

## Homework for CFC

1. Load the file **LFP-2.mat** available at the GitHub repository into Python. You will find two variables. The variable LFP corresponds to an LFP recording. The variable t corresponds to the time axis, in units of seconds. Use these data to answer the following questions.
  - a. **Visualize** the time series data. What rhythms do you observe? Do you detect evidence for CFC in your visualizations?
  - b. **Plot the spectrum** versus frequency for these data. Are the dominant rhythms in the spectrum consistent with your visual inspection of the data?
  - c. **Apply the CFC** method we discussed in class to these data. In doing so, you must choose the low-frequency and high-frequency bands. What choices will you make, and why? What – if any – CFC do you find?
  - d. **Describe** (in a few sentences) your spectrum and CFC results, as you would to a colleague or collaborator.
2. Load the file **LFP-3.mat** available at the GitHub repository into Python. You will find two variables. The variable LFP corresponds to an LFP recording. The variable t corresponds to the time axis, in units of seconds. Use these data to answer the following questions.
  - a. **Visualize** the time series data. What rhythms do you observe? Do you detect evidence for CFC in your visualizations?
  - b. **Plot the spectrum** versus frequency for these data. Are the dominant rhythms in the spectrum consistent with your visual inspection of the data?
  - c. **Apply the CFC** method we discussed in class to these data. In doing so, you must choose the low-frequency and high-frequency bands. What choices will you make, and why? What – if any – CFC do you find?
  - d. **Describe** (in a few sentences) your spectrum and CFC results, as you would to a colleague or collaborator.
3. Generate synthetic data consisting of Gaussian noise. More specifically, generate 100 s of artificial noise data sampled at 1000 Hz. Then compute the

CFC of these data. To do so, use the low-frequency band of 5–7 Hz and the high-frequency band of 80–120 Hz. What do you expect to find (i.e., will this noisy signal exhibit CFC)? What do you find?

**(OPTIONAL)** In our analysis of CFC, we focused on distinct choices of high- and low-frequency bands. However, sometimes we would like to explore a broader range of potential cross-frequency interactions. To do so, we need a comodulagram. Use the code developed in this module to define a new function that computes a comodulogram. Your comodulogram should have two axes:

- a. x-axis: the phase frequency (e.g., 3 Hz to 12 Hz in 1 Hz steps)
- b. y-axis: the amplitude frequency (e.g., 50 Hz to 200 Hz in 10 Hz steps)

For each pair of (x-axis, y-axis) values, determine the statistic  $h$  and plot the three-dimensional results. For reference and motivation, consider the comodulograms in <https://www.ncbi.nlm.nih.gov/pubmed/23345227>