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Classifying fMRI data for context-dependent and context-independent language tasks

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Story comprehension and arithmetic calculation are cognitive processes that both involve language processing but are quite different in their dependency on the preceding context. We hypothesize that brain activity during these language tasks has distinct differentiating characteristics. We verify our hypothesis by using machine learning techniques to visualize the fMRI data and classify it into the two categories. For this, the language task data of HCP (Human Connectome Project)¹ was used. For these tasks, the brain has been divided into 360 parcels and BOLD signals of each parcel were recorded at every 0.72 seconds.

Dimensionality reduction techniques like t-SNE and PCA were used for visualization. With t-SNE, we were able to visualize the trajectory of brain activity as the two tasks progressed as interleaved blocks. We also observed clusters for these blocks of different stories and math problems thus signifying the presence of distinct intra-task characteristics. Primarily, three models were used for classification - Logistic Regression, Linear Discriminant Analysis (LDA) and Linear Support Vector Classifier (SVC). The accuracy of the latter two was high (90%) whereas the former failed to converge. We interpret the ineptness of the logistic regression model to get an insight into the distribution of high-dimensional fMRI data. We further analyse the weights of successful models to understand these characteristic differences. We observe a similar distribution of weights over parcels in the brain in both LDA and SVC models. We also investigate the parcels with the highest weights to identify the parcels most important for classification. We observed that along with parcels that were active during either arithmetic or story task, few parcels that were comparatively less active during both had also significantly contributed to the classification.

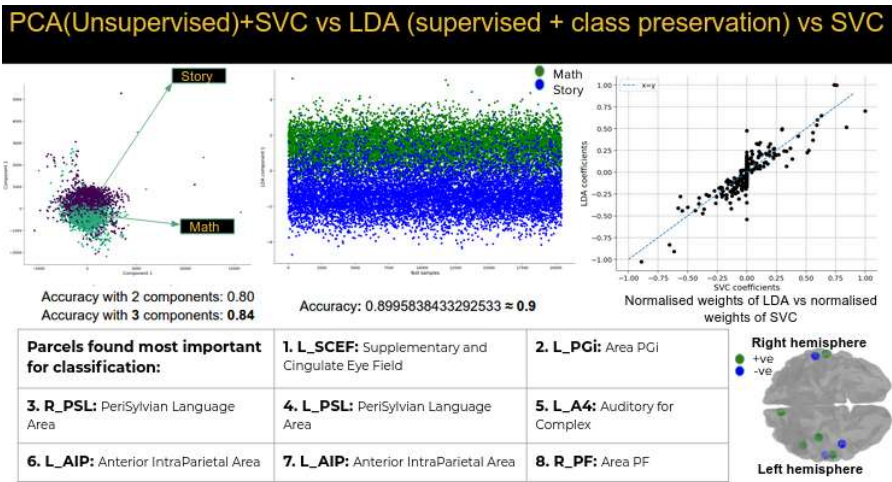


Figure 1: Summary of project results

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