Chapter 6

CONCLUSION AND FUTURE WORK

The conclusions of work done in this thesis and suggestions for future research are presented in this chapter.

6.1 CONCLUSIONS

We have analysed the fMRI data from three perspectives- 1. Noun level analysis, 2. Sentence level analysis, and 3. Discourse level analysis. We analysed nouns from different categories in noun level analysis and formulated a computational model to classify the nouns. We proposed a computational model to classify affirmative and negative sentences in the sentence-level study. We figure out neural representation of different word categories and emotion words at discourse-level analysis. Finally, we proposed a computational model to identify the reader's mood. Noun level analysis- Similar words activate the similar neurons in the brain; hence identical brain areas are highly activated in the processing of nouns in the brain. Neural representation of nouns can be used as input to the computational model to identify the noun class to which a particular noun belongs. Nine participants viewed 60 concrete nouns of twelve categories and line drawing on the screen while fMRI data were recorded. Taking fMRI data of a particular noun entity as input, our task is to find out the class to which this particular noun belongs. For this, we employed cascaded feature selection and appropriate classification methodology to classify the nouns. We adopted two approaches of classification – first classified in binary classes and then classified in twelve classes. We employed Variance threshold+ PCA+ LDA in a cascaded fashion for feature selection for binary class classification. We choose MLP and random forest for classification by selecting the prominent features from this approach. We chose variance threshold + PCA for twelve category classification as feature selection and then used the random forest for classification strategies. We classified the concrete nouns with acceptable accuracy. We have used an only fMRI recording as input to our model. This is the first approach in the classification of nouns on this data to the best of our knowledge. At sentence level analysis, we analysed the processing of affirmative and negative sentences in the brain. This study aimed to devise a computational model that can identify the polarity of the sentence taking fMRI data as input. Analysis of the cognitive state of the brain in processing negative and affirmative sentences has given rise to mixed results. Some part of the brain shows greater activation in the processing of negative sentences, while others show enhanced activation for affirmative sentences. For this, we analysed the data set named Star Plus data available online. Six participants view a picture on the screen, and next, the sentence explains the image. From here, we extract the fMRI data set corresponding to the sentence. The sentences are of two types- affirmative and negative. The model takes fMRI data and identifies whether a person views affirmative or negative sentences. Protruding voxels are selected using appropriate feature selection and applying adequate classification techniques; our model provides good accuracy. First, analyse the affirmative and negative sentences in the brain based on fMRI data employing the k-NN classification algorithm. The fMRI data for the sentence is extracted, and the info-gain feature selection technique selects major feature vectors. Using this feature vector classification of brain state was made possible in the sentential negation identification task. Further, we analyse the brain's neuronal activity in sentence polarity detection tasks using multilayer perceptron classification methodology. The whole brain is divided into almost 5000 three-dimensional volumes called voxels, from which prominent voxels are selected using symmetrical uncertainty based on entropy for the classification of brain state. The proposed method achieved significantly higher accuracy in classifying brain states in affirmative and negative sentences processing. The result obtained also shows that certain brain regions like the left dorsolateral prefrontal cortex (LDLPFC) and calcarine sulcus (CALC) are prominent areas that are deterministic in the classification of affirmative and negative sentences in the brain. In contrast, the right posterior precentral sulcus (RPPREC) and right supramarginal gyrus (RSGA) are less contributing. Next, we investigate the processing of affirmative and negative sentences in the brain. Using a greedy stepwise correlation-based feature selection technique and random forest classification approach, our model can classify the cognitive state in sentence polarity detection task with, on average, 95.41% accuracy. We have also analysed the category-specific selected feature voxel set to determine the brain's sentence polarity. Our result shows that CALC, RDLPFC, and LDLPFC are positively contributing areas of feature selection. In contrast, RPPREC, RSGA, RFEF add very little to polarity check. Finally, we employed the SVM-RFE feature selection and Rotation Forest classification technique and obtained optimal solutions for the polarity detection task with 100% accuracy. We analysed the fMRI data for a chapter 9 from Novel Harry Potter and the Sorcerer's stone at discourse level analysis. The reader was reading the chapter so that one word at a time appeared on the screen. The data was collected in such a way that for 4 consecutive words, one fMRI image was captured. We extracted a token-level fMRI vector using Gumbel distribution and calculated the corresponding activated areas for each POS tag set. We tagged the whole chapter using the spacy tag set. Further, we analysed the emotional categories following Paul Ekman's classification. There six kinds of emotions are proposed in literature- anger, fear, disgust, happiness, sadness, and surprise. We analysed all these basic emotions and their corresponding activation patterns in detail. Further, we classified the reader's mood based on emotion category using MLP and Random Forest classification methodology. Our model proposed identifying the reader's perspective with more than 75% accuracy.

6.2 FUTURE WORKS

The research work presented in this thesis can help further into different directions. The scope for future works is as follows: learning techniques can be applied to reduce the semantic gap. Since computational efficiency can be improved with large data size and deep learning implementation

- New similarity measures can be defined for further improvement of the retrieval.
- For the application of brain and language, the proposed methods can be tested in an extensive collection of diverse databases.