Emotional Brain State Classification on fMRI data using 3D Residual Neural Networks

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What is Emotional Brain State Classification?

Brain state classification refers to cognitive state classification, or brain decoding[1]. Emotional brain state classification based on fMRI data aims to recognize brain activity patterns in specific regions of interest (ROIs) (such as amygdala and medial prefrontal cortex) activated during an emotion task. However, how to select the features from the whole 3D brain image for the classifier is still challenging. The proposed deep learning method could classify the 3D fMRI data directly without specifying ROIs.

fMRI data acquisition

We acquired fMRI data from a group of subjects with a history of Major Depressive Disorder (N=10) as well as Healthy Control subjects (N=12) on GE MR750 3T at New York State Psychiatric Institute (IRB approved). Subjects passively viewed either negative or neutral images from the International Affective Pictures System[2] (IAPS) for continuous 20-second blocks, alternated with resting blocks during which they saw only a single crosshair for 20 seconds. Our aim was to predict the label of the image (negative vs neutral) given the subject's 3D fMRI brain scan (one TR=2s).

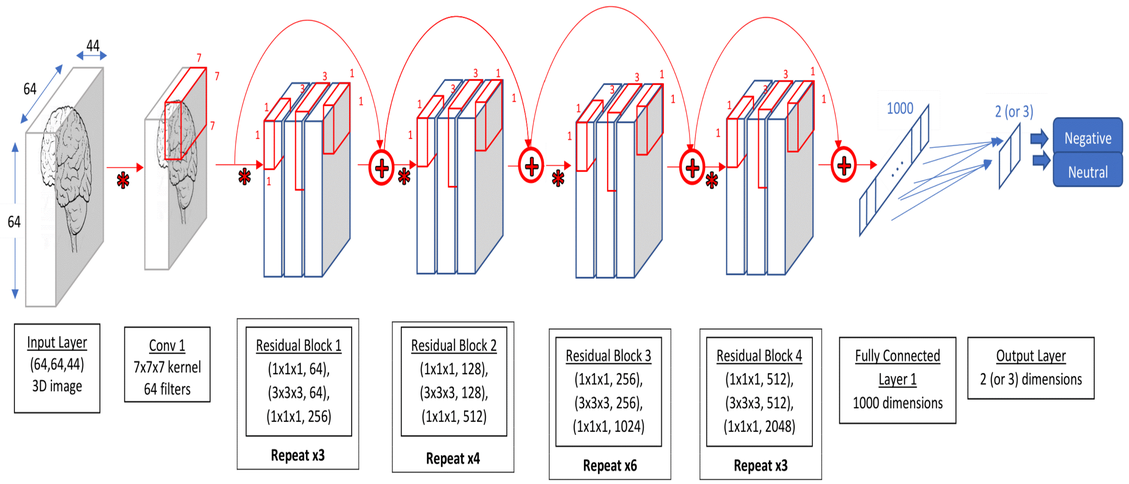

Figure 1. Architecture of the 3D Emotional Brain State ResNet Classifier.

A Residual Neural Network Using 3-Dimensional Kernels

We trained a Residual Neural Network (ResNet) with 3D convolutions (**Fig.1**) to infer the brain state for each 64x64x44 scan which is associated with either negative and neutral image presented during the emotion task, with equal proportion (in total 3,048 fMRI scans). Scans were randomly shuffled and split into 80/20 train-validation and test sets. While traditional methods rely on statistical classifiers and intricate feature extractions, this Deep Learning approach allows us to extract complex 3D features without needing to select ROIs.

Key Findings From our Experiment

Our Deep Learning model achieved an emotional brain state classification accuracy of 78% (±4.4) on the balanced fMRI dataset, with an F1 score of 0.816. The model's loss and accuracy convergence were shown in **Fig 2**.

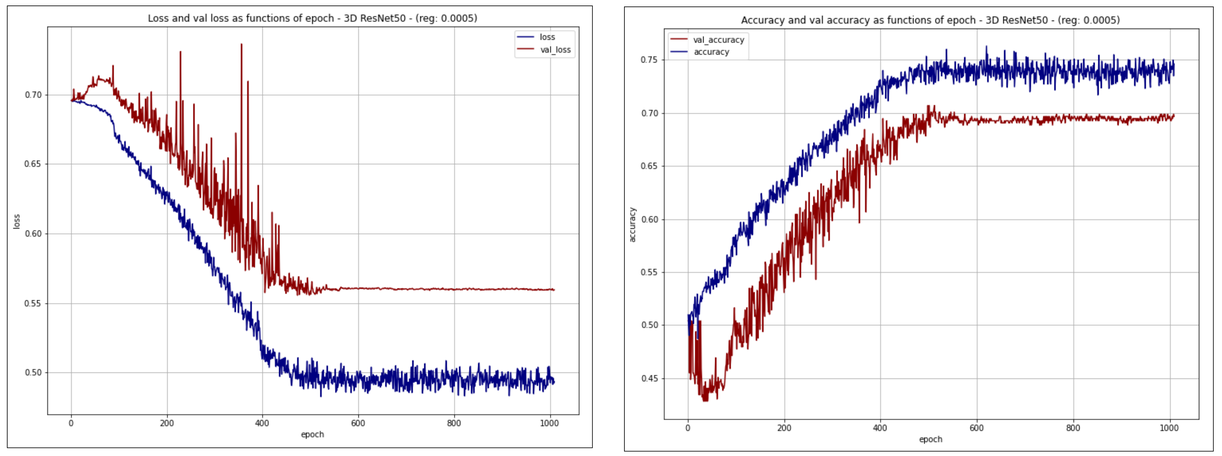

Figure 2. Convergence of the model loss and accuracy functions.

Conclusion and Future Work

We provide a 3D ResNet for emotional brain state classification. The results are promising which may indicate that we can capture the 3D patterns/features of brain activity which are associated with the cognitive state to reduce the reliance on feature extraction (ROIs selection). In the future we will test the proposed model on a large dataset such as Human Brain Connectome project dataset and apply the model to depression research.

Acknowledgments

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References

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