Homework 1

Simulation and Performance Evaluation – University of Trento

DEADLINE: 17:29 on April 08, 2025

You can solve the following assignments using any programming language. Being the first homework, exercises are simple and designed mainly to "cut your teeth," expose possible issues, and unveil misunderstandings rather than to evaluate you on what you can or cannot do.

So, it is important that you do the homework by yourselves, without any help from AI tools. You can use all functions made available by the programming language of your choice, including functions to extract random numbers.

You will see a facility on Moodle to upload your homework. Please upload your code, and separately upload a **short** report where you describe your findings (no more than 2 pages). Upload **two versions** of the report: one with your names, and a second, fully anonymized one.

If you have not done so already, be sure to communicate your working group to the instructor.

Exercise 1

Use simulation to test the conditional expectation and conditional variance formulas as follows.
You draw data samples at random from one of four Gaussian distributions, having the following mean and variance (μ, σ^2):

1. $(-2, 2)$
2. $(4, 1)$
3. $(10, 3)$
4. $(15, 2)$

The probability that the numbers you draw come from the above distributions are

1. 0.15
2. 0.25
3. 0.35
4. 0.2

Draw a dataset of at least 1,000,000 numbers at random as described above, and verify that the mean and variance of the resulting dataset obey the conditional mean and conditional variance formulas.

Exercise 2

Use simulation to find the probability than an exponential random variate of mean $\mu = 1$ is larger than a random variate uniformly distributed in the interval $[0, 5]$.

(Facultative) Can you justify the result with theoretical arguments?