Project Review 2

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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.

Data preparation:

The data used in the study that we are referring for this project is the pre-processed version of Autism Brain Imaging Data Exchange (ABIDE) dataset. This dataset publicly available and can be obtained using the Functional Connectomes Project (FCP) configurable pipeline, the analysis of

Connectomes (CPAC). After filtering the data as per the preprocessing requirements of the study, we obtain 871 quality fMRI images with phenotypic information.

Parcellation atlas of the brain used for this project as per the study referred is **CC400**.
The steps included in preprocessing are as follows: -

- Slice timing correction
- Correction for motion
- Normalization of voxel intensity
- Nuisance regression (employed to delete the signal fluctuations)
- Bandpass filtering (0.01–10 HZ)
- Repetition time adjustments (varies with the site)
- Echo time adjustments (varies with the site)
- T1 (tissue time)

Different parameters which include TR, TE, T1, voxel size and flip angle in structural MRI imaging for each site in the ABIDE I dataset is shown in the table below.

	Voxel size (mm3)	Flip angle (deg)	TR (ms)	TE (ms)	T1 (ms)
CALTECH	1	10	1,590	2.73	800
CMU	1	8	1,870	2.48	1,100
KKI	1	8	8	3.7	843
LEUVEN	0.98×0.98×1.2	8	9.6	4.6	885.145
MAXMUN	1	9	1,800	3.06	900
NYU	1.3×1.3	7	2,530	3.25	1,100
OHSU	1	10	2,300	3.58	900
OLIN	1	8	2,500	2.74	900
PITT	1.1×1.1×1.1	7	2,100	3.93	1,000
SBL	1	8	9	3.5	1,000
SDSU	1	45	11.08	4.3	NA
STANFORD	0.86×1.5×0.86	15	8.4	1.8	NA
TRINITY	1	8	8.5	3.9	1060.17
UCLA	1×1×1.2	9	2,300	2.84	853
UM	1.2×1×1	15	250	1.8	500
USM	1×1×1.2	9	2,300	2.91	900
YALE	1	9	1,230	1.73	624

Each row in the data obtained after preprocessing represents a brain voxel and the column represents the time-slices of each 400 regions from CC400 atlas. Below is the sample of the structural data obtained for one patient after preprocessing:

#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12
1.288359	-22.4637	-4.98757	-6.03065	10.37785	1.099065	-0.34758	-3.25409	-8.92825	2.448179	5.587133	-0.57148
1.530402	-30.9086	7.205127	-2.87108	6.870298	5.38872	2.895479	-0.20633	-12.0516	-2.59444	6.907773	-0.11248
-4.30062	-24.7335	15.9552	-1.26083	1.010922	6.43349	-0.90197	1.319136	-8.90797	-1.27667	3.478904	1.800717
-9.19304	-11.1652	12.95361	-3.17527	-0.73286	2.194801	-11.6234	0.641052	-2.35353	6.654646	-4.00238	2.892987
-4.41202	-4.31407	1.934714	-6.96939	3.418279	-3.82601	-21.2113	-2.38271	2.406439	13.12303	-12.6136	1.506189
7.861188	-7.40124	-5.24468	-8.87516	8.91448	-6.06465	-20.1839	-8.01453	3.204292	10.9138	-18.8281	-1.14904

Below are the configurations possible for preprocessing the ABIDE dataset. The configuration is chosen as based on the architecture used for the study.

Acceptable derivatives:

- alff (Amplitude of low frequency fluctuations)
- degree_binarize (Degree centrality with binarized weighting)
- degree_weighted (Degree centrality with correlation weighting)
- eigenvector_binarize (Eigenvector centrality with binarized weighting)
- eigenvector_weighted (Eigenvector centrality with correlation weighting)
- falff (Fractional ALFF)
- func_mask (Functional data mask)
- func_mean (Mean preprocessed functional image)
- func_preproc (Preprocessed functional image)
- lfcd (Local functional connectivity density)
- reho (Regional homogeneity)
- rois_aal (Timeseries extracted from the Automated Anatomical Labeling atlas)
- rois_cc200 (" " from Cameron Craddock's 200 ROI parcellation atlas)
- rois_cc400 (" " " 400 ROI parcellation atlas)
- rois_dosenbach160 (" " from the Dosenbach160 atlas)
- rois_ez (" " from the Eickhoff-Zilles atlas)
- rois_ho (" " from the Harvard-Oxford atlas)
- rois_tt (" " from the Talaraich and Tournoux atlas)
- vmhc (Voxel-mirrored homotopic connectivity)

Acceptable pipelines include:

- ccs
- cpac
- dparsf
- niak

Strategies include:

- filt_global (band-pass filtering and global signal regression)
- filt_noglobal (band-pass filtering only)
- nofilt_global (global signal regression only)
- nofilt_noglobal (neither)