3D semi-supervised encoder-based neural network anomaly detection in 7T functional MRI to detect epileptogenic regions

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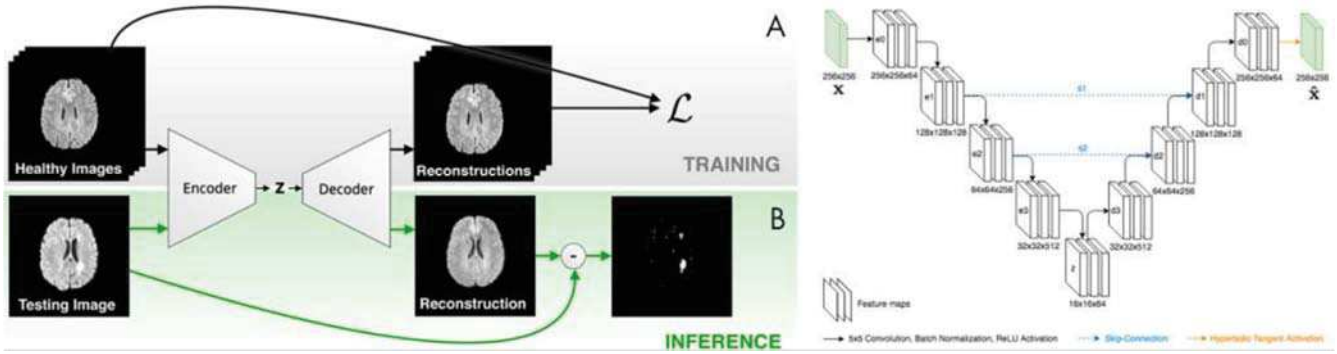
Background: Focal epilepsy is a neurological disorder that is presumed to have a specific origin in the brain. Epileptogenic activity can be caused by both structural or functional abnormalities. Unfortunately, functional abnormalities cannot be detected by standard visual inspection, therefore post-processing is necessary. Blood-oxygen level dependent functional magnetic resonance imaging (BOLD-fMRI) allows us to indirectly study the neuronal activity. From BOLD-fMRI, we can derive various maps which describe the overall temporal activity of the brain. Subsequently, these maps can be processed using neural networks to gather more information about the disease onset. In this project, the focus is to use autoencoders and their utility for anomaly detection. Autoencoders are types of convolutional neural networks which are trained to deconstruct and reconstruct the input back to its original state. This approach can be leveraged to identify differences between healthy subjects and patients with focal epilepsy.

Goal: Train an autoencoder on healthy subject data. After training, supply the trained model with data from epilepsy subjects and subsequently subtract the network output from the original input. The residual image may reveal abnormalities which relate to the epilepsy focus.



Student Task Description: There is 7T BOLD-fMRI data available from 44 healthy controls and 23 patients with focal epilepsy. The students tasks are as follows;

1) Calculate 3D maps from the 4D fMRI dataset which are to be used as inputs for the network
2) Set up a 3D autoencoder which takes the calculated 3D fMRI maps as inputs and learns to predict them
3) Train the model
4) Supply the patient data to the model and collect residual images
5) Correlate the findings from the residual images with the findings from a neuroradiological evaluation

Useful knowledge/skills:

- Programming experience in Python (some prior experience with deep learning is highly recommended for this project)
- Basic understanding of convolutional neural networks (CNNs). Specific knowledge about autoencoders not necessary.