Humboldt-Universität Berlin
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Computer Praktikum 4
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Computational Neuroscience II: Foundations of Neural Coding

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! General advice

Remember to not directly invoke the commands at the matlab prompt. Use scripts instead.

9. Calculating Correlations

- Produce two vectors `v1` and `v2` that contain the values of the discretized function

$$v(t) = t\,\exp(-t/\tau)\,\sin(2\pi\, f\, t)$$

for $(\tau_1, f_1) = (1, 0.25)$ and $(\tau_2, f_2) = (1.5, 0.33)$ in the interval $[0, 20]$. Take $\mathrm{d}t = 0.05$ as bin size.

- The correlation between two vectors `v1` and `v2` of equal length N for a given lag n can be understood as the dot product of the two vectors, where the entries of one of them are shifted by n positions. Write the Matlab function `correlate` that takes as arguments two vectors of equal length N and returns the correlation for all possible shifts n. *Hint: a vector of length* $2\,N - 1$. Plot the correlation between `v1` and `v2` for all time lags $s = n\,\mathrm{d}t$.
- Explore the documentation of the Matlab command `xcorr` and plot the correlation between `v1` and `v2` with `xcorr`.
- Calculate the correlation between the vectors you will find in the files "/home/tutor/CompNeuroII/Assignment4/noiseX.dat", where X=1,2. Plot the correlation in the interval $[-100, 100]$.

10. Correlations of spike trains

Use `xcorr` to plot all correlations between the spikestrains from Assignment 2 into one figure with >> `subplot`. *Hint: Produce histograms of the spiketrains first (*`histc`*) using a binsize of 5 ms! The Histogram of the spike trains should look like*
$\ldots, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 2, 0, 0, 1, 0, 0, \ldots$. Plot the autocorrelations of the spiketrains and the crosscorrelation in the intervals
$[-500\text{ ms}, 500\text{ ms}]$, $[-3000\text{ ms}, 3000\text{ ms}]$ and $[-2000\text{ ms}, 2000\text{ ms}]$, respectively.

11. **For specialists.**

    You will have experienced that your function `correlate` performs much worse than the built-in Matlab function `xcorr`. Find and implement a numerically cheap correlation routine using Fast Fourier transformation. *Hint: In your Math lectures you may have heard about the Fourier-convolution theorem. If not, see what you can find on the internet. Try to apply the fourier convolution theorem to the correlation formula*

$$Q_{v_1 v_2} = \int_{-\infty}^{\infty} v_1(t)\, v_2(t+s)\, \mathrm{d}s$$

    and implement it using `fft, ifft,ifftshift`.

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