

# CENG222 Probability and Statistics

## HOMEWORK 1

**DUE DATE: 05.05.2024 - 23:55**

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### **Submission Rules:**

1. This is **NOT** a group assignment. All kinds of cheating and plagiarism will be penalized and such submissions will be graded as **0**.
  2. You should submit your assignments through TEAMS until due date. There will be no extensions.
  3. You have to submit one zipped file including one file for your code (**py**) and one file for your report (**pdf**).
  4. Your homework should be named as **CENG222\_HW1\_studentID.zip**
  5. You should write your **student ID** both in your code and report files.
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Your task is to conduct the following experiments in Python by filling in the provided skeleton code and documenting your findings in a report. It is crucial to note that for random number generation, you are **ONLY** permitted to use the **random.random()** function. This function requires no parameters and yields values uniformly distributed in the range of 0 to 1

### **Experiment 1:**

A fair 6-face and a fair 4-face dice are rolled, alongside a fair coin toss. The random variables **A** and **B** represent the outcomes of the dice rolls, with A ranging from 1 to 6 and B from 1 to 4. Variable **C** is determined by the result of the coin toss, assigned +1 for heads and -1 for tails. Another random variable **X** is formulated as  $A + (B * C)$ .

In your code:

1. Simulate and iterate through this experiment 30000 times. For each iteration, store the generated variables, the updated average value for all four random variables and the variance of X in the given lists.
2. 4 plots are already implemented. DO NOT change them. (Figures 1-4)
3. Plot the average values of all four variables calculated throughout the experiment. (Figure 5-8)
4. Plot the variance of X calculated throughout the experiment. (Figure 9)

In your report:

1. Inspect the existing plots and comment on them. What do Figures 10-12 show?
2. Calculate and plot the probability mass function and the cumulative distribution function of X.
3. Compute the expected value and variance of X.
4. Compare your results with the simulation outputs.

## Experiment 2:

A random variable  $X$  has the following cumulative distribution function:  $F(x)=x^2$ , for  $0 \leq x \leq 1$ .

### Part a:

In your code:

1. Create 30000 samples of  $X$  using the Inverse Transformation method. At each step, store the generated variables  $u$ ,  $x$  and the updated average and variance of  $X$  in the given lists.
2. 3 plots are already implemented. DO NOT change them. (Figures 10-12)
3. Plot the average value of  $X$  that you calculated through the generation steps. (Figure 13)
4. Plot the variance of  $X$  that you calculated throughout the generation steps. (Figure 14)

In your report:

1. Inspect the existing plots and comment on them. What do Figures 10-12 show?
2. Calculate the expected value and variance of  $X$ .
3. Compare your results with the simulation outputs in Figures 13 and 14.

### Part b:

In your code:

1. Create 30000 samples of  $X$  using the Rejection method. At each step, store the generated variable  $x$  and the updated average and variance of  $X$  in the given arrays.
2. 2 plots are already implemented. DO NOT change them (Figures 15-16).
3. Plot the average value of  $X$  that you calculated throughout the experiment (Figure 17).
4. Plot the variance of  $X$  that you calculated throughout the experiment (Figure 18).

In your report:

1. Inspect the existing plots and comment on them. What do Figure 15 and Figure 16 show?
2. Compare your results in (a) with the simulation outputs in Figures 17 and 18.