mean and the standard deviation of the sequence of numbers generated above of part (d).

   (f) Now compare the efficiencies of the two above-algorithms, by comparing the execution **times** to generate 5,000 normally distributed random numbers by the two methods. Which one is more efficient? If you do not see a clear difference, you need to increase the number of generated realizations of random variables to 10,000, 20,000, etc.

6. ***Optional (Not for grading – do not submit its solution)***

   a. Which is larger – the Delta of a 3 month or the 6-month Call options on a non-dividend-paying stock?

   b. Which is larger – the Gamma of a 3 month or the 6-month At-The-Money Call options on a non-dividend-paying stock?