Detection and localization of Focal Cortical Dysplasia lesions in MRI using fully convolutional neural network

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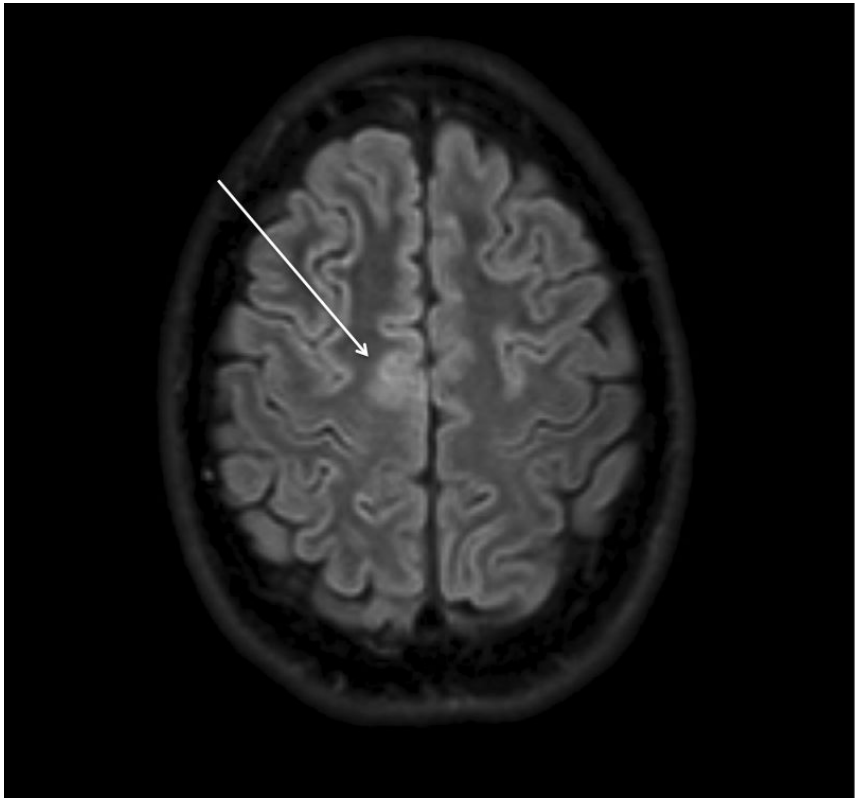
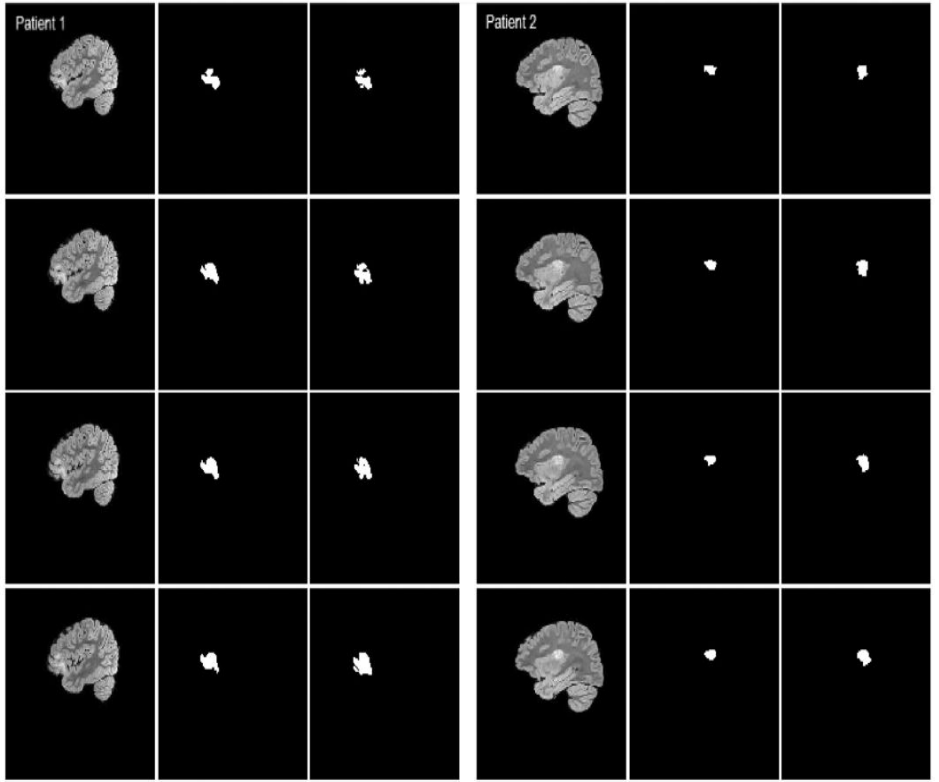
Abstract

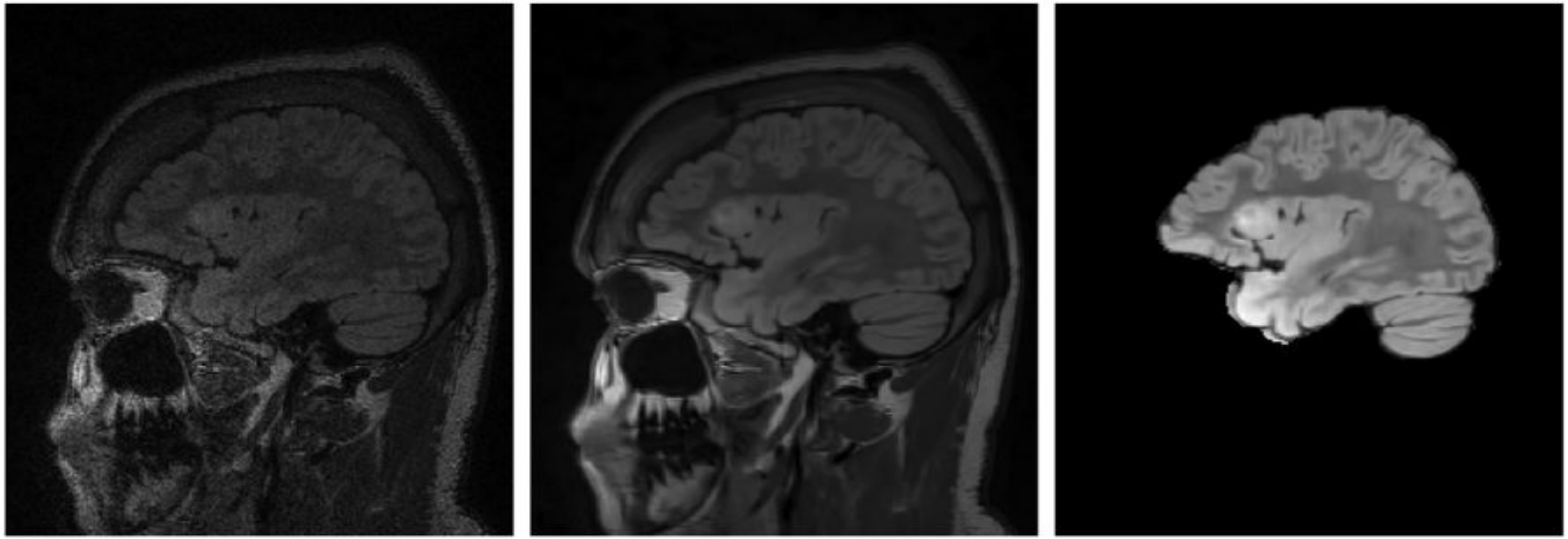
- What is Epilepsy? Epilepsy is a central nervous system (neurological) disorder in which brain activity becomes abnormal, causing seizures or periods of unusual behavior, sensations, and sometimes loss of awareness.
- What is Drug-Resistant Epilepsy? In this scenario epilepsy cannot be cured with medication.
- Focal cortical dysplasia (FCD) is the leading cause of drug-resistant epilepsy in both children and adults. At present, the only therapeutic approach in patients with drug-resistant epilepsy is surgery.
- The quantification of FCD via non-invasive imaging techniques helps physicians to decide on surgical interventions.
- The FCD lesions vary in size, shape, and location for different patients and make the manual detection time consuming and sensitive to the experience of the observer.

Examples of FCD





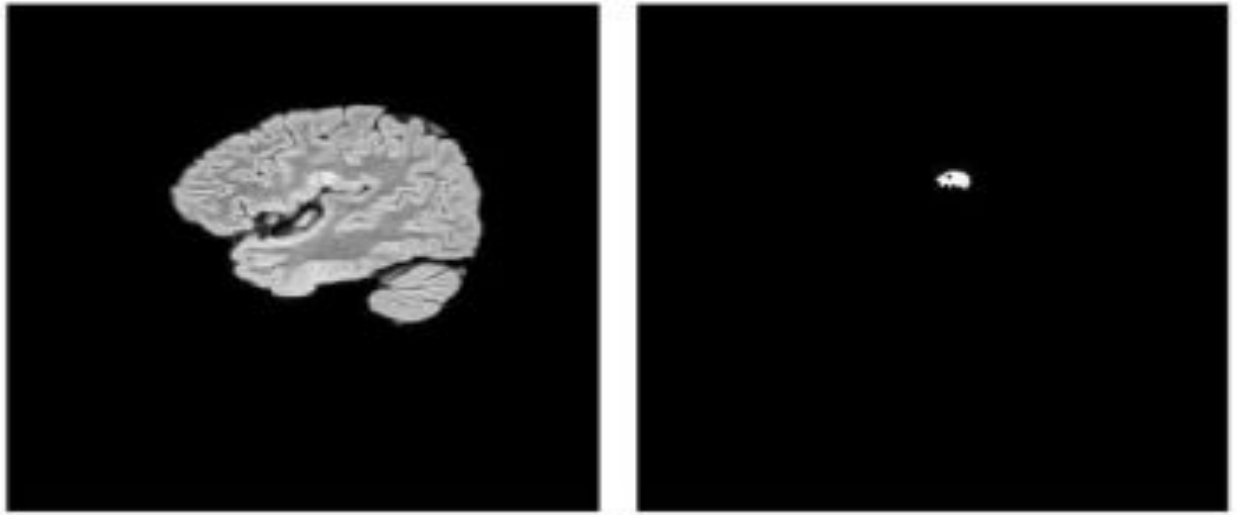
Preprocessing steps of images



(a) Noisy image (b) Denoised image (c) Skull stripped image

- Noise Reduction: BM3D Algorithm is used in order to reduce the SRN.
- Skull-stripping: FSL-BET toolbox to perform the skull-stripping to reduce the area of interest to brain region.

Segmentation of image



- A customized version of U-net architecture is used for image segmentation in the paper.

Progress till now

- Started work with creating different types of classification models for example:cat vs dog classification.
- Build the classification model for insect identification in the agriculture feilds.
- Task performed in insect identification :
- Data collection
- Data augmentation
- Building training models
- Comparing results of models

Data Acquisition

- The most important and crucial part of an image classification model is the acquisition of data that it is trained upon.
- Different sources of image acquisition are:
- Web Scraping: Web scraping technique of obtaining unstructured information from webpages. If the API is not available then we can use Web scraping
- ImageNet: ImageNet is a dataset of over 15 million labelled high-resolution images belonging to roughly 22,000 categories
- Existing project repositories: There are readily available repository for insect images.

Data Augmentation

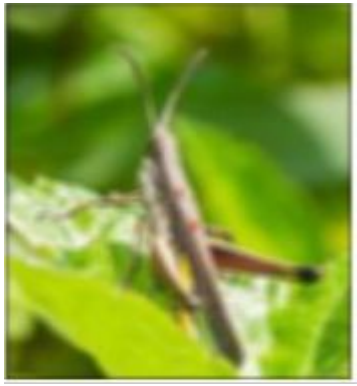
Different data augmentation operations performed on the images are

1. Average filtering
2. Gaussian filtering
3. Cropping the image
4. RGB to GREY image
5. Rotation of image
6. Horizontal and vertical flip of images

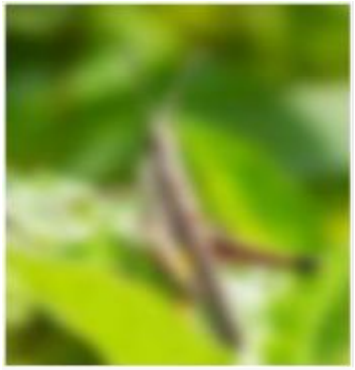
By performing this operation each original image is converted to 15 augmented image.

Examples of image Augmentation

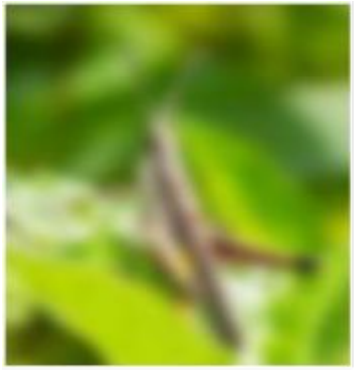
Orignal image



Average filtering



Guassian filter m=4



Guassian filter m=4

Cropped image

Grey image

Vertical flip

Rotate 45

Training model layers

- Conv2d layer:convolutional layer is used to extract features from the image or the parts of the image.it extract features by passing the filter throughout the image,the convolution operation computes the dot products between the values of the image pixels and the weights defined in the filter
- Pooling layer:The objective of pooling layers is to downsample or reduce the dimensionality of the input image. Pooling layers make feature detection free of noise and small changes like image rotation or tilting.
- Dense layer: it is a fully connected layer,in which the results of the convolutional layers are fed through one or more neural layers to generate a prediction.this layer are used as the output layer.
- Flatten layer:In between the convolutional layer and the fully connected layer, there is a ‘Flatten’ layer. Flattening transforms a two-dimensional matrix of features into a vector that can be fed into a fully connected neural network classifier.

Results

Layers in model	Training accuracy	Testing accuracy
5 layers(3 conv-2d layer,1 flatten layer,1 dense layer)	99.58	58.17
10 layers(conv2d, maxpooling2d, conv2d, maxpooling2d, conv2d, maxpooling2d,flatten, 3 dense layer)	96.23	95.54
VGG-16 network	94.25	61.22

Image segmentation

- Region based segmentation using global and local threshold
- Edge detection segmentation using different types of filters for example sobel filter.
- Image Segmentation based on Clustering:using the k means clustering, and using pixel intensity values in order to find out the clusters.
- Till now i have only experimented the above three types of segmentation.

Work done after mid sem

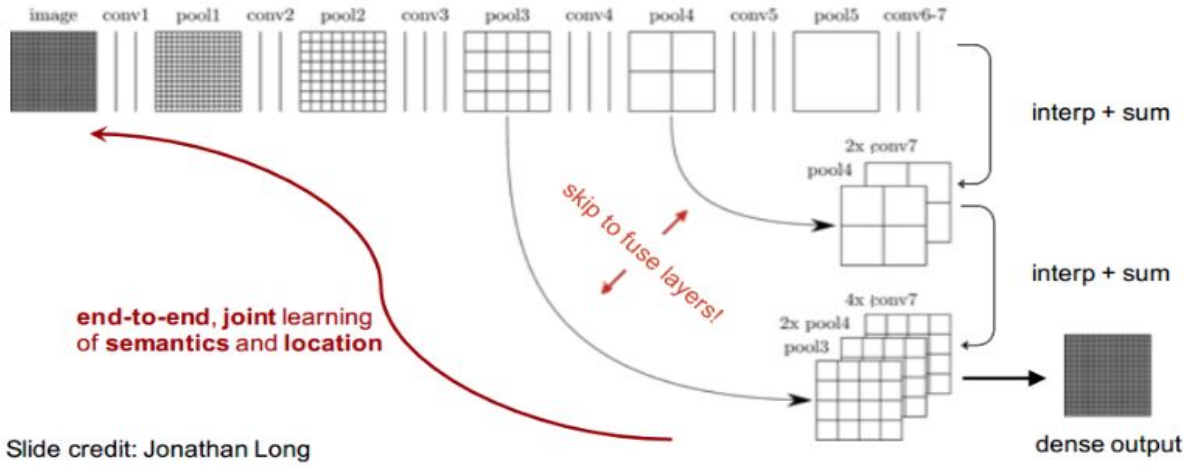
- We started with online and offline data augmentation process, and proceed with online augmentation as we longer need to store huge augmented data in our RAM(which was done in offline model).
- In Online data augmentation the augmented images are served to model during training in form of batch. We can perform online data augmentation using ImageDataGenerator class of keras.
- After image augmentation we learned basic upsampling techniques and we mostly use 3 different types of techniques while building our model.

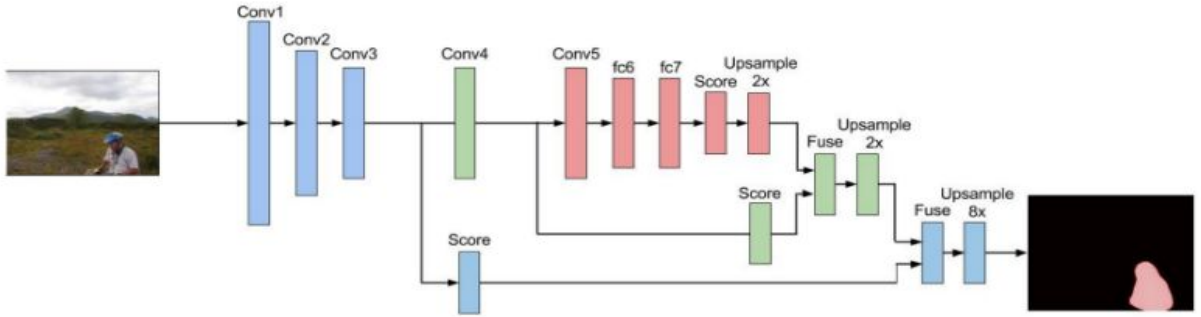
Upsampling techniques used

- Use padding=’same’ and don't apply any kind of pooling layer to model ,hence it will provide the same output of same dimensions as input dimensions
- By using Conv2DTranspose function of keras which is used to perform transpose convolution
- By using the Upsampling functions of keras which generally increases the size of image with the help of zero paddings

All of the above techniques are used across different model such as FCNN-8, UNET architecture over the skin dataset.

FCNN-8 architecture

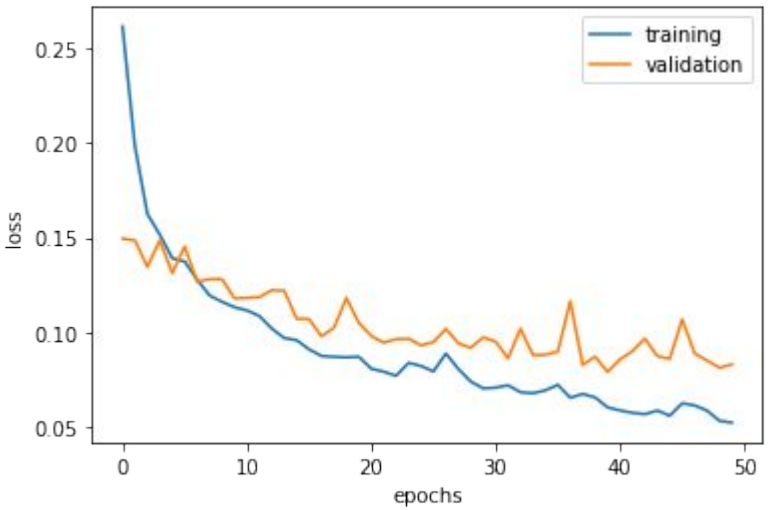


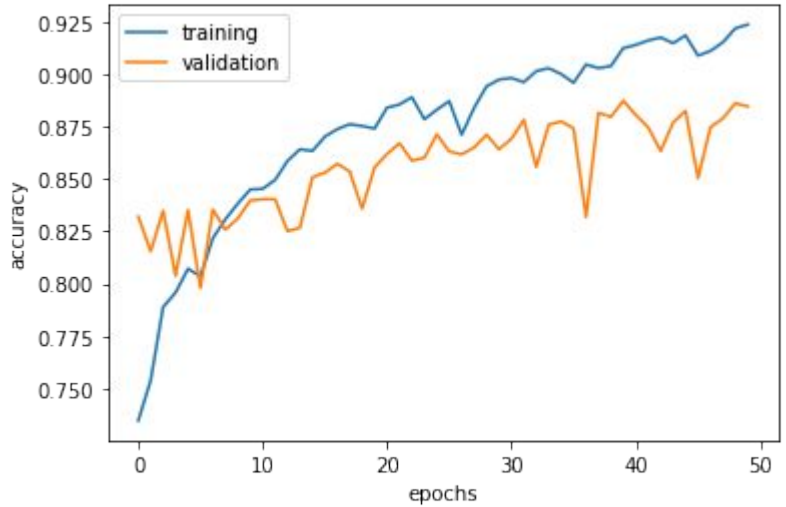


Results of FCNN8

Test_loss = 0.062221657534440 36

Test_accuracy = 0.9147550463676453

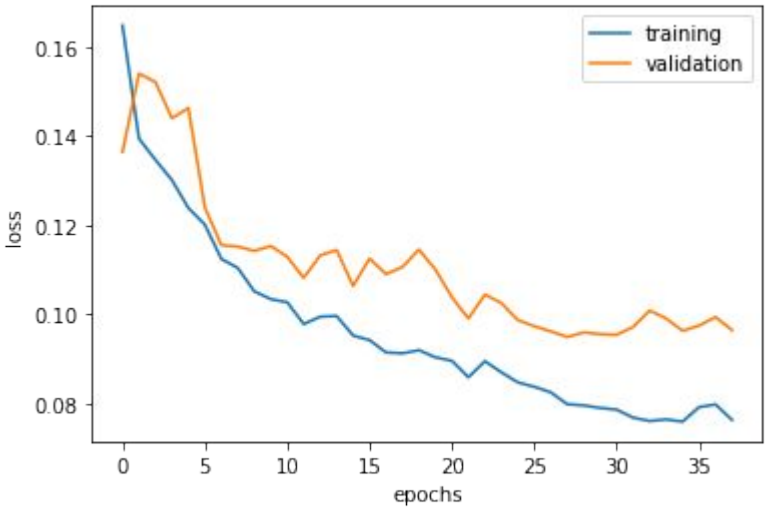


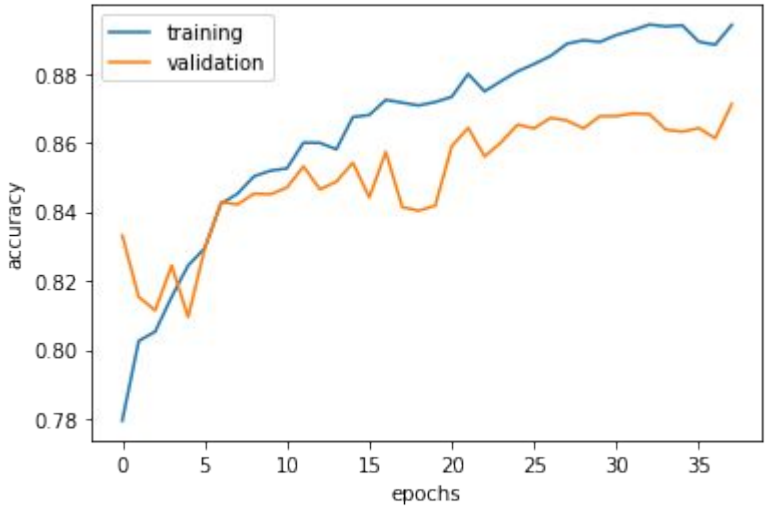


Results of UNET

Test_loss = 0.064273223032553 99

Test_accuracy = 0.91311115026474





Results

- There are many other experiments done with different models , all of those results along with graph can be checked in the link below :
- https://github.com/mohdrahil7/image-Segmentation