2021 REHS Neuroscience Gateway Internship: HPC & EEGLAB

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1.
HPC Work

High Performance Computing

1. Multiple cores

- Pro: faster computation(speed-up)
- Con: speed-up can be limited by communication

2. Parallel computing

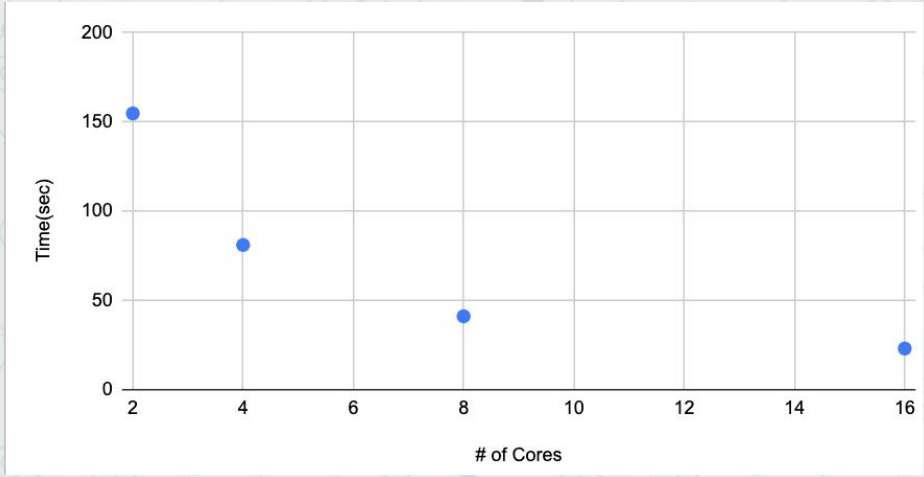
- Shared memory: OpenMP
- Distributed memory: MPI

Learning and Applying

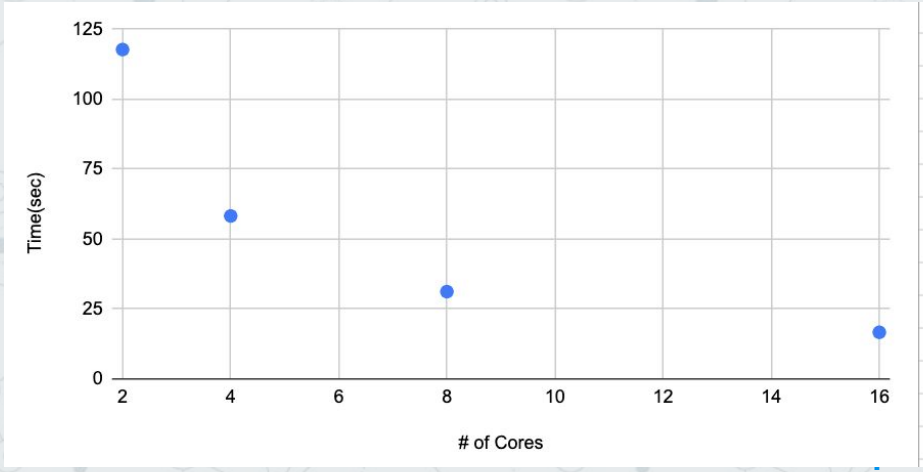
- Used Vi Editor to edit and submit Simple Linux Utility for Resource Management(SLURM) scripts in Comet's Unix environment
- Identified the difference in using OpenMP and MPI to complete the same task

8000 x 8000 Matrix Multiplication on Different Number of Cores

Shared Memory (OpenMP)



Distributed Memory (MPI)



2.
EEG

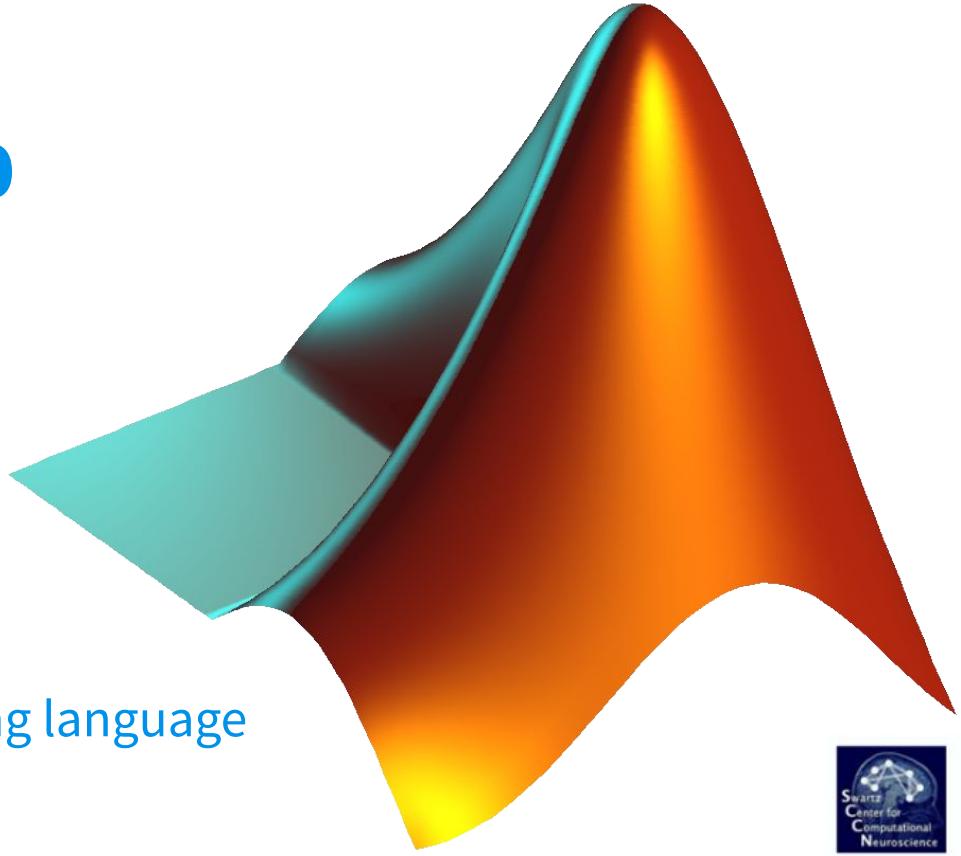
an introduction to electroencephalography...

electroencephalography

- electro (electrical)
- encephalon (brain)
- graphy (to record)

“to record the brain’s electrical activity”

Matlab

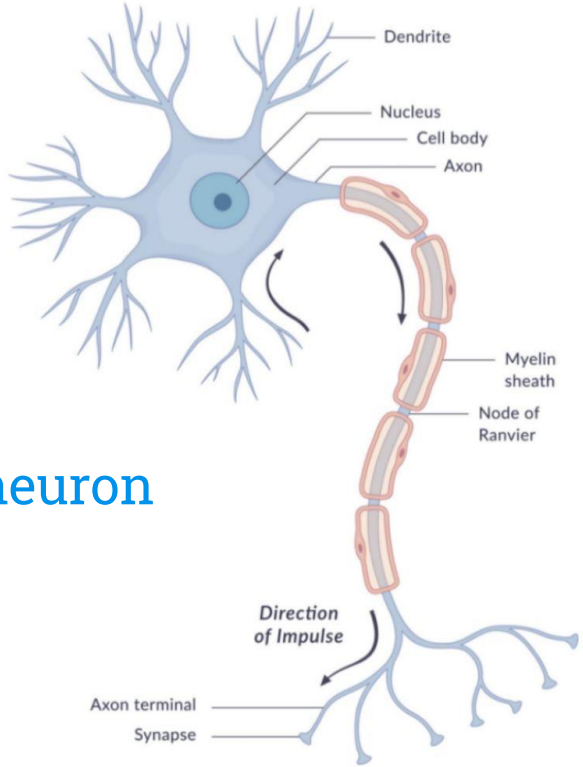


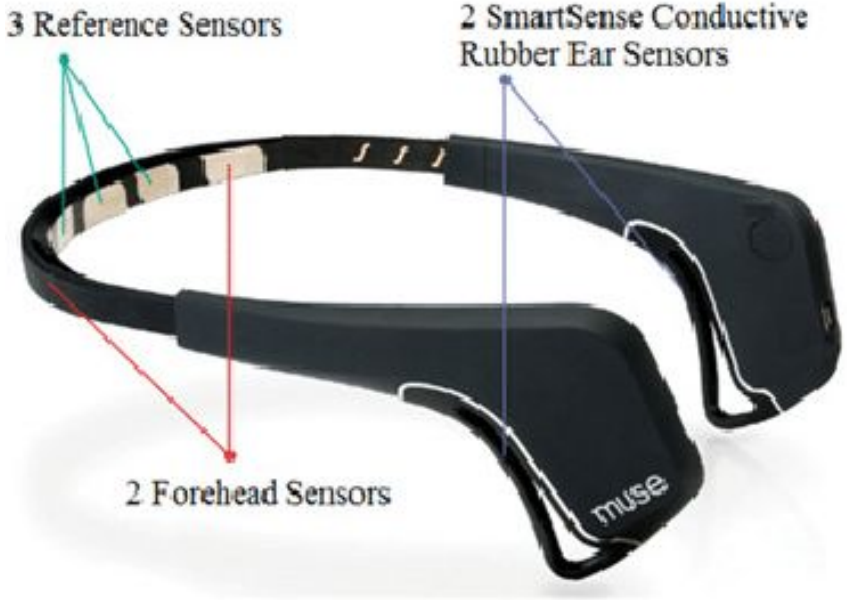
programming language

EEGLAB
an open source environment for electrophysiological signal processing

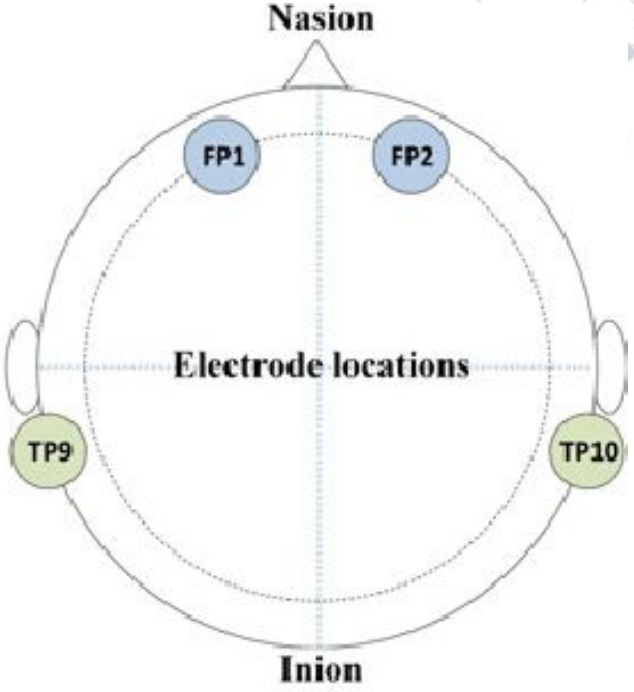
toolbox (GUI)

neuron

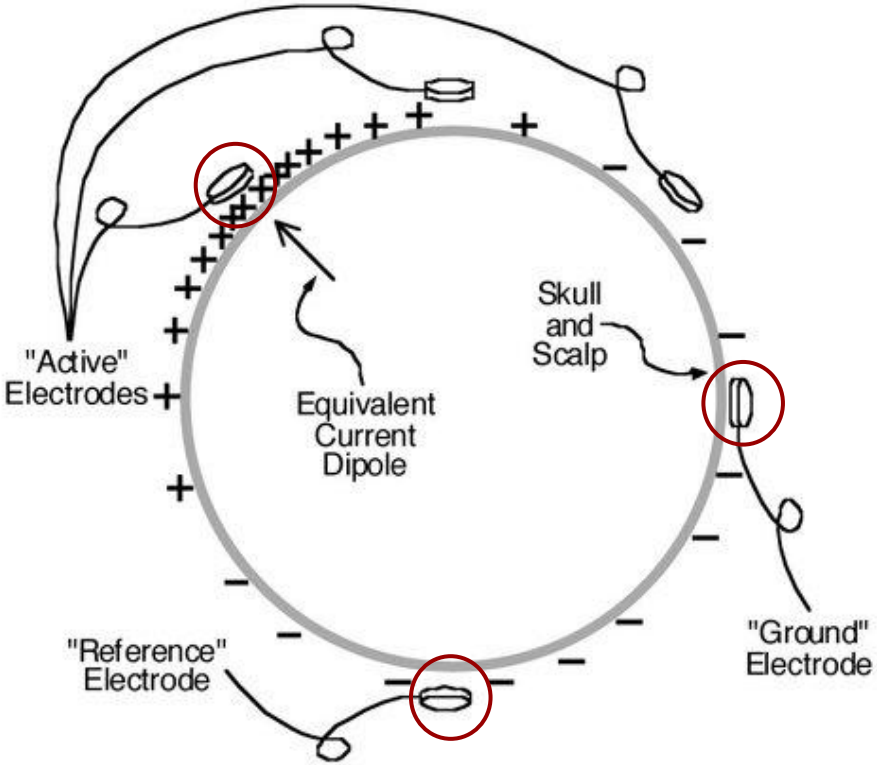

Dendrite
Nucleus
Cell body
Axon
Myelin sheath
Node of Ranvier
Direction of Impulse
Axon terminal
Synapse


3 Reference Sensors
2 SmartSense Conductive Rubber Ear Sensors
2 Forehead Sensors
muse

(a)


Nasion
FP1
FP2
Electrode locations
TP9
TP10
Inion

(b)


"Active"
Electrodes
Equivalent
Current
Dipole
Skull
and
Scalp
"Reference"
Electrode
"Ground"
Electrode

3.
Data Analysis

Data Collection

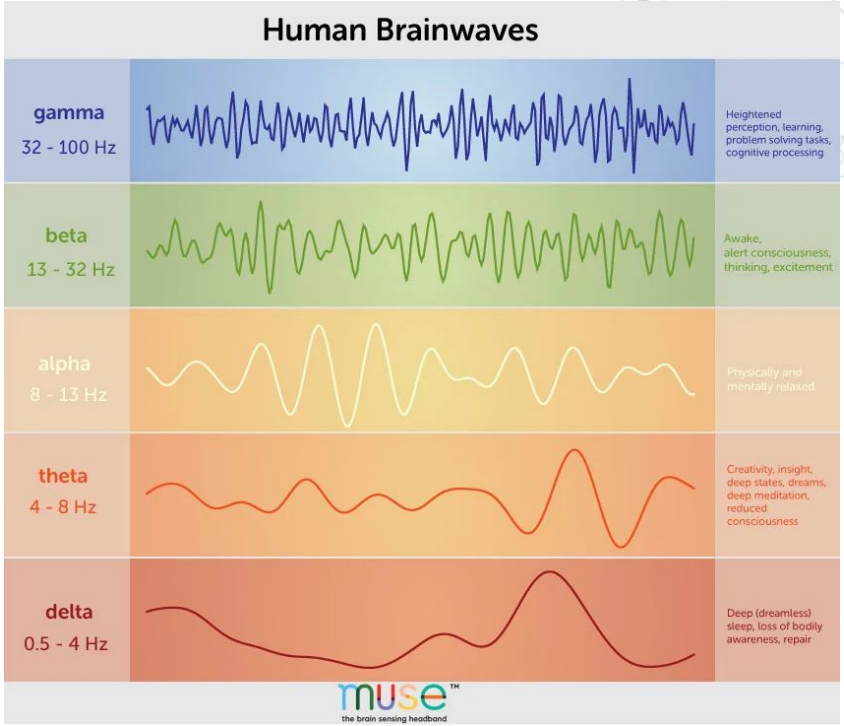
- We collected EEG data with our eyes closed and eyes opened using the Muse Device
    - Recorded 20 total EEG data files, 10 one minute eyes-closed(EC) and 10 one minute eyes-opened(EO)
- The purpose of collecting this data was to compare alpha level peaks when our eyes are open vs when our eyes are closed.

1. Put on Muse Headband and make sure all electrodes are sensed, connected, and functioning.
2. Record the files, either eyes closed or eyes opened for a minute and transfer the files to Dropbox
3. Convert files to .set files on Computer and label Eyes Closed as EC# and Eyes Opened as EO#
4. Open up EEGLab in Matlab and load the existing datasets.
5. Merge the 10 EC or EO datasets into one big dataset.
6. Remove EPOCH Baseline, use ASR to remove noise and disturbances in EEG Data
7. Plot 100% of the data and analyze alpha peaks on Spectra

Alpha Waves and Spectral Density

As mentioned before...

- Are usually in between 8-13 Hz
  - (Hertz (Hz) is the unit for frequency)
- Occur when people feel relaxed and when the brain is an idle state without concentrating on anything
- High Alpha Wave Spectral Density indicates that you are in a state of calmness and relaxation
- Absence or Low Alpha Wave Spectral Density indicates that your mind is not at its peak calm state
- Spectral Density: The level of electric potential energy as a function of frequency



Time and Rejection in Data

ASR - Artifact Subspace Reconstruction

(Separates noise from signal)

EPOCH - Time recorded of EEG Data

After ASR is done, the EPOCH of the Merged datasets will go down significantly since almost half of the data is noise and other disturbances that are removed with ASR.

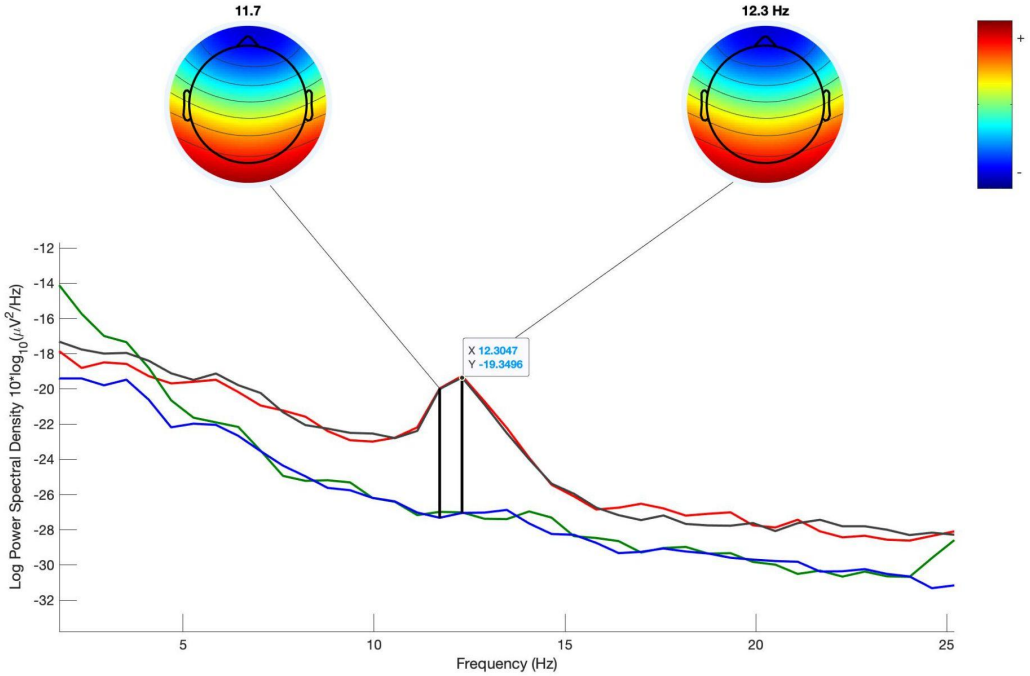
Sampling Rate: 300 Hz

EPOCH Before ASR: ~ 556.317 Seconds

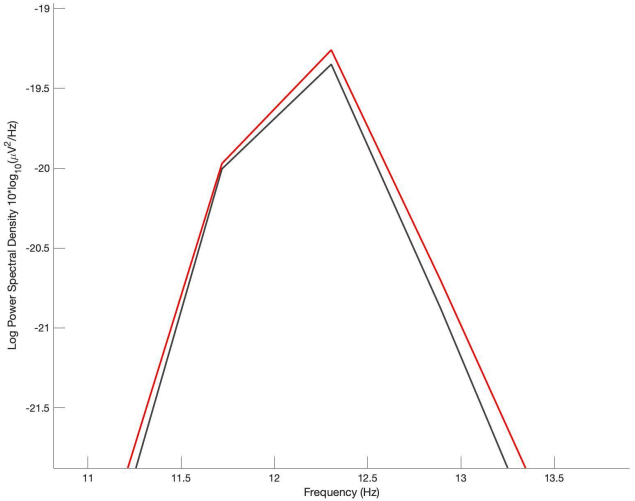
EPOCH After ASR ~ 415.274 Seconds

Results

Eyes Closed Graph:

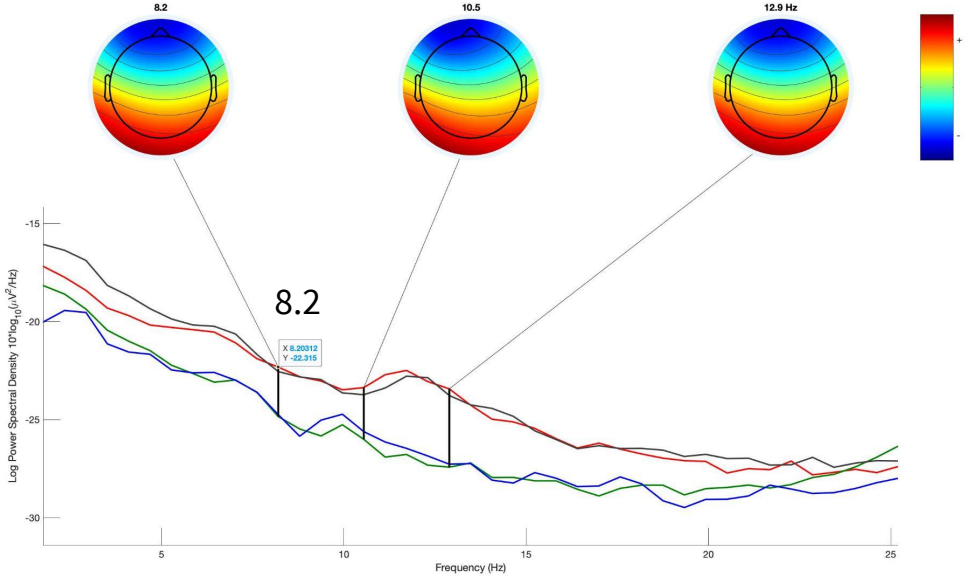


Zoom-in on Peak:

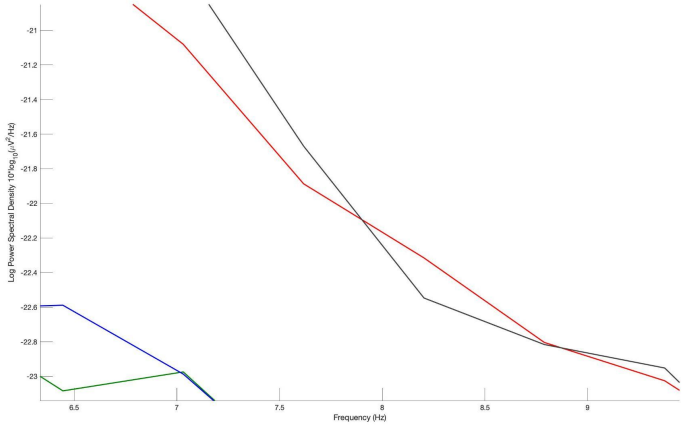


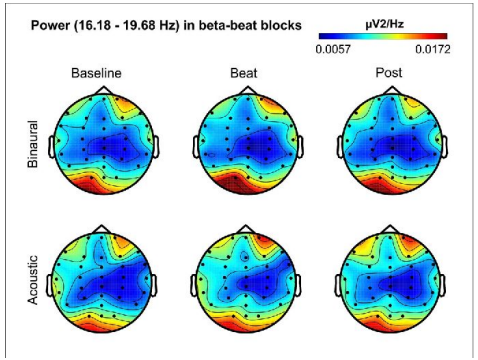
Results

Eyes Opened Graph:



Zoom-in on Peak:





Discussion

What did we find out?

What else can we do with EEGLAB?