Signal & Data Analysis in Neuroscience
Bar-Ilan, Spring 2020 Due: Thursday March 26 10:00 AM

Assignment 01

1) Stochastic process

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) Firing rates and convolution

The data file 'ex1Question2.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 0.2s. Repeat this for windows of 0.5s, 1s and 3s.
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(30,1)] with a small rectangular window (length = 6 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 0.2s.
Repeat this for windows of 0.5s, 1s and 3s.
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 = 0.8 sec, std =0.25s).
Repeat with a Gaussian window of span = 0.45 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**.

3) Convolution

Calculate analytically the result of the convolution between the input signal x(t) and the window h(t) are given by:

$$x(t) = e^{\alpha t}u(t)$$
$$h(t) = e^{-\alpha t}u(-t)$$
$$u(t) = \begin{cases} 1 & t \leq 0 \\ 0 & \text{otherwise} \end{cases}$$
$$\alpha > 0$$

according to the convolution integral formula. Solve analytically (no Matlab)

Instructions

1. Remember legends, axis labels (for all axes) and units for all graphs/plots.
2. Submit a softcopy (including source code) to biu.sigproc@gmail.com.
3. Note the due date and time.
4. Individual work - No code sharing please.