Universidade Federal do ABC

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 SE0N_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

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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).

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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 $0 \leq \tau \leq 0.2$ (step of 0.01) and $0 \leq \tau \leq 1.5$ (step of 0.1).

(c) Calculate the time averages considering 1000 instances of $X(t)$.

(d) Observe the variation in the time average across instances. Can the process be considered stationary in the broad sense?

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Additional data: $R_{xx}(\tau) = 16 + 9/2\cos(5\tau)$

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?

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