Worksheet: Circular statistics

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In this worksheets you will practice:

- accesing electrophysilogy data from Dandi,
- bandpass filtering a signal,
- calculating the instantaneous amplitude and phase of a signal with the Hilbert transform,
- computing the circular mean of a set of phases,
- testing for non-uniformity in a set of circular variables with the Rayleigh test,
- detecting traveling waves in local field potentials,
- performing a linear regression analysis.

You will quantitatively characterize traveling waves in human electro corticographic recording from humans during the production of consonant vowel syllables, as described in Rapela (2016, 2017, 2018). A video illustrating these traveling waves can be found here. This video shows the local field potential (LFP) voltages bandpass filtered between 0.4 and 0.8 Hz, around the mean frequency of consontant-vowel syllable production of 0.62 Hz.

1 Install the Python packages required to obtain data from Dandi

2 Calculate the mean frequency of consonant-vowel syllable production

3 Bandpass filter the raw voltages

Reproduce Figure 6 from Rapela (2016).

4 Compute the Hilbert transform of the filtered voltages

5 Calculate phase histograms and test for circular non-uniformity

Reproduce Figure 17 from Rapela (2017).

6 Find traveling waves events

Reproduce Figure 15 from Rapela (2018).

References

Rapela, J. (2016). Entrainment of traveling waves to rhythmic motor acts.

Rapela, J. (2017). Rhythmic production of consonant-vowel syllables synchronizes traveling waves in speech-processing brain regions.

Rapela, J. (2018). Traveling waves appear and disappear in unison with produced speech.