EE5471: Assignment on Random Number Generation

Harishankar Ramachandran
EE Dept, IIT Madras

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1 Reading Assignment

Chapter on Random Numbers

2 The Assignment

1. Implement the function to generate normally distributed random numbers in Python. Plot a histogram of the random numbers generated and compare to the theoretical pdf.
2. Packets arrive from a Poisson Source ($p(t) = e^{-t}$). Generate N packets ($N = 30$) and identify the packet arrival times (packet 2 arrival time follows the same statistics, starting at the time 1st packet arrived.) Repeat this experiment 100 times, and plot a histogram of the arrival time of the 30^{th} packet. Explain the shape (see Q4).
3. Consider the following function:

$$f(x,y) = u^2 + v^2 \tag{1}$$

where

$$\begin{pmatrix} u \\ v \end{pmatrix} = \begin{pmatrix} \cos\alpha & \sin\alpha \\ -\sin\alpha & \cos\alpha \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} - \begin{pmatrix} 0.5 \\ 0.5 \end{pmatrix} \tag{2}$$

where $\alpha = \pi \sin\left(10\left(\sqrt{x^2+y^2} - 0.5\right)\right)$. We wish to compute

$$I = \int_{|f|<1} dxdy$$

   (a) Write a Python function to implement this function of two variables, x and y.
   (b) Plot a contour plot (use `contourf` to get filled contours) of the function with contour values `[0.0,1.0]` and consider the region corresponding to $|f| < 1$.
   (c) Find a covering function that contains all the places where $|f|$<1, and use it to estimate the integral above.

4. Understand and implement in Python, the algorithm to generate the probability of getting m events in a time t when the arrival rate is λ, i.e.,

$$p_{\lambda,m}(t) = \frac{(\lambda t)^m e^{-\lambda t}}{m!}$$