Perceptron - Detecting Schizophrenia

Paul Fleming, Adam Curl, Sam Meagher, Kevin Peterson, Robert Walters

Detecting Schizophrenia

- Schizophrenia is a mental disorder, so traces of it can be found in the brain
  - Can be detected from:
    i. Physical examinations
    ii. Test and screenings
    iii. Psychiatric evaluation
- We wanted to see if a neural net could detect schizophrenia from brain scans (the most popular method)

Our Data - fMRI & the COBRE Dataset

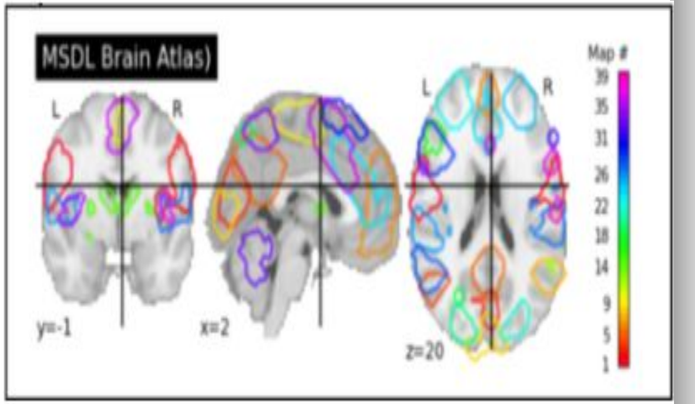
- fMRI measures the blood oxygen levels of regions in the brain
    - This can be used to find out what regions are active at what levels
- We used the Center of Biomedical Research Excellence (COBRE) dataset of 72 schizophrenic patients and 75 (147 scans) healthy patients ranging from ages 18 to 65
- Each scan is 4D in that it has a width and height, is split into 26 slices, and taken across 150 timestamps

Challenges with the Data

- Each scan is comprised of 4 dimensions and contains a lot of data
    - A lot for a net to process, and adds a complexity for reading the data in
- 2 ways to prepare this data for efficient neural net use
    1. Condense the image and place the average blood-oxygen levels of the slices into a single image
    2. Create numerical data based on the relationships between brain regions
- Our goal was to create 2 nets utilizing the 2 different data types above and see which net would most accurately detect traces of schizophrenia in a patient

Masking the Data

- Our data was masked with a predefined brain atlas (MSDL atlas). The brain atlas contains a set of 39 different brain regions that are known to be informative in resting state FMRI data.
- All the blood oxygen levels within each region are averaged together which results in one blood oxygen value for each of the 39 brain regions. This significantly reduces our data size and allows us to reduce much of the noise in the data.
- Result is the blood oxygen values of those 39 regions over time for each subject



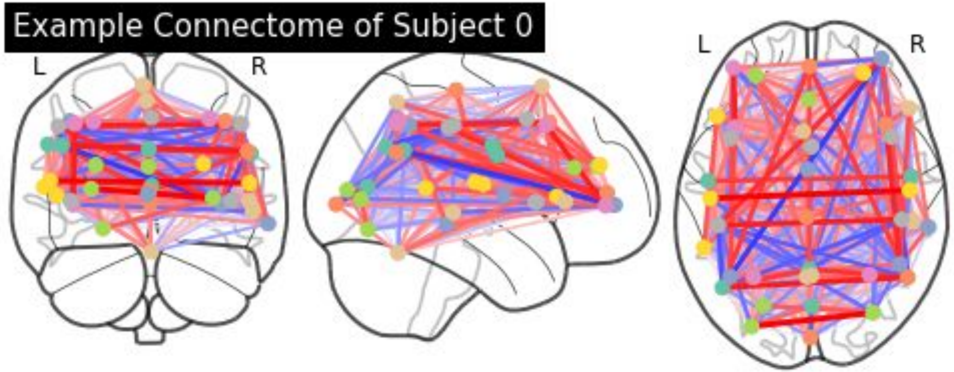
Net A - Convolutional

- For our first net, we used a basic convolutional neural net to scan over the images to try and learn to detect schizophrenia from the blood-oxygen levels in separate regions
- Steps:
    1. Averaged the blood-oxygen levels across the various slices and timestamps
    2. Masked the brain scan to 39 separate regions
    3. Ran it through the net for 20 epochs

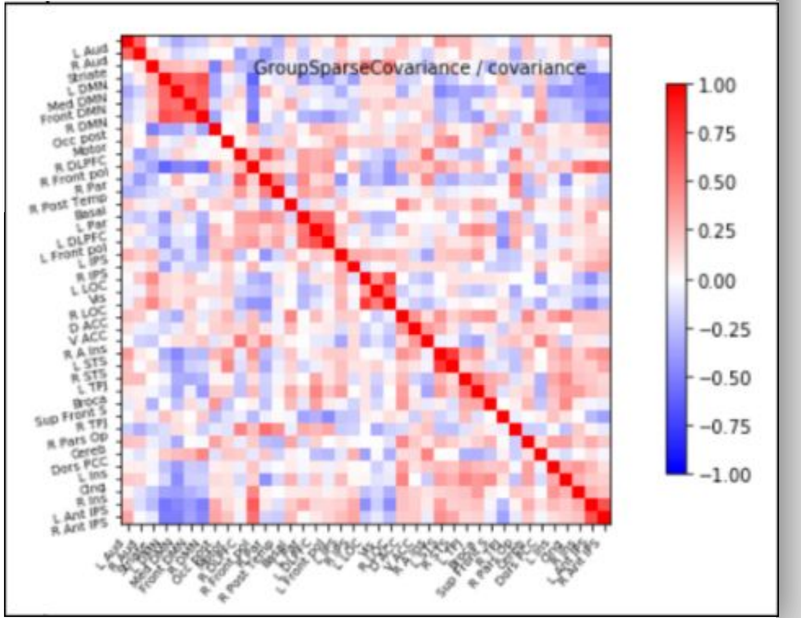
Net B - Feed Forward Net (using a covariance matrix)

- For our second net, we used a basic multilayer feed forward net with 10% dropout rate
- Steps:
  1. Masked the brain scan to 39 separate regions
  2. Computed a covariance matrix based on how each region is connected to each other
  3. Flattened the covariance matrix into a 1D array
  4. Ran it through the net for 800 epochs

Brain Region Connections



Covariance matrix of masks created from fMRI scans



Results

- Convolutional Net would get anywhere from 25%-50% accuracy
  - Suffered from overfitting
  - Perhaps performed poorly due to looking at each region's blood-oxygen levels separately, instead of as being connected
- Feed Forward Covariance Net would perform about 77.10% (+/- 10.16%) on average
  - Performed well due to condensed, numerical data
  - Took into account the relationship between each region in the brain, which helped the net to generalize what it was learning

Team Contributions

- Adam - Demo and Presentation
- Paul - Milestones and Research paper
- Sam - Research paper
- Kevin - Covariance Multilayer Net
- Robert - Convolutional Net