

Simulation Exercise #03: Random Variable Generation

INF301 – Systems Modeling and Simulation – W03
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Report Guidelines

Use a notebook on the Google Collaboratory platform to generate a report containing any explanations and comments you deem relevant, along with your codes and figures.

The graphs in the figures should be self-explanatory, with axis names and data captions. Use a font size appropriate for presentation in a document.

The language to be used is Python. However, the use of pre-built Python libraries is not permitted, except for those used in the examples.

Submit a single notebook file in ipynb format, with the file name in the format SEON_NameSurname.ipynb, where N is the SE number, Name is your first name, and Surname is your last name.

Remember that plagiarism will not be tolerated under any circumstances!



Problem 1 (20 points)

Consider the probability distribution defined below. (a) Generate 4000 random values that follow this distribution and compare them, using a bar graph, with the theoretical results; (b) Generate 10 experimental values for p(x) and, taking x = 3 as a reference, calculate the 95% confidence interval for p(3).

x	p(x)
0	0.25
1	0.10
2	0.20
3	0.40
4	0.05



Problem 2 (30 points)

Consider the empirically generated random values:

$$x = \{1, 3, 3, 4, 6, 7, 10, 15\}$$

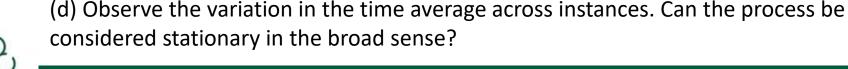
- (a) Assume that the above data characterize the distribution and find the distribution function F(x).
- (b) Find the inverse distribution function $F^{-1}(x)$.
- (c) Generate 1000 random values with the characterized distribution from the above data.
- (d) Show the resulting distribution and density functions based on the random values from part c).



Problem 3 (30 points)

Consider the random process $X(t) = 4 + 3\cos(5t + \theta)$, where θ is uniformly distributed on $[0, 2\pi]$.

- (a) Implement the random generator for θ from a RND in [0, 1[. (It is not necessary to implement a LCG).
- (b) Graphically show the autocorrelation function of X for $0 \le \tau \le 0.2$ (step of 0.01) and $0 \le \tau \le 1.5$ (step of 0.1).
- (c) Calculate the time averages considering 1000 instances of X(t).





Problem 4 (20 points)

Consider Example 10, which models additive white noise in a signal. Using the same code as the example, consider the signal amplitude multiplied by a factor of 4 and by a factor of 8.

- (a) Plot the resulting signal (signal plus noise), comparing the two new amplitude levels.
- (b) What changes from the example? Can any conclusions be drawn about the (pure) signal and noise levels?

