Project Review 1

Team members:

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Project topic:

Classification of Autism Spectrum Disorder using computer vision with deep learning and the ABIDE dataset

Project description:

Autism spectrum disorder is a neurological disease which affects the social interactions and causes repetitive behaviors in patients. As per the data from WHO, one child in every 160 is affected by ASD worldwide also according to the report from CDC, ASD affects one in 69 children in the USA.

This project aims at identifying ASD patients using functional Magnetic Resonance Imaging data from of ASD patients from typical control patients using a Convolutional Neural Network. Diagnosing neurological diseases such as epilepsy, Alzheimer and autism requires developing a model based on functional and structural region relationships in the brain. Therefore, we are using fMRI data to detect potential biomarkers from the brain for autism. It mainly detects the correlated fluctuations in the blood oxygen level-dependent signals from the brain regions. We will be investigating objective biomarkers in the Autism Brain Imaging Data Exchange (ABIDE I) dataset.

Research paper references:

Automated Detection of Autism Spectrum Disorder Using a Convolutional Neural Network [Zeinab Sherkatghanad, Mohammadsadegh Akhondzadeh, Soorena Salari, Mariam Zomorodi-Moghadam, Moloud Abdar, U. Rajendra Acharya, Reza Khosrowabadi and Vahid Salari.]

This study focuses on classifying autism spectrum disorder patients from typical control patients using resting state fMRI image data obtained from ABIDE dataset. This method uses a convolutional neural network and can classify ASD and control subjects with 70.22% accuracy based on patterns of functional connectivity. The parcellation atlas used in this study is the CC400 functional parcellation with 400 co-ordinates in the brain region. The ABIDE dataset used in this study includes 505 ASD and 573 control patients from 17 international imaging sites and is composed of structural, resting-state fMRI data and phenotypic information. These datasets mainly contain T1 structural brain images, fMRI images and phenotypic information classified based on sex, age and Autism Diagnostic Observation Schedule (ADOS) score for autistic patients and mean framewise displacement related to different patients. The data is further preprocessed using a CPAC configurable pipeline where the data was slice time corrected, motion corrected, and voxel intensity was normalized. The preprocessing also comprises of nuisance regression was employed to delete the signal fluctuations caused by respiration, cardiac pulsation, and scanner drift.

The network architecture developed for classification of ASD and controls in this study used CC400 functional parcellation for each subject which resulted in co-activation correlations of 392 different brain areas as input. Several convolution layers are concatenated, and the entire obtained result was given to the MLP for classification. This resulted in higher classification accuracy with fewer parameters which also reduced the training time. The authors of this study claimed to have the best results using the ABIDE I dataset when the results were published in 2020.

Identification of autism spectrum disorder using deep learning and the ABIDE dataset [Anibal Sólon Heinsfeld, Alexandre Rosa Franco R. Cameron Craddock, Augusto Buchweitz, Felipe Meneguzzi]

The goal of this research is to identify ASD vs developing control patients using deep learning on the ABIDE dataset. The results obtained also presents empirical evidence in justifying the correlation and anti-correlation of anterior and posterior regions of the brain using the connectivity matrix. This matrix contains the average value of time series of region of interests. The dataset used for this study was the ABIDE I dataset with pre-processing from the Preprocessed Connectomes Project's C-PAC preprocessing pipeline. The data had voxel

intensity normalized and slice time and motion corrected. The CC200 functional parcellation atlas was used for this study. After dimensionality reduction on the connectivity matrix, the resultant features obtained by the CC200 atlas produced a total of 19,900 features.

The classification method used two denoising autoencoders and a multi-layer perceptron to better train the predictive model for generalization. Denoising autoencoders were used to reconstruct the inputs based on the corrupted version of input. The first autoencoder has 19,900 units corresponding to the 19,900 features in the input and output layers and with a bottleneck of 1,000 units in the hidden layer. The second autoencoder maps outputs to the 1000 inputs from the previous autoencoder's output with a bottleneck of 600 units. The trained weights of the encoders are the utilized by applying to a multi=layer perceptron with a configuration of 19,900-1000-600-2. The weight adjustment of the multi-layer perceptron, referred to as fine-tuning, is to predict the expected class for minimizing the prediction error of the supervised learning task. Finally, the results are evaluated using 10-fold cross validation schema which mixed the data from 17 different sites while maintaining the proportions of different sites. The results for correlation between the rs-fMRI data showed two regions to be under connected in control patients whereas the same regions were highly connected in the ASD patients.

Multisite functional connectivity MRI classification of autism: ABIDE results [JaredA.Nielsen, Brandon A. Zielinski, P. Thomas Fletcher, Andrew L. Alexander, NicholasLange, ErinD.Bigler, Janet E. Lainhart and Jeffrey S. Anderson]

This study has attempted to replicate the method of single subject classification with the ABIDE dataset using the whole brain point-to-point functional connectivity into ASD and control subjects across a wide range of age. This is method uses a leave-one-out classifier on ABIDE dataset comprising of 1112 datasets out of which 539 are ASD patients and remaining 573 are typical control patients. Each dataset consists of resting state fMRI acquisitions and volumetric MPRAGE images. For this study, out of the 1,112 patients from 17 different international sites, 964 subjects from 16 different sites are considered since patients only with 50% higher BOLD (Blood Oxygen level-dependent) level are considered after motion correction. Pairwise functional connectivity measurements obtained from a lattice of 7266 regions of interests covering the grey matter. Preprocessing of the fMRI data included motion correction, slice time correction, normalization to standard space and voxel wise removal by regression of motion parameters, Cerebrospinal fluid, and white matter signals.

The implementation of classification algorithm included the following steps: 1). Leaving out one subject and creating functional connectivity association matrix of the remaining 963 subjects. 2). A general linear model was fit for ASD and control subjects. Difference between the estimated value of left out and remaining subjects were calculated. 3). The difference was

then added to the running total of the subjects for each binning schemes. 4). This is performed for all 26.4 million connections and the final classifier value is totaled for every subject.

The classification accuracy significantly outperformed chance but it was significantly lower for multi-site classification than for single-site classification. 60% accuracy, 62% sensitivity and 58% specificity when connections were included in the classification algorithm.

Form this study it was concluded that resting state functional magnetic resonance imaging data from 26.4 million connections per subject can classify ASD patients from developing controls with accuracy, sensitivity and specificity mentioned above using the leave one out approach.

Timeline:

Task	Expected Completion Time
Finalizing Project Presentation	9th Sept 2022
Data Collection	24th Sept 2022
Data Pre-processing	30th Sept 2022
Model Creation	8th Oct 2022
Model Training	15th Oct 2022
Testing and Validation	22nd Oct 2022
Documentation	29th Oct 2022