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| **Source:** | Columbia University |
| **Title:** | Classification of autism spectrum disorder based on brain image using convolutional neural networks |
| **Purpose:** | Discussion |
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| **Abstract:** | Autism Spectrum Disorder (ASD) is a developmental disorder that affects social skills and behaviors. In neuroimaging studies, machine learning or deep learning methods are applied to diagnosis of ASD which may assist physicians or psychiatrists. In this proposal, we explored classification of the brain images for ASD using Convolutional neural networks (CNN), which is based on resting-state functional MRI (rs-fMRI) and structural MRI data. The CNN model was tested on ASD brain imaging data from Paris-Saclay Center for Data Science. Results of our classification accuracy is around 65% using three hidden layers and multiple nodes of CNN. The limitation of this study is that the correlation map obtained from the rs-fMRI data is not a real image, so CNN would not perform well. Further research direction is to apply another deep learning models such as Google’s Inception and ResNet-v2 to deal with larger data sets. |

Overview:

Autism spectrum disorders (ASD) are developmental disorder in which restricts interests and has difficulty in communication (DSM-5). The ASD was reported to affect about one in 59 children (DSM-5). Since ASD usually has other neurological and psychiatric disorders, such as anxiety and mood disorders, and has complexity of phenotypes, it is challenge to find clinically useful diagnostic biomarkers (Andrew et al. 2018).

Impact:

Recently, the pattern classification of ASD using machine learning and deep learning has increased dramatically for diagnosis and predictions. For example, results from recent study using Deep neural network achieved 70% accuracy in identification of ASD verses controls in the ABIDE (Autism Brain Imaging Data Exchange) dataset. (Heinsfiled et al, 2018).

Data Availability:

Data we used for this project is available at <https://paris-saclay-cds.github.io/autism_challenge/> and initially published for competition: Imaging-psychiatry challenge: predicting autism (IMPAC). The data contained 1150 subjects (601 health controls and 549 ASD patients).

Benchmarking pipeline:

The pre-processed IMPAC dataset includes anatomy T1 features, rs-fMRI features and subject’s site, age and sex. For Structural MRI data (T1 Anatomy), a set of structural features have been extracted for each subject with normalized brain volume computed using subcortical segmentation of FreeSurfer and cortical thickness and area for right and left hemisphere of Freesurfer. For rs-fMRI data, each subject comes with fMRI signals extracted on different brain parcellations and atlases, and a set of confound signals.Those brain atlases and parcellations are: (i) BASC parcellations with 64, 122, and 197 regions (Bellec 2010), (ii) Ncuts parcellations (Craddock 2012), (iii) Harvard-Oxford anatomical parcellations, (iv) MSDL functional atlas (Varoquaux 2011), and (v) Power atlas (Power 2011).

We first extract features from pre-processed T1 and rs-fMRI data, and then train our CNN model. Finally, we evaluate the prediction with the ROC score. Since we used CNN for our classification, we used all anatomy and functional connectivity features.

Organizer details:

Our institute is interesting in this project because we can provide an objective diagnosis of ASD and assists psychiatrists in clinics. However, we have limited sample size that will result in challenges of convergence of the model.

References:

Heinsfeld et al. (2018), Identification of autism spectrum disorder using deep learning and the ABIDE dataset, NeuroImage 17, 16-23.

Andrews et al. (2018), Using Pattern Classification to Identify Brain Imaging Markers in Autism Spectrum Disorder, Current Topics in Behavioral Neurosciences.

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American Psychiatric Association (2013). *Diagnostic and Statistical Manual of Mental Disorders* (Fifth ed.). Arlington, VA: American Psychiatric Publishing. pp. 5–25.

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