Signal & Data Analysis in Neuroscience
Bar-Ilan, Spring 2018 Due: Mon March 19 8:00 AM.

Assignment 01

Stochastic process

1) The data file 'ex1Question1.mat' contains 3 matrices: *eeg1*, *eeg2* and *eeg3*. Each matrix contains 300 repetitions each of an experimental EEG recording. Each 5 second recording has 200 samples performed at a rate of 40 samples/second (i.e. 200 random variables). For each of the matrices is the data stationary in the wide sense? Explain your answer.

2) The famous hand tuned magic dice factory was asked to produce magic dice whose probability for drawing [1,2,..,6] are [p_1, p_2, p_3, …, p_6]. Unfortunately when testing a single dice we don't get the desired probabilities for drawing [1,2,..,6], but rather the constant probabilities $P^{Dice} = [p^{Dice}_1, p^{Dice}_2, \ldots, p^{Dice}_6]$. When testing a group of dice the group average probabilities for drawing [1,2,..,6] equals [p_1, p_2, p_3, …, p_6]. Let us define a stochastic process as the drawing results of a single magic dice.

a) Is the process ergodic? Elaborate.
b) Is the process wide sense stationary? Elaborate.
c) Is the process strict sense stationary? Elaborate.

3) Firing rates and convolution

The data file 'ex1Question3.mat' contains spikes times recorded over one minute. Spikes times are in milliseconds. Use milliseconds bins to create the spike train.

a) What is the mean firing rate over the whole periods?

b) Find the spike firing rate r(t) using non-overlapping windows of length 0.1s. Repeat this for windows of 0.6s, 1s and 4s.
Plot r(t) for the different windows on the same plot (in different colors).

c) Write your own convolution function 'MyConv'. Compare 'MyConv' to Matlab's 'conv'. Display the result of convolving a simple uniform function [x = ones(40,1)] with a small rectangular window (length = 8 bins). Show the result from Matlab's conv()for comparison. Make sure to treat the edges correctly.

d) Find the spike firing rate r(t) using a sliding rectangular window of length 0.1s.
Repeat this for windows of 0.6s, 1s and 4s.
Plot r(t) for the different windows on the same plot.
Remember to normalize each window's area to 1.

e) Find the spike firing rate r(t) using a sliding Gaussian (window span = 0.9 sec, std =0.35s).
Repeat with a Gaussian window of span = 0.35 sec and std = 0.1s.
Plot r(t) for the different windows on the same plot. Plot both windows.

Explain the results!

Note: In a case 'MyConv' results are different form Matlab's 'conv', use Matlab's 'conv' for **d-e**.

Remember legends, axis labels (for all axes) and units for all graphs/plots.