

Assignment 1.1: Extracting Theta Activity from raw EEG (2%)

Due Date: September 15th, 2025 at 11.59 pm

You are a trainee in the lab studying circuits that control Rapid Eye Movement (REM) sleep. In particular, you are interested in whether lateral supramammillary area (SUML) neurons generate theta oscillations. Theta oscillations are rhythmic brain waves

typically in the 4-8 Hz frequency range, and they are a hallmark of REM sleep (Peever & Fuller, 2017). You are interested in studying them because they play a key role in memory consolidation and emotional regulation, making them a vital component of healthy brain function (Hutchison and Rathore, 2015).

REM Sleep



sawtooth-like
appearance: 4-8 Hz

To manipulate SUML glutamate neurons and test whether they are important for theta generation, you injected these mice with an excitatory opsin in the SUML and implanted an optic fiber in the same region to activate these cells (**see Lecture 2 - Optogenetics**). Additionally, you implanted an electrophysiology apparatus to record the mouse's brain waves (**see Lecture 1 - Electrophysiology**).

In this example, you are given an array of raw EEG values labeled as REM_Baseline1. The data was collected at 1024 Hz sampling rate.

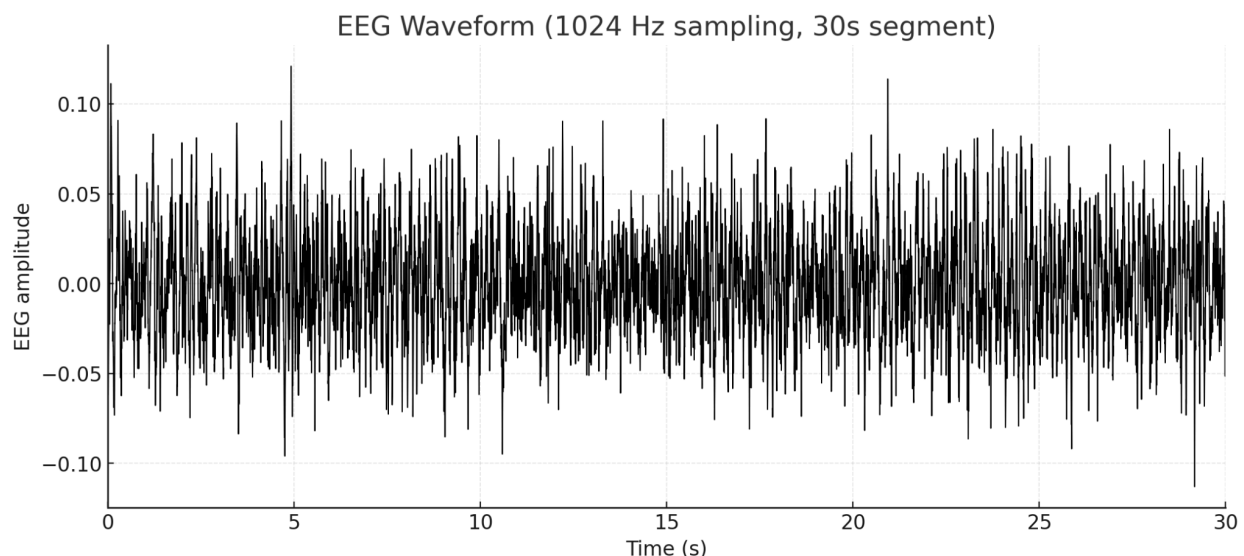


Figure 1: Example trace of EEG Recording during REM Sleep for one baseline trial

Q1: What mathematical method would you use to extract information about theta activity from these EEG signals?

Q2: Create a Python function that:

- Takes the raw EEG signal and sampling rate as inputs
- Applies a mathematical method to transform the EEG signal into appropriate frequencies
- Return the frequency values and the corresponding power spectrum

Q3: Write a function that calculates the power of theta. Your function should do the following:

- Takes the output from your function from part 2
- Selects only the values in the appropriate theta range
- Calculate the total power in the appropriate range
- Return the theta power as your output

Q4: What is the proportion of theta power (in %) for this segment?

Data is collected and provided by two graduate students in the Peever Lab, Anita Taksokhan and Vasilisa Nikiporets.

References:

Peever, J., Fuller, P.M. (2017). The biology of REM sleep. *Curr Biol* 20, 1237–1248.

Hutchison, I.C., Rathore, S. (2015). The role of REM sleep theta activity in emotional memory. *Front Psychol* 6. doi: 10.3389/fpsyg.2015.01439.