

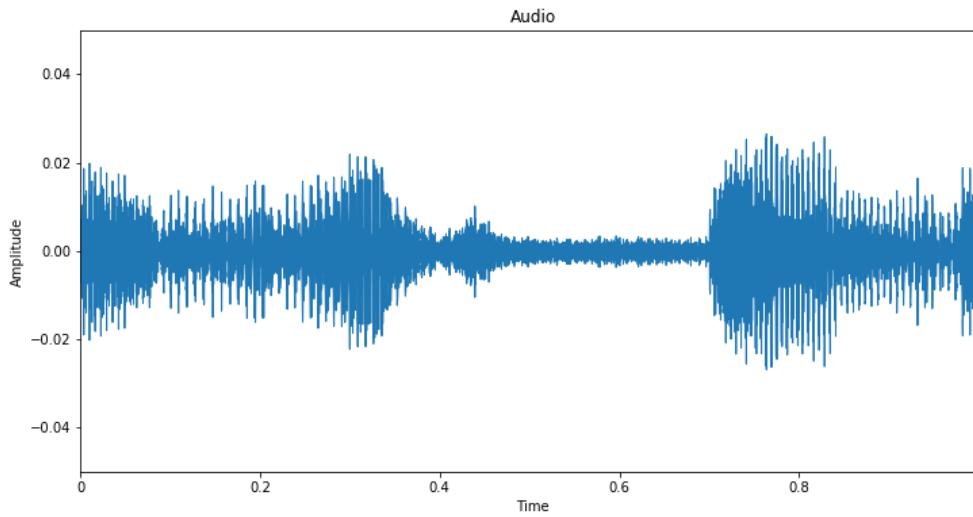
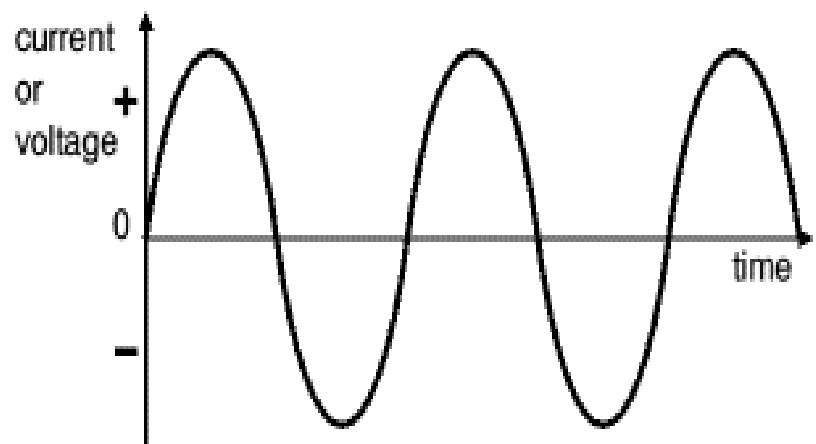
# **EEGLAB and ERPLAB**

Interdisciplinary Schools  
Signal Processing Department  
Parisa Khoorahe

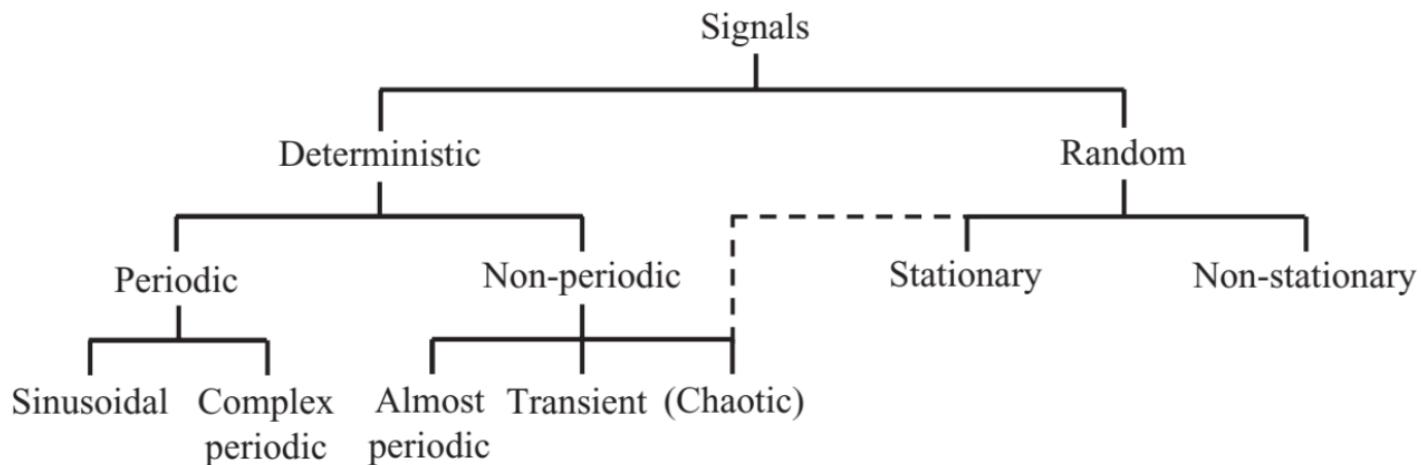
# **EEGLAB and ERPLAB**

- + Introduction (session 1)
- + EEGLAB (sessions 2 & 3)
- + EEGLAB-ICA (session 4)
- + ERPLAB (sessions 5 & 6)

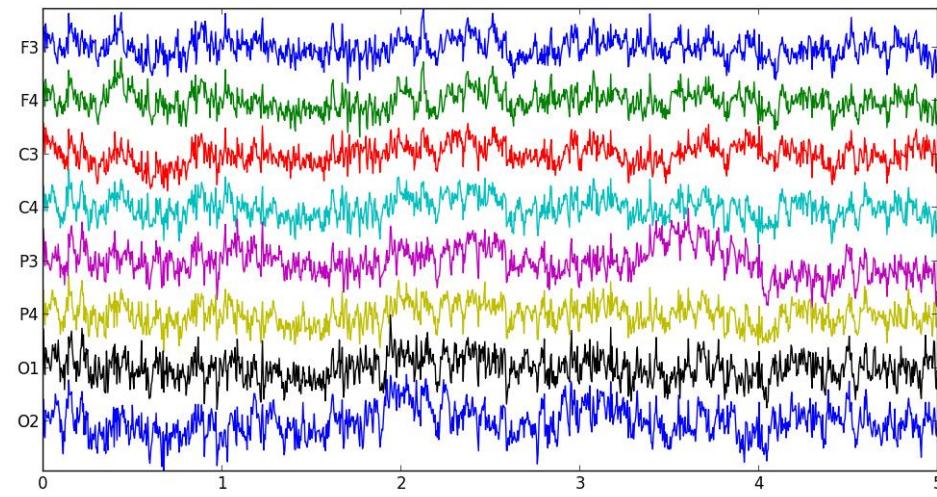
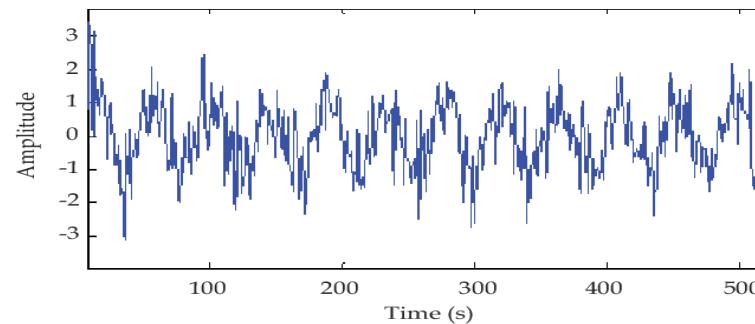
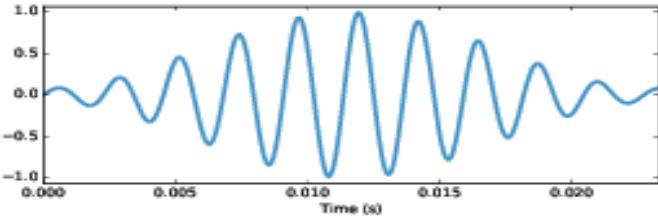
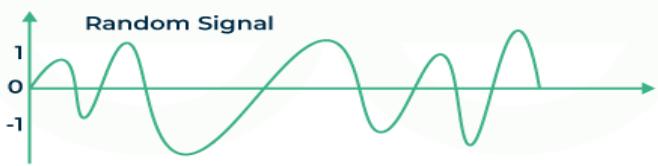
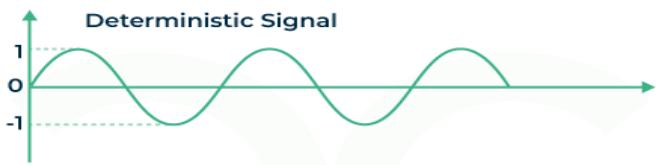
# Signal



# Signal Classification

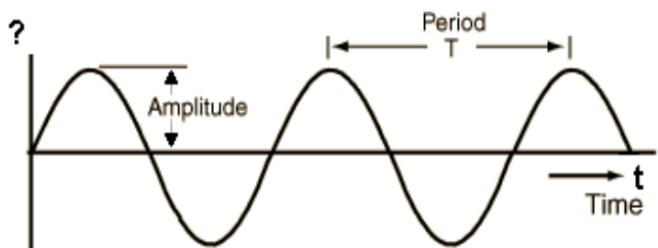
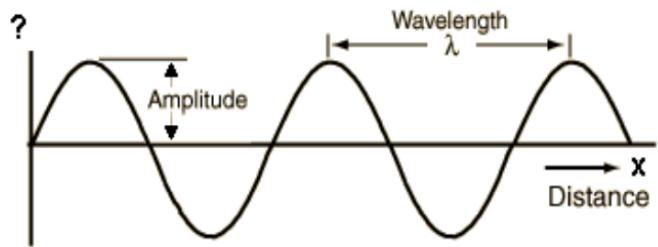


# Signal Classification



# Signal Characteristics

Characteristics of a sinusoidal signal

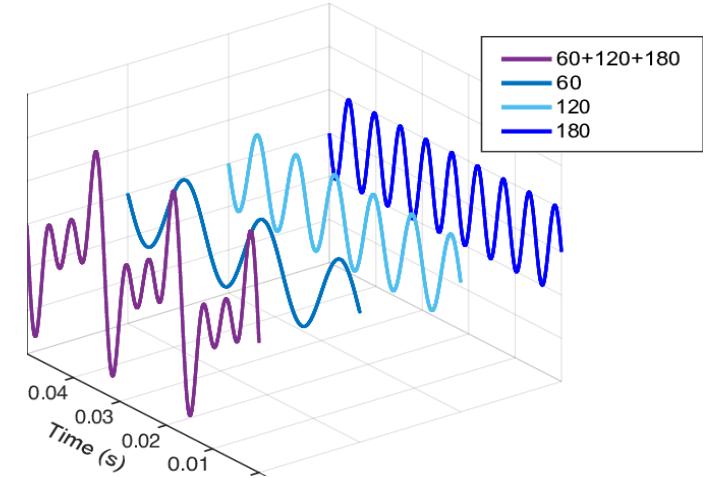


$$x(t) = A \sin(2\pi ft + \phi)$$

$$\begin{aligned} f &= \frac{1}{T} \\ f &= \frac{v}{\lambda} \\ f &= \frac{\omega}{2\pi} \end{aligned}$$

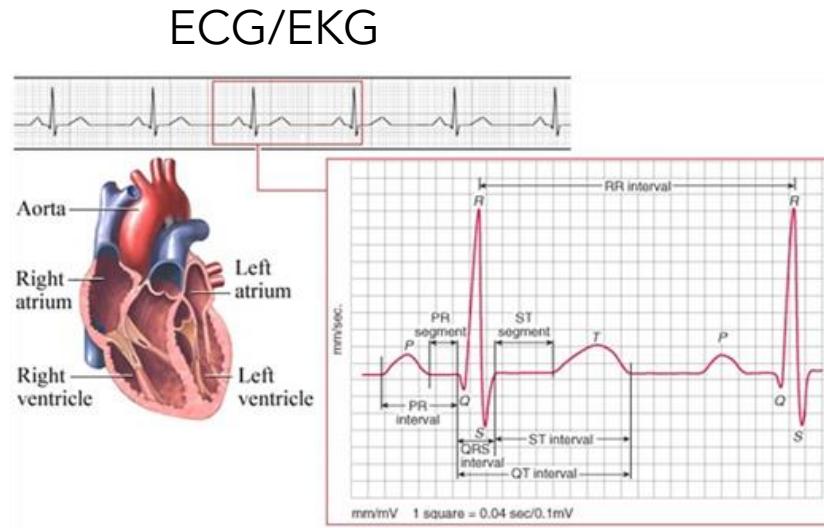
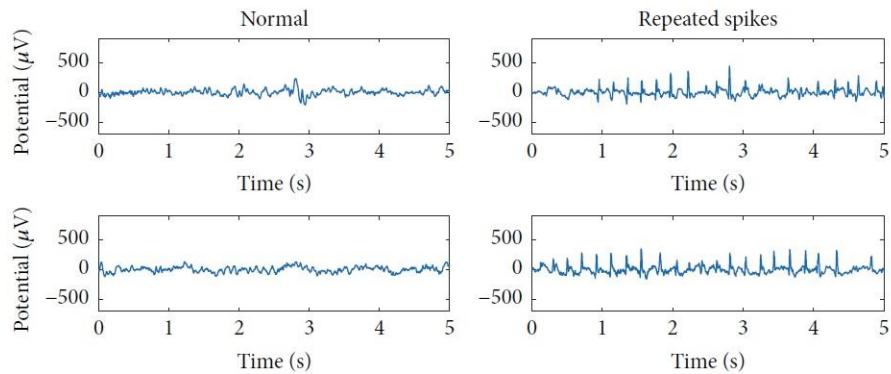
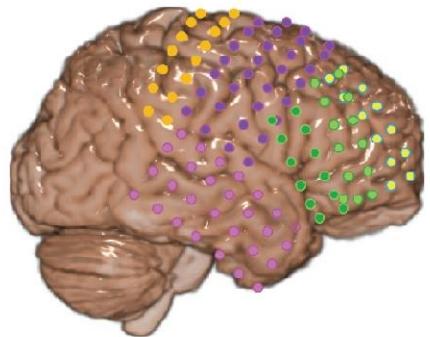
where,

- $f$  is the frequency in hertz, and
- $T$  is the time to complete one cycle in seconds
- $v$  is the wave speed, and
- $\lambda$  is the wavelength of the wave
- $\omega$  is the angular frequency

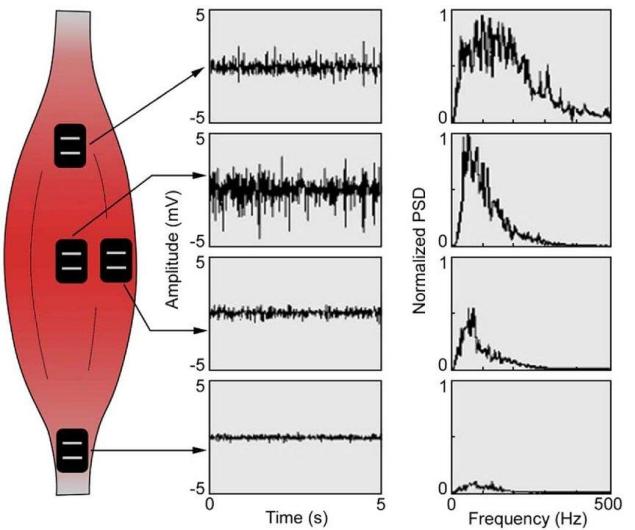


$$x(t) = \sum_{n=1}^N A_n \sin(2\pi f_n t + \phi_n)$$

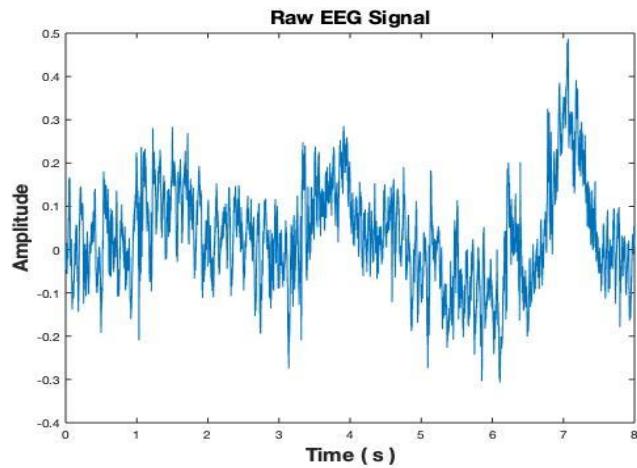
# Biosignals



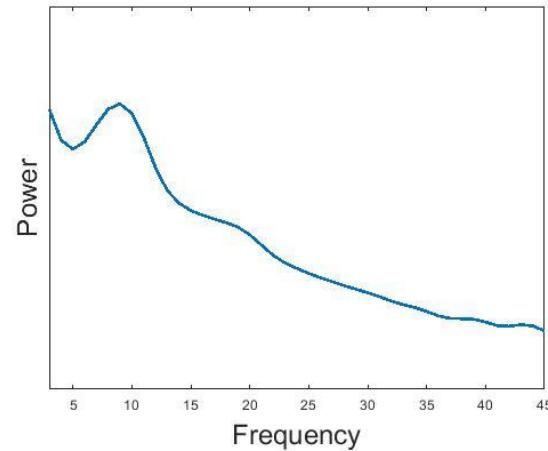
**EMG**



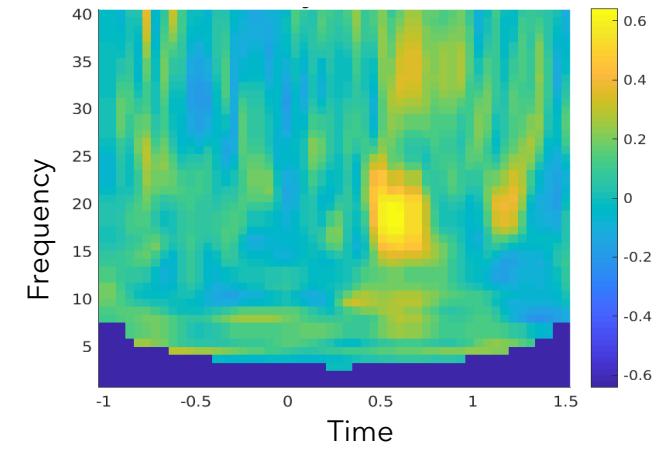
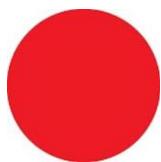
# Signal Characteristics



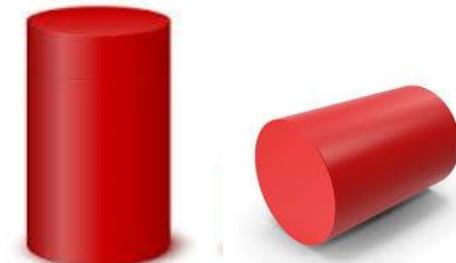
Time-domain



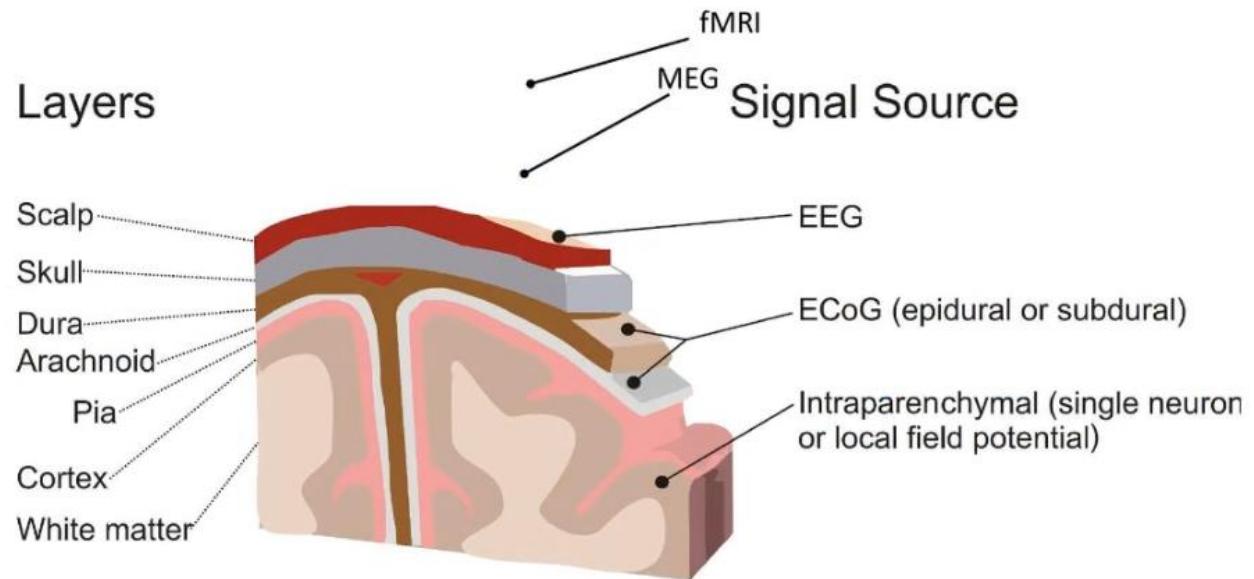
Frequency-domain



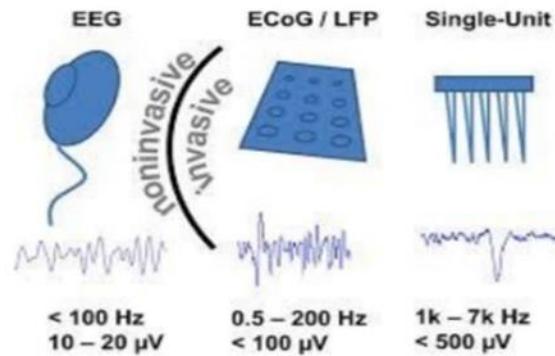
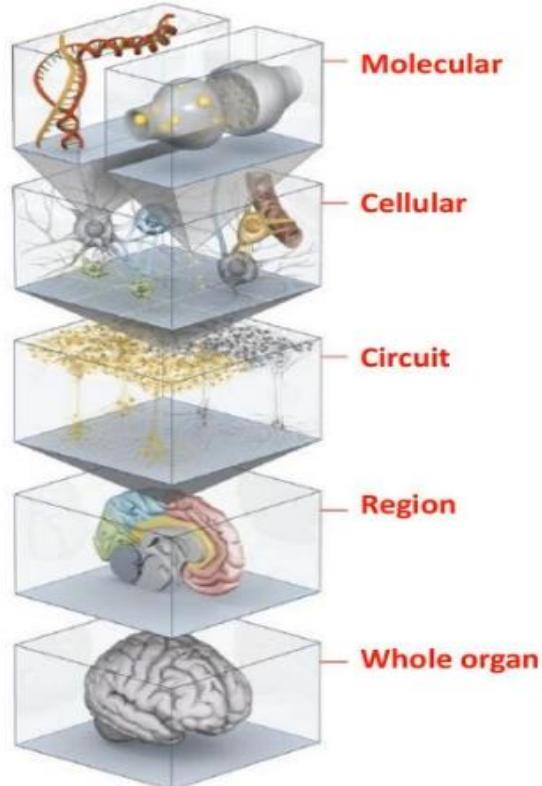
Time-frequency domain



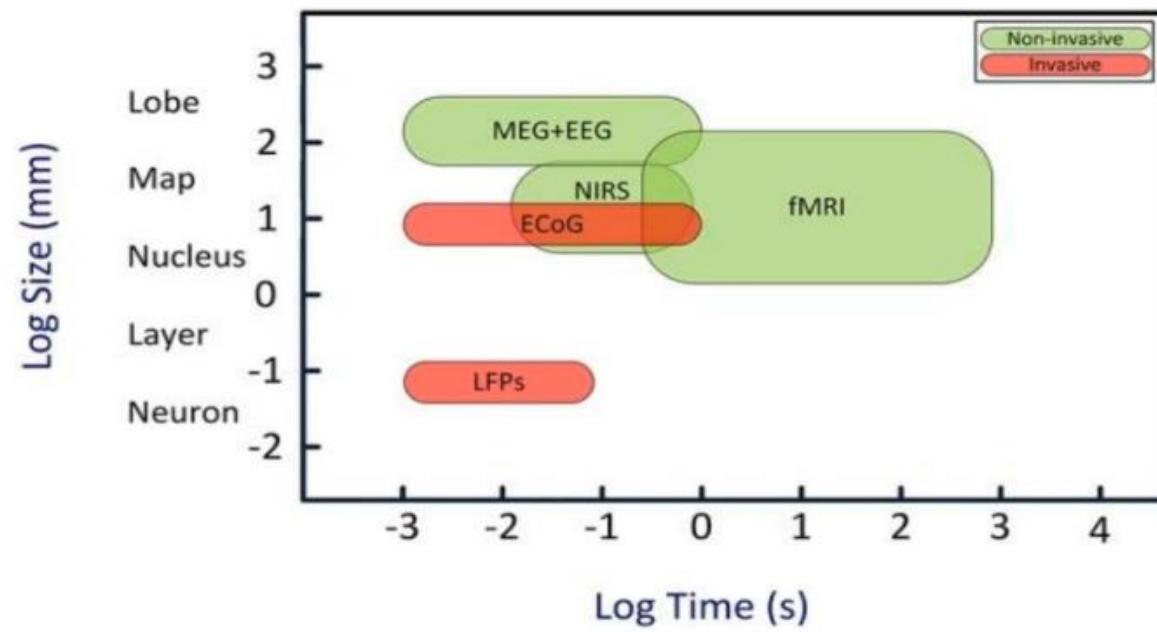
# Brain Signal Recording



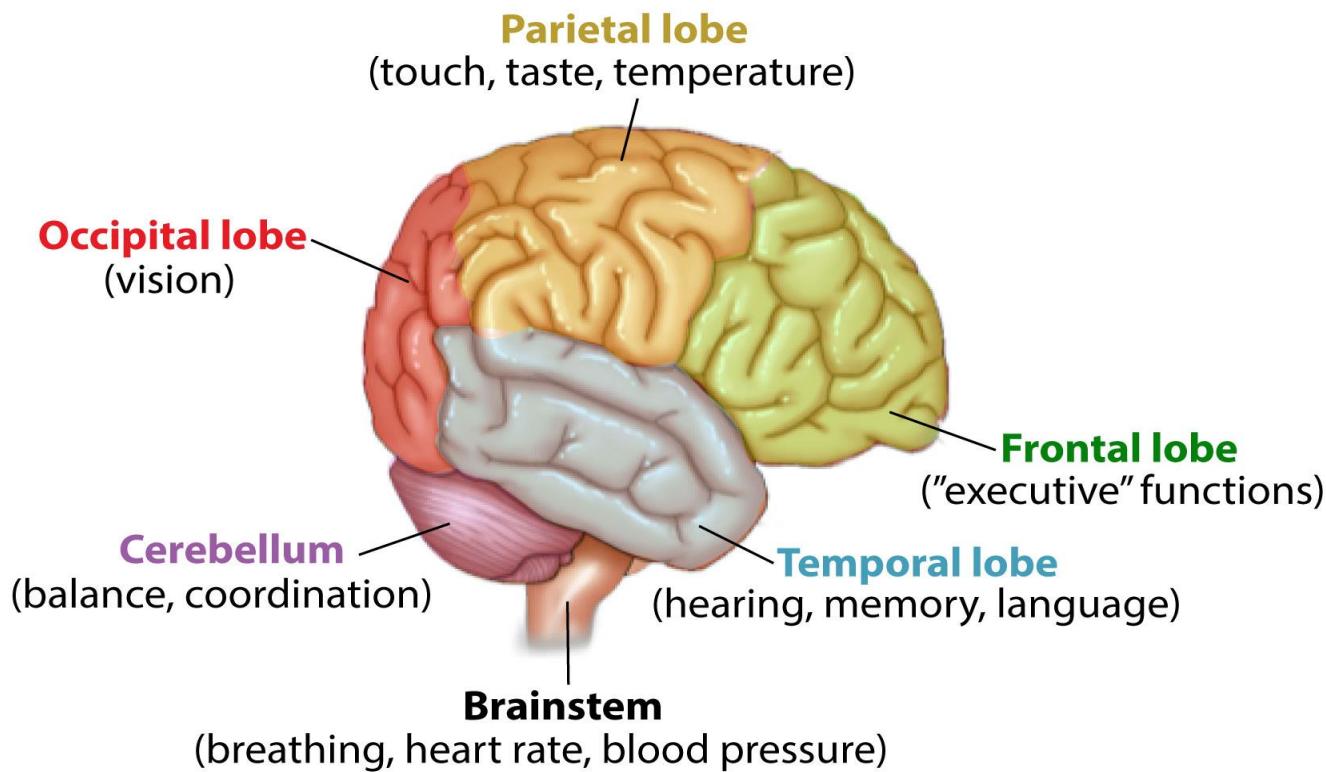
# Brain Signal Recording



# Brain Signal Recording



# Brain Lobes



# Brain Frequencies



GAMMA:  
Active Thought



BETA:  
Alert, Working



ALPHA:  
Relaxed, Reflective



THETA:  
Drowsy, Meditative



DELTA:  
Sleepy, Dreaming

31-60 Hz

14-30 Hz

8-13 Hz

4-7 Hz

0.5-3 Hz

frequency  
High

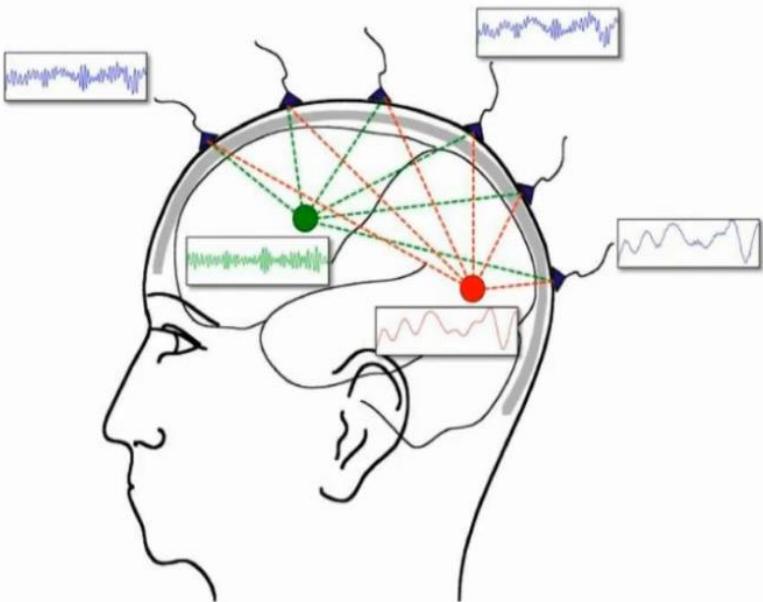
Low

amplitude  
Low

High

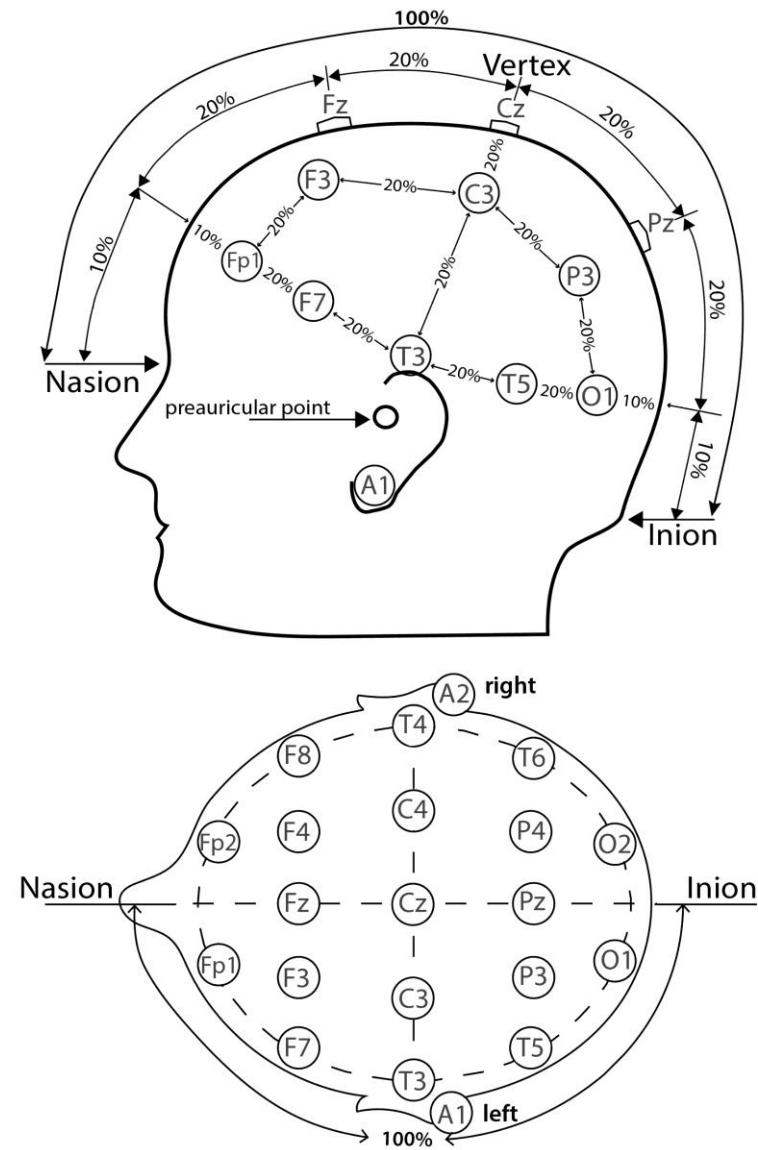
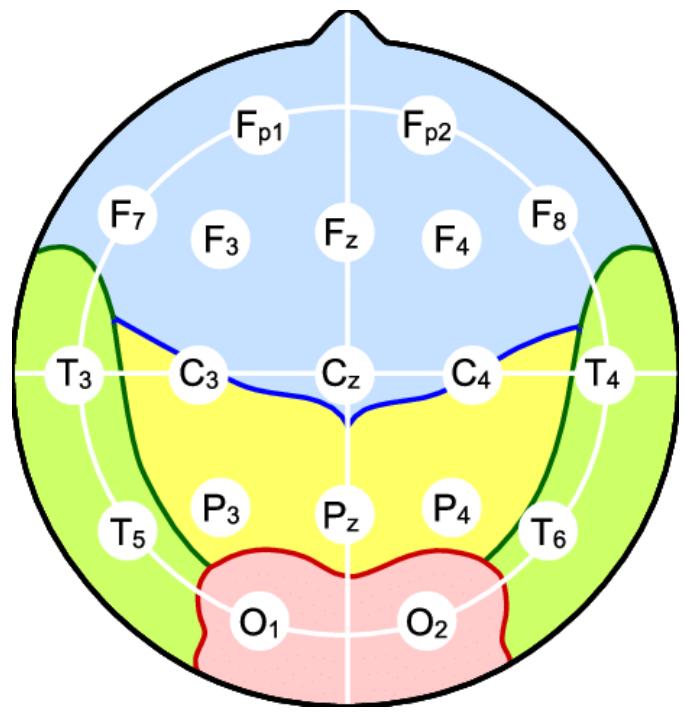
# EEG

## Sensor vs. Source



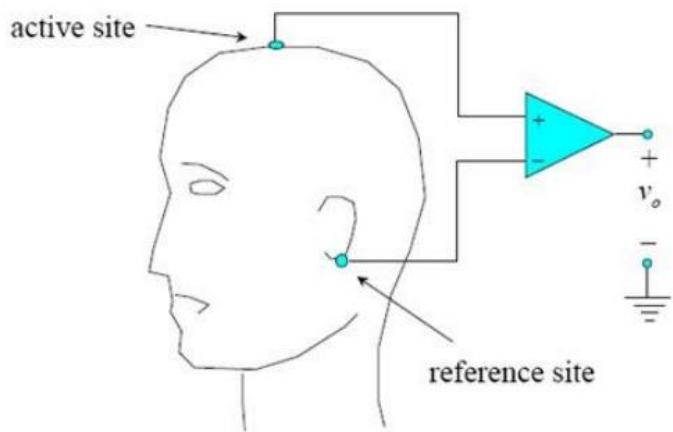
# EEG

10-20 system of EEG recording

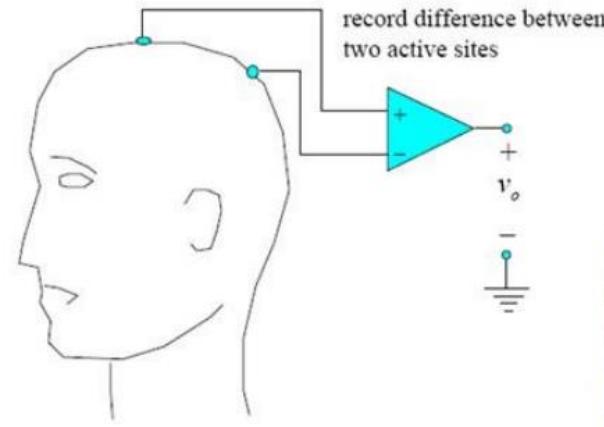


# EEG

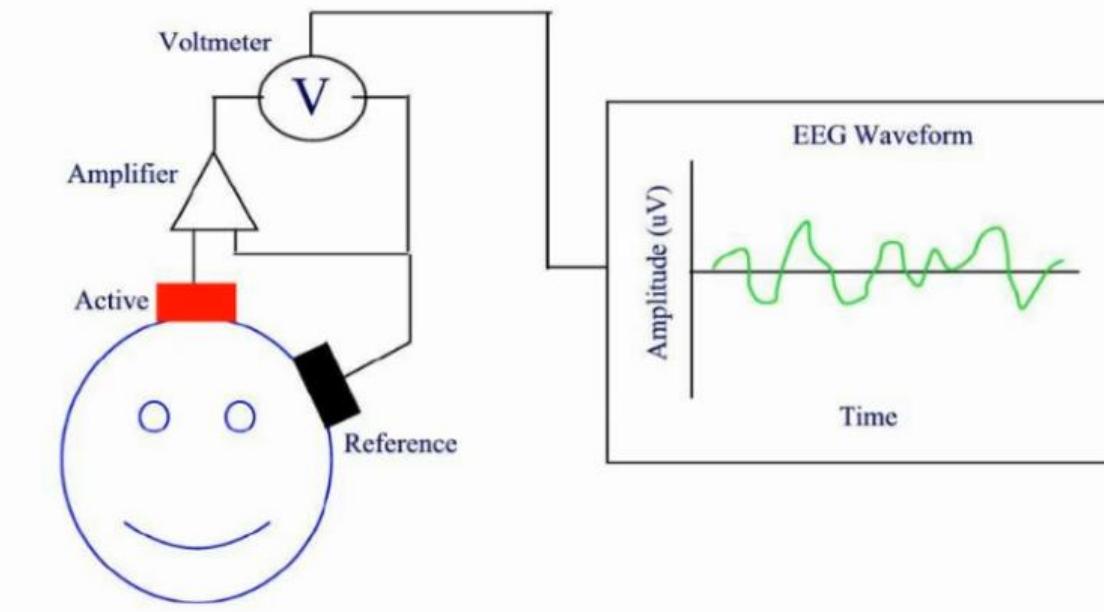
Unipolar EEG Recording



Bipolar EEG Recording

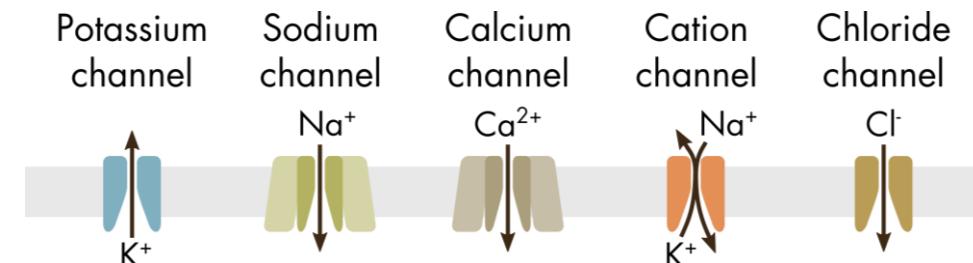
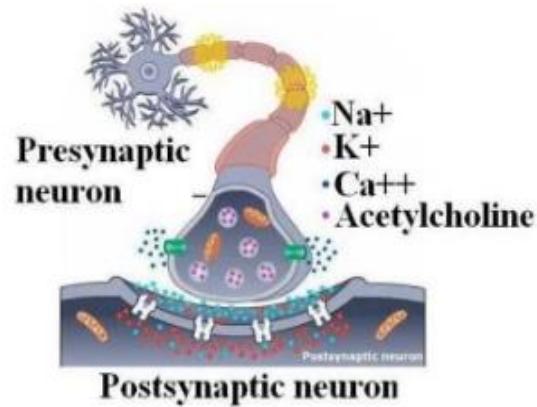


# EEG



# EEG

Main source of EEG signals



# EEG

## Frequency and Amplitude

### At cranial surface

EEG amplitude  $\approx$  0 to 100  $\mu$ V

EEG frequency  $\approx$  0.5 to 100 Hz

## Effective Factors

- Age
- Fatigue (level of consciousness)
- Level of blood oxygen, glucose, ...
- Mind state (mental effort)
- ...

# EEG

## Sources of EEG noise and artifacts

- **Nonphysiologic**

- Electrodes
- Headbox
- Amplifier
- Cable
- Environment
- Laptop and electronic devices
- Intravenous Fluids drip
- Respirator
- Phone ringing
- Bed/patient movements

- **Physiologic**

- Respiration artifact
- Eye blinks
- Eye movements
- ECG
- EMG
- Glossokinetic

# EEGLAB

Research News Events **EEGLAB** Contact

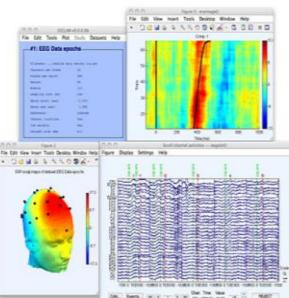
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- EEGLAB Workshop 2025 will be held from November 21 –

## What is EEGLAB?



EEGLAB is an interactive Matlab toolbox for processing continuous and event-related EEG, MEG and other electrophysiological data incorporating independent component analysis (ICA), time/frequency analysis, artifact rejection, event-related statistics, and several useful modes of visualization of the averaged and single-trial data. EEGLAB runs under Linux, Unix, Windows, and Mac OS X.



EEGLAB provides an interactive graphic user interface (GUI) allowing users to flexibly and interactively process their high-density EEG and other dynamic brain data using independent component analysis (ICA) and/or time/frequency analysis (TFA), as well as standard averaging methods. EEGLAB also incorporates extensive tutorial and help windows, plus a command history function that eases users' transition from GUI-based data exploration to building and running batch or custom data analysis scripts. EEGLAB offers a wealth of methods for visualizing and modeling event-related brain dynamics, both at the level of individual EEGLAB 'datasets' and/or across a collection of datasets brought together in an EEGLAB

<https://sccn.ucsd.edu/eeglab/>

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