Asynchronous Activity 2: Identifying Noise Distributions

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Abstract

This activity contains exercises related to DSP, statistics, and probability as part of our COSC360 course. Please watch Course Videos 5.1-3 for a review of recent material. Course video 5.3 pertains directly to the asynchronous activity below. Course videos 4.1, 4.2, etc. review many Octave techniques used so far in the course.

1 Probability Distribution Functions (PDFs) and Cumulative Distribution Functions (CDFs)

1. Create a graph of the *uniform distribution* by using the `rand` in Octave. The graph should be a histogram containing 10^6 data values and split into 100 bins.
2. Suppose we have an exponential function $p(x) = b\exp(-bx)$ describing the PDF of a random variable x that can be measured on $[0, \infty]$. Show that this function is normalized if you integrate it from 0 to ∞.
3. Following the procedure in Course Video 5.3, work out the CDF of $p(x)$. THis involves integrating it up to a constant value.
4. Show that, if the CDF $\phi(x)$ is inverted (solve for x), one obtains $x = -b^{-1}\ln(1-\phi)$. Modify your code used above to plot the histogram, to first insert the uniform random numbers from `rand` into the inverted CDF $x(\phi)$. Make a histogram of the outputs x. The histogram should no longer follow a uniform distribution, but *an exponential distribution.*

2 Fourier Transforms and Random Noise

Locate the script `FFT.m` on Moodle under the Unit 1 code folder. Alter the script to do the following:

1. Change the sine wave frequency to 200 Hz, rather than 75 Hz. Re-run to see the effect on the plot.
2. Turn off the noise hy setting the parameter `noise_sigma` to zero. Re-run to see the effect on the plot.
3. In the line defining the data to be transformed, y, multiply the original sinusoid with a second sinusoid of similar but not identical frequency. Re-run to see the effect on the plot.