Machine Learning and Analysis of Neural Data

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Exercise Sheet : Spectral analysis 2. 9.06.22

Exercise 2.

Data: 16 channels of hippocampal LFP time series from a file lfp_1shank.mat.
Matrix lfps (1250Hz sampling rate samples x 16 channels)

1. Take a 30s long segment of data on a channel with largest theta power. Compute dynamic spectrum in the low frequency band (<20 Hz) using
    a. multitaper spectrogram with a sliding window (overlap can be large, vary the window size and NW to see the effect on frequency/time resolution). Plot. Describe.
    b. using scalogram computed using wavelet transform (e.g. using Morlet wavelet using some package). Plot. Describe
    c. filter the signal in [5 20] Hz band, compute analytic signal using Hilbert transform and extract instantaneous power/phase, compute inst. frequency. Plot. Describe

2. Compare estimates of theta frequency derived as frequencies with maximal spectral power in theta band at every spectral window (multitaper) or sample (wavelet and inst. frequency derived from Hilbert transform).

3. Using AR model fit (p=2 or 3) implement signal whitening. Compute gamma band spectrum with and without whitening.

4. Compute spectrogram using different estimation methods for a piece of data (1 sec) at a channel 7 in the high frequency range [30 200]. Slide it over time to explore the signal.
    a. Compare multitaper, wavelet and EMD-based methods for resolving single gamma oscillation bursts.
    b. Use whitening from (3) for multitaper spectrogram estimation.