The Prediction of Fluid Intelligence based on Human Connectome Data using Deep Neural Networks

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This work investigated whether Deep Neural Networks (DNN) can be used to predict fluid Intelligence, an innate intelligence, when weights or graph theoretical features of functional brain networks were input. rfMRI timeseries data of 461 healthy adults and their corresponding fluid Intelligence measures were obtained from Human Connectome Project (HCP). Functional brain networks were constructed from the timeseries data using partial correlation, and graph theoretical features were calculated from functional networks. Claimed to be state-of-art, prediction based on elastic net regression provided by the HCP served as baseline. Granularity of the parcellation of the rfMRI data, the coefficient of the L2-regularizer in model training, and the structure of the DNN were tested during dual parts of experiments: 1) when the weights of the functional brain networks were input , with the optimal parameter set, the coefficient of determination (CoD) is 0.3524, 704.8% of the baseline; 2) when graph theoretical features were input , the CoD is 0.3173, 634.6% of the baseline. These results indicate that predictions based on DNN method are significantly better than that of baseline, that functional brain networks are highly predictive to fluid intelligence, and that DNNs are able to process the connectome data effectively. In the future, I will focus on the relationship between connectome and cognition, and try other deep learning methods and brain network modeling methods. I hope this research provides useful insights on cognitive science and psychological researches.

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