**Intro to Computational Medicine: Imaging Fall 2023**

**Final Project**

**Instructions:**

In your final project, you will be working with data derivatives from MRI images from real research studies. In particular, you will be looking at volumes of structures in a particular brain region and how they vary with age, sex, and disease/disorder. This project will take the form of a **5-minute long presentation.** Make sure that work is equally distributed to everyone in your group and fill out the Members’ contribution form. Presentations will be given in person in **Shaffer 300 on Wednesday 10/18 at 12PM ET**. Upload your slides along with any code you used, and the contribution form to Canvas by **Wednesday 10/18 at 8 AM ET**.

The presentation should be rich in figures/images and include the following components (pick **one** disease and **one** brain region).

* Describe the function and shape of the brain region. Where is it located in the brain? What does it look like?
* How might it be involved in the disease/disorder? Existing literature out there?
* Within each structure, compute the volume means and standard deviations for the control/healthy subjects. Then, for each subject (healthy and diseased), compute the z- score relative to this mean/standard deviation. These z-scores will give each patient a “bar code.” Plot these bar codes as a heat map where black is 0, red is positive and blue is negative. Show some of these bar codes.
* Choose a statistical test to compare the structure volumes between the “control” and “disease/disorder” groups. Describe it and present its results on the volume data.
* Segment the MNI atlas (curated by Dr. Can Ceritoglu) MRI image on MRICloud (<https://mricloud.org/>)
  + Create an account
  + Go to Segmentation->T1-Multiatlas
  + Upload the hdr file as the Header, and the img file as the Image
  + Note: the MNI atlas image was created by combining scans from several healthy, young adults. Therefore, we will be segmenting this atlas using MRI Cloud.
  + Use the default atlas, and the **“Axial” Slice type**
  + This tutorial may be useful - <https://www.jove.com/video/57256/whole-brain-segmentation-change-point-analysis-anatomical-brain>
* Make a barcode for this subject, where do they fall compared to your dataset?

**Grading breakdown: (20pts)**

1. Discuss the location (1 pt), shape (1 pt), and function (1 pt) of your ROIs
2. Discuss possible involvement in disease (2 pts) and motivate with the relevance of past work/literature (2 pts)
3. Create and explain the “barcode” results (4 pts)
4. Conduct appropriate statistical analysis and discuss (3 pts), compare these results to the literature (2 pts)
5. Create a barcode for the patient and discuss where they fall in relation to your populations (3 pts)
6. PRESENTATION TIME <= 5 MINUTES (1 pt)

**Diseases/Disorders Options:**

* ADNI (<http://adni.loni.usc.edu/>) – Alzheimer’s disease
* BIOCARD (<http://www.alzresearch.org/biocard.cfm>) – Alzheimer’s and General Cognitive Decline
* ADHD – ADHD 2000 (<http://fcon_1000.projects.nitrc.org/indi/adhd200/>) – ADHD
* TRACK-HD (<http://hdresearch.ucl.ac.uk/our-results/track-hd/>) and PREDCT-HD (<https://predict-hd.lab.uiowa.edu/>) – Huntington’s disease

**Brain regions (ROIS) and associated structure – Name (Code)**

* Limbic system
  + Amygdala (Amyg)
  + Fimbria (Fimbria)
  + Hippocampus (Hippo)
  + Mammillary bodies (Mammillary)
* Basal Ganglia
  + Caudate (Caud)
  + Putamen (Put)
  + Globus pallidus (GP)
  + Nucleus accumbens (NucAccumbens)
* Diencephalon/Mesencephalon
  + Thalamus (Thalamus)
  + Hypothalamus (Hypothalamus)
  + Midbrain (Midbrain)
  + Red nucleus (RedNc)
  + Substantia nigra (Snigra)
* Frontal Lobe
  + Superior frontal gyrus (SFG)
  + Middle frontal gyrus (MFG)
  + Lateral fronto-orbital gyrus (LFOG)
  + Middle fronto-orbital gyrus (MFOG)
  + Inferior frontal gyrus (IFG\_opercularis/orbitalis/triangularis)
  + Precentral gyrus (PrCG)
* Cingulate Lobe
  + Dorsal anterior cingulate gyrus (dorsal\_ACC)
  + Rostral anterior cingulate gyrus (rostral\_ACC)
  + Subcallosal anterior cingulate gyrus (subcallosal\_ACC)
  + Subgenual anterior cingulate gyrus (subgenual\_ACC)
  + Posterior cingulate gyrus (PCC)
* Parietal lobe
  + Angular gyrus (AG)
  + Insula (Insula)
  + Postcentral gyrus (PoCG)
  + Precuneus (PrCu)
  + Supramarginal gyrus (SMG)
  + Superior parietal gyrus (SPG)
* Occipital lobe
  + Cuneus (Cu)
  + Inferior occipital gyrus (IOG)
  + Lingual gyrus (LG)
  + Middle occipital gyrus (MOG)
  + Superior occipital gyrus (SOG)
* Temporal lobe
  + Inferior temporal gyrus (ITG)
  + Entorhinal area (ENT)
  + Fusiform gyrus (FuG)
  + Middle temporal gyrus (MTG)
  + Parahippocampal gyrus (PHG)
  + Superior temporal gyrus (STG)
* Ventricles
  + All components of the lateral ventricles (LV)