Identifying ADHD Brain Network

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Motivation

The process of creating a research paper on the analysis of ADHD brains can be daunting. Our motivation to start the research on the brain was because of our interest in its complexities. One of us wanted to research the brain and its correlation to the action of moving different parts of our hand. Another wanted to study the brain patterns and signal processing of epilepsy on the brain. Due to unforeseen circumstances related to gathering data for analysis, our research project kept on evolving and revising. This led to our final presentation of analyzing brains with ADHD. With the help of all the provided resources from our professor, Yanning Shen, we were able to kickstart our research paper with leads on what websites and scholarly articles to read in order to help our research. In addition, we also had external (grades and presentation) and internal (self accomplishment) motivations to do well. After the submission of our project proposal, we received feedback that would be crucial to guide our final project. The feedback we received was the fact that it was “not clear what dataset and specific datasets you plan to look at. In the final report, please clarify what real dataset you used”. We wanted to think outside of the box to come up with a solution to our critique. As UCI students under The Henry Samueli School of Engineering, we have the ability to ask permission to access facilities and professionals that would be useful for our research. We wanted to take advantage of that fact in order to gain more sources, data, and experience. Thus, we were able to apply our topic with brain networks to a biological problem along with machine learning.

Meeting The Experts

In order to gather the necessary dataset and information that we needed for our research, we reached out to the School of Biological Sciences, this process eventually led us to the Department of Neurology. After reading through all the faculty, and their area of expertise, we came upon Dr. Liz Chrastil. Her research revolves around performance and brain function through fMRI. Their experiments are set with the patients in a Virtual Reality (VR) environment with an fMRI on them. With the VR environment, they are able to test which parts of the brain are activated by performing different physical activities.

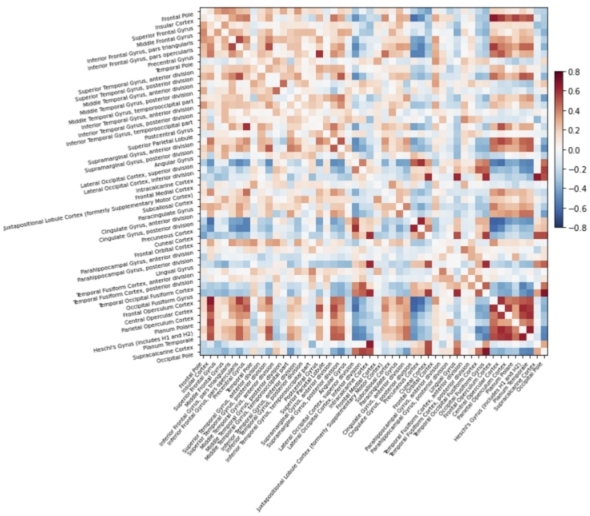
Dr. Chastril was the expert that we needed in order to gain some insight and data for our project. We reached out to her and described the time frame and background of our project. She gave us some information and tips on how to approach our project. At first, we wanted to get our database from her lab, but she was not able to provide it due to patient confidentiality. However, she directed us to the Human Connectome Project (HCP), which will be described in more detail below. Next, we wanted our brain fMRI data to come from patients doing different activities, such as writing with their right hand and throwing the ball. She told us this was not possible in our time frame due to the large amount of data coming in and the complexity would go far beyond the scope of our intro to network science class. Instead, she recommended our dataset to be extrapolated from patients who are trying to stay still as much as they can.

Databases

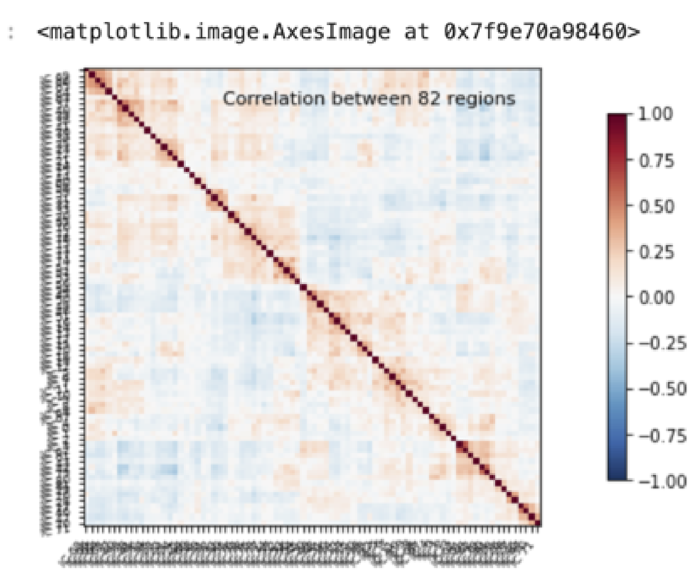
The “Human Connectome Project aims to provide an\ unparalleled compilation of neural data, an interface to graphically navigate this data and the opportunity to achieve never before realized conclusions about the living human brain." It is the largest database for brain information worldwide and highly reputable in its field. You are not simply allowed to go on the website and download the necessary .nii file (type of file formatting for neuroimaging), but instead you are required to apply to get the data. We applied, explained our exact situation, combined it with our school email, and got access to the data. Data from HCP is so coveted because it does not have any patient confidentiality issue, which is a big hurdle for this type of research. As we were working and extrapolating information from this large dataset, we ran into some problems. First the data was not preprocessed, which made it hard to work with. Second, it did not have any metadata provided along with this. Metadata is a representation of what the data represents."Simply defined, metadata is the summary and the description about your data that is used to classify, organize, label, and understand data, making sorting and searching for data much easier" (Precisely). Without any context and organization of the data, our algorithm does not really know what it is looking for.

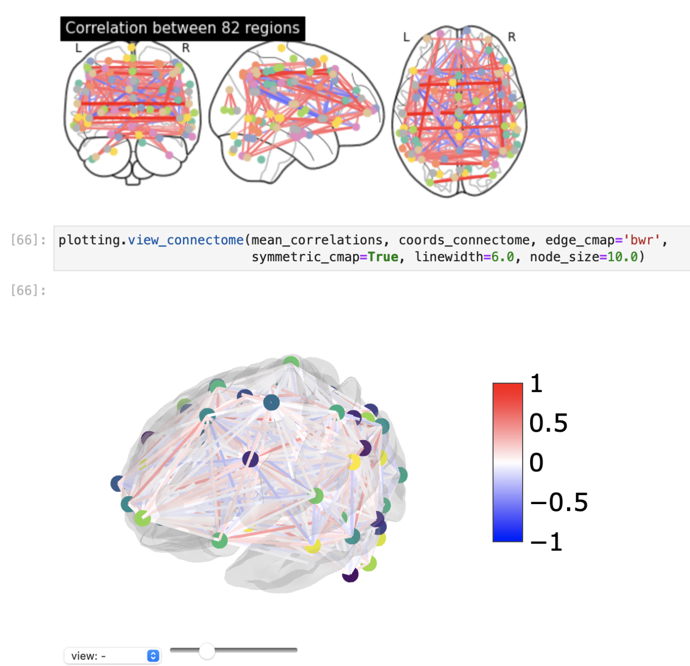
As we looked for more meaningful data, we came upon Azrieli National Institute for Human Brain Imaging and Research. It was established for "Promoting in-depth examination of brain physiology, biochemistry, and functioning, as well as the onset and progress of brain-related pathologies"(Azrieli). Just like HCP, there were no patient confidentiality issues and it provided a processed data source with metadata included. Metadata established the amount of movement that each patient had, even though they were trying to stay as still as possible. This was the most optimal condition for us, and allowed our data analysis algorithm to work much better.

Model Descriptions and Algorithms



In our analysis we leveraged the Nipye and Nilearn python libraries to generate network graphs from MRI scans. We were able to generate correlation matrices of the MRI scans by extracting a time series from the scan's metadata. The Nodes were generated in a bimodal fashion using a brain atlas in conjunction with the active regions of the scans. These nodes with the supporting time series allowed us to measure the connectivity between the nodes using the ConnectivityMeasure functions. After generating an adjacency matrix for each scan we ran an averaged correlation across all ten scans to generate the final matrix used to plot our network graph. 82 Nodes were generated with their local activity and correlations between nodes being plotted as the connecting edges.





Conclusion

In conclusion, our group was able to research the neural networks of brains with ADHD. We ran into multiple intricacies regarding our dataset and lack of metadata, however with persistence, we were able to obtain a complete dataset on brains with ADHD. We discovered the Azrieli National Institute after failing our previous attempts at gathering data for our research. This accomplished the task of finding what data and dataset we needed in response to professor Shen's critique. We concluded our research on ADHD when we started on research with epilepsy. We were able to take advantage of resources that our status as UCI students for more thorough research. We learned more about neural networks in the brain and the different types of technologies used to gather information. We learned the complexities of the Jupyter notebook, Python, Nilearn, Nipype, and their uses for analyzing MRI scans.

As we gain more knowledge in this field of neural networks, we could possibly use the information we gathered in order to look at different datasets for different disorders. Using the Jupyter notebook and analyzing the data in python using Nipype, Nilearn, etc. , we could extend our research from ADHD to other brain conditions. Another interest could be the more complex research on patients and the correlation of the brain and hand movement. Since this type of research was initially one of our interests and since we could not afford to do it due to time constraints, we could expand onto this type of analysis in the future.

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