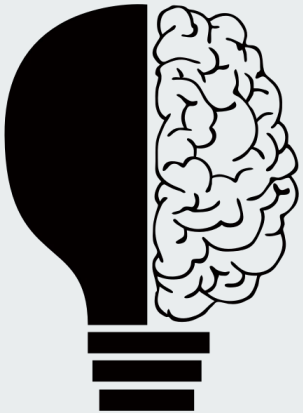
Brain Tumor Segmentation using 3D MRI scans:



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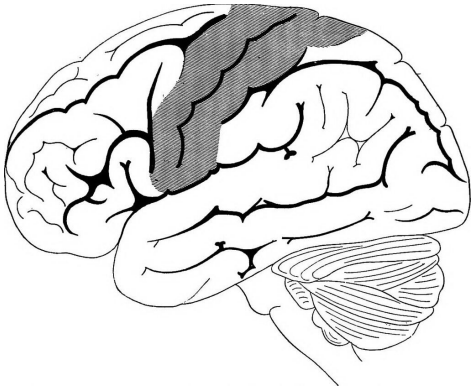
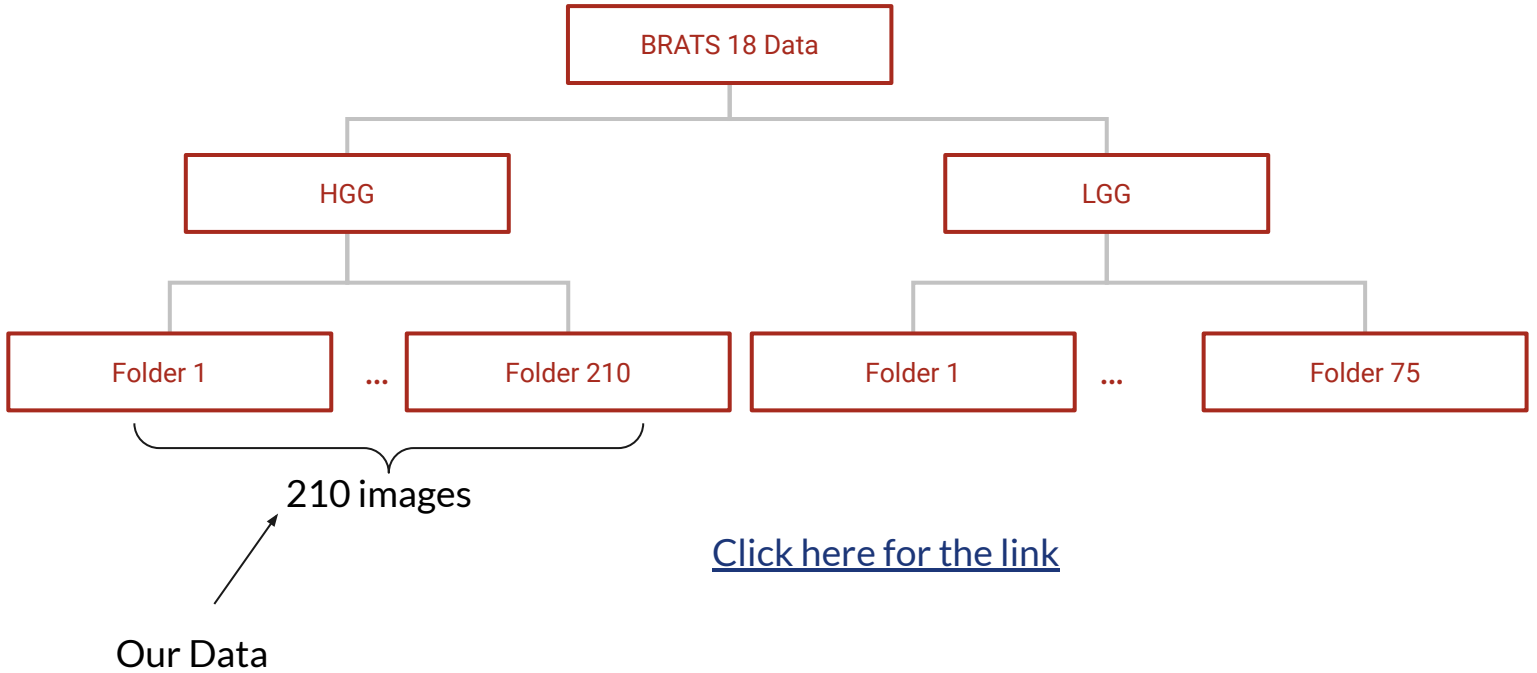
Brief Description of brain tumors- utility of this project:

- **Brain tumors:** Growth of abnormal cells in the brain, that might be malignant or benign.
- **Segmentation task:** Separating the tumor tissues from the healthy tissues.
- Automation in extracting/ differentiating the tumor from the surrounding healthy tissue using CNNs help to detect the tumor both faster & more accurately.
- Helps to decide future treatment procedural and better results



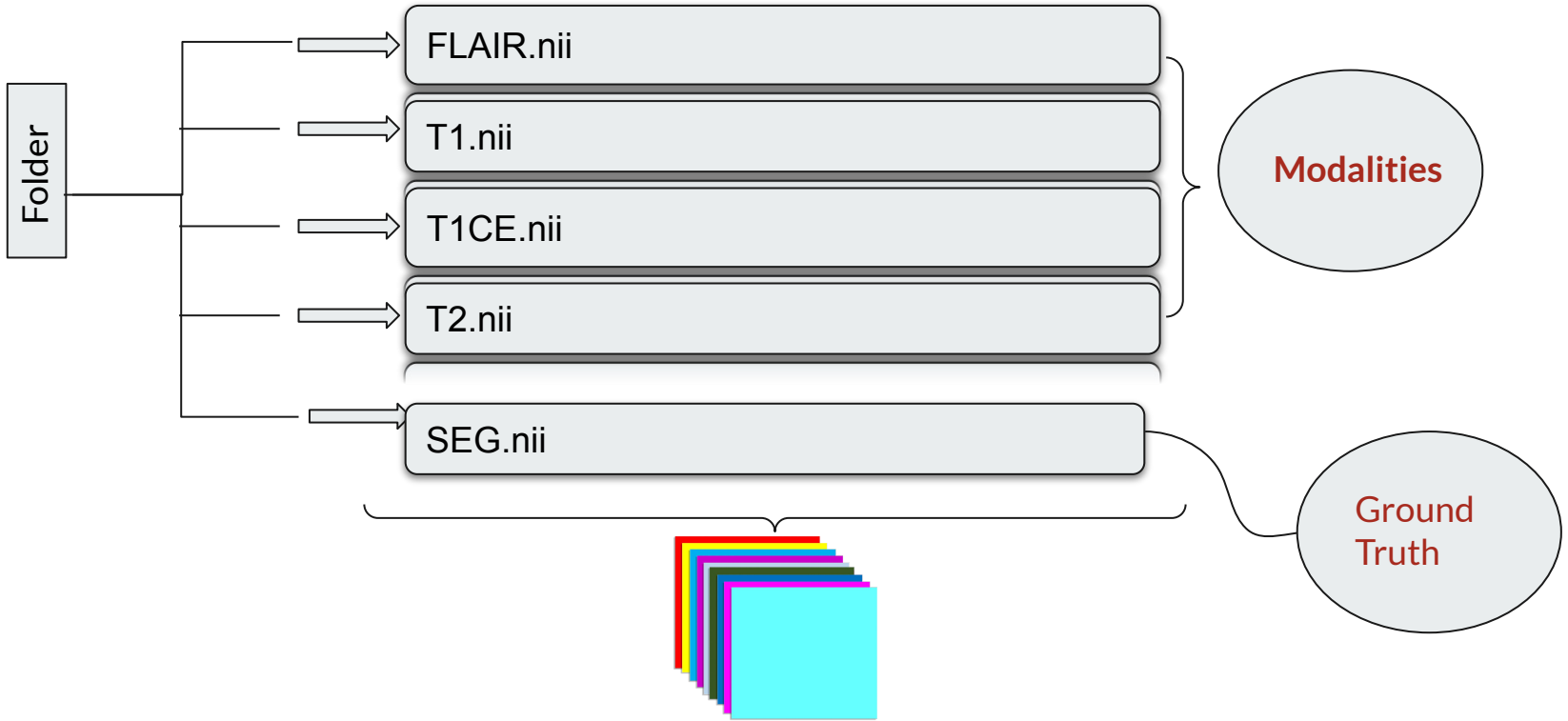
Dataset description:

- **Dataset:** MICCAI BRATS 2018 Dataset (Downloaded from Kaggle)

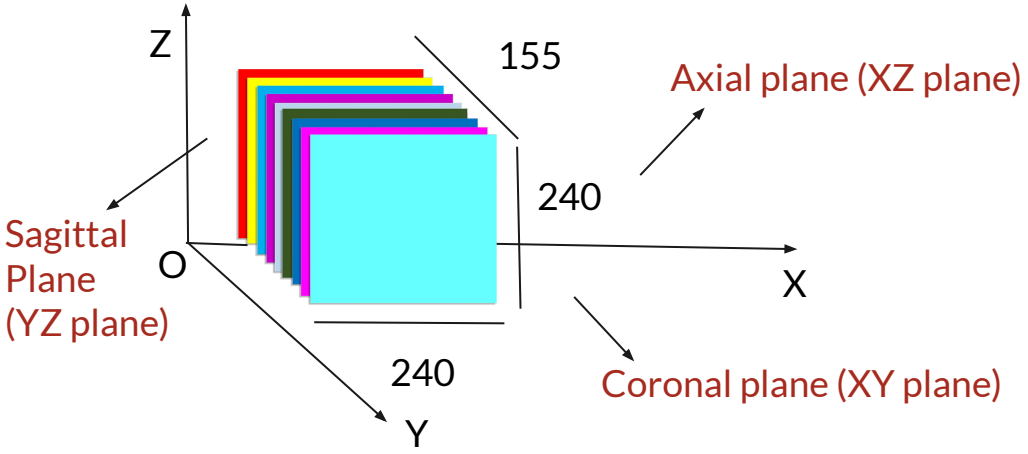


Click here for the link

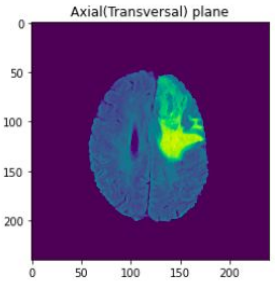
Dataset description:

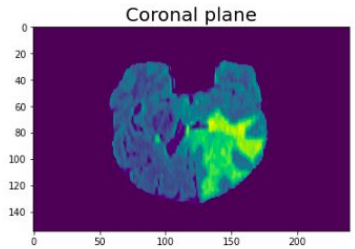


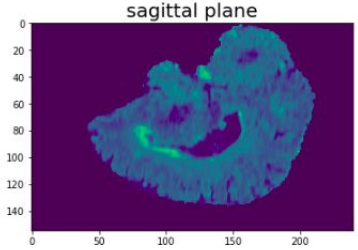
Data Visualization:



Visualizing a sample image in these 3 planes:

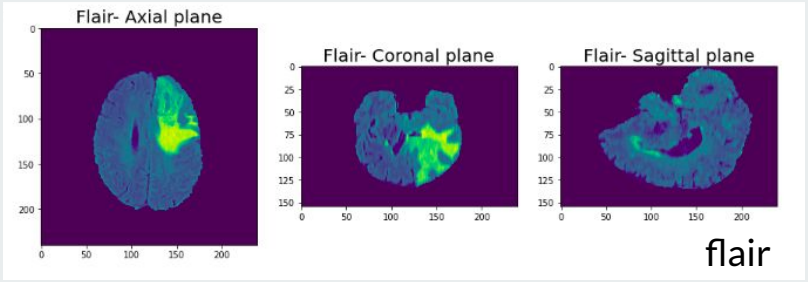


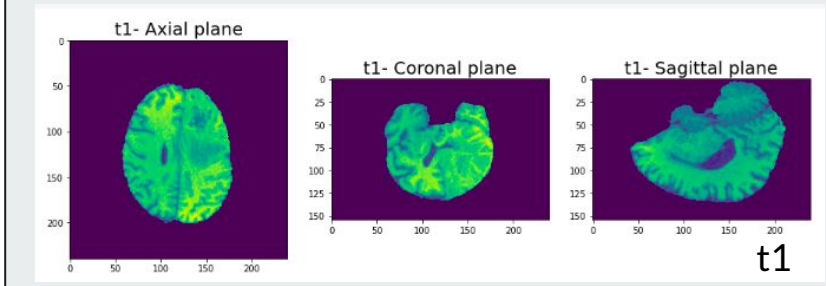


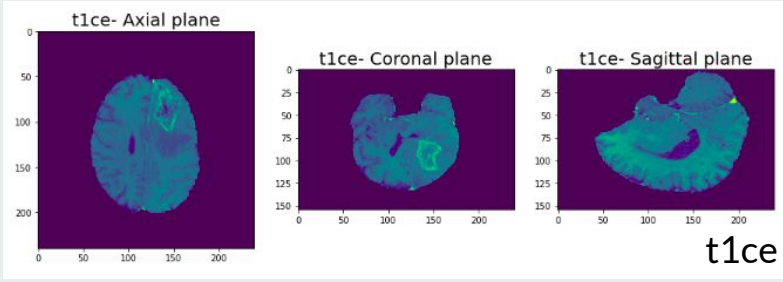


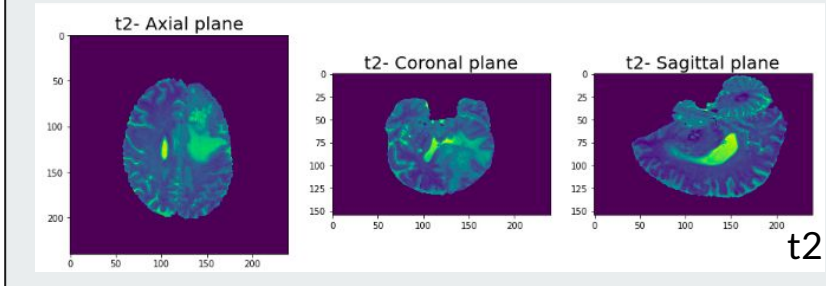
Data Visualization (Contd.):

Visualizing the four modalities in 3 planes:



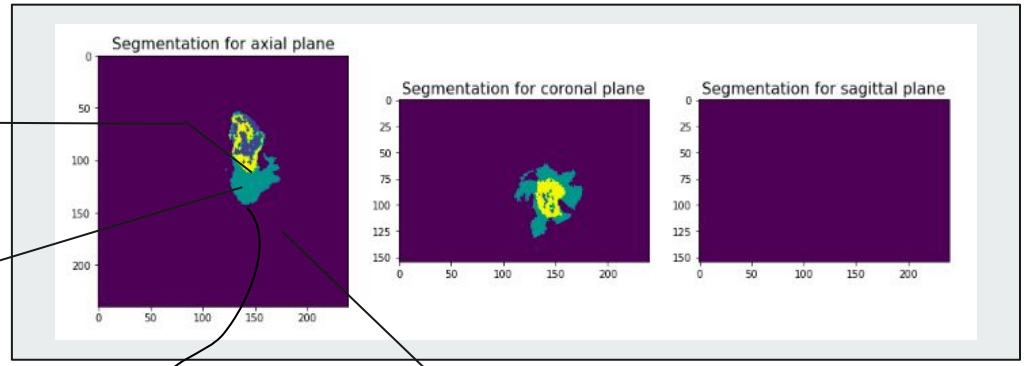






Data Visualization (Contd.):

The Segmented image- Exploring different labels:

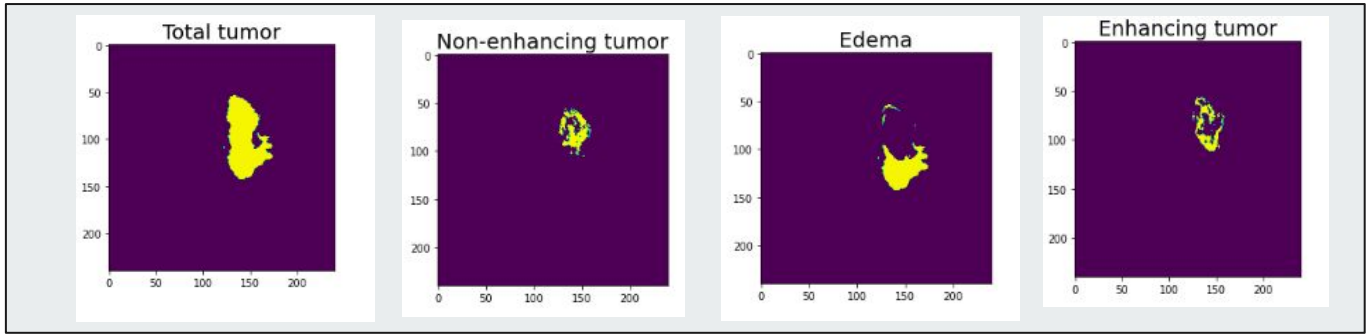


Non-enhancing Tumor (label 1)

Enhancing tumor (Label 4)

Edema(label 2)

Healthy tissue(Label 0)

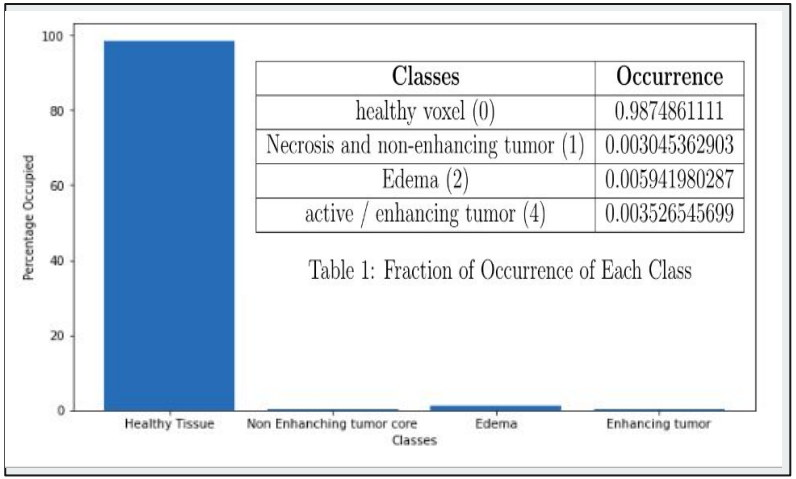


Class imbalance problem:

- **What is class imbalance problem?**

  When there is an unequal distribution of **classes** in the training dataset.

- **How it affects our dataset:**



Classes	Occurrence
healthy voxel (0)	0.9874861111
Necrosis and non-enhancing tumor (1)	0.003045362903
Edema (2)	0.005941980287
active / enhancing tumor (4)	0.003526545699

Table 1: Fraction of Occurrence of Each Class

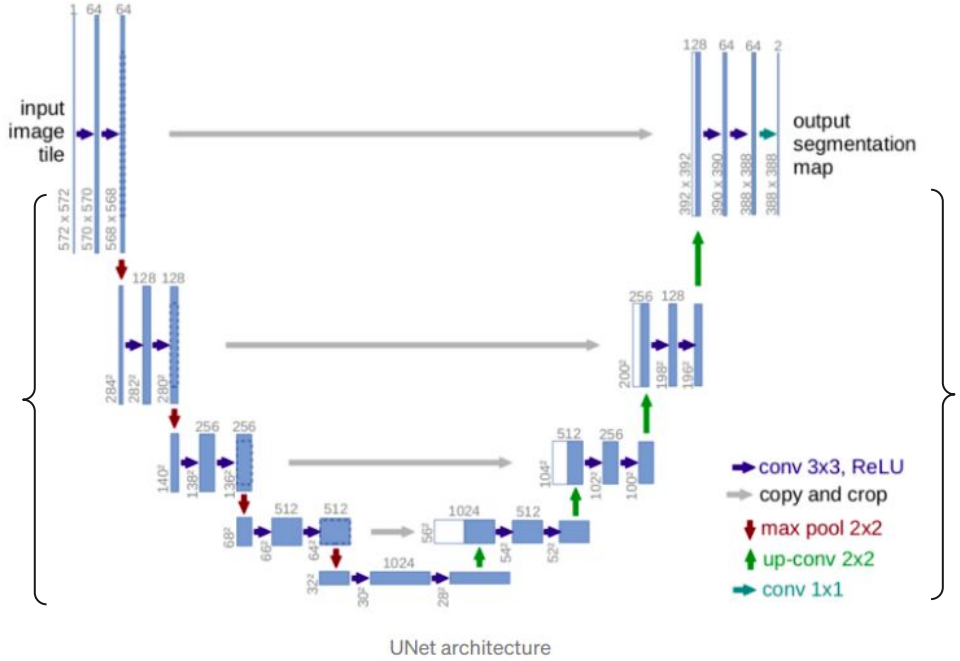
- **Strategies to cope up class imbalance:**

  - Use multi class Dice loss
  - Different weights to penalize labels.

Architecture of our model:

UNet :

ENCODER



UNet architecture

DECODER

Training Details:

Trained on 200 HGG images with validation split of 0.25, i.e. 150 images for training and 50 images for validation.
Epochs=50, lr=1e-4,drop out=0.25

- **Loss function:- Dice loss**

$$1 - \frac{2\sum_{pixels} y_{true} y_{pred}}{\sum_{pixels} y_{true}^2 + \sum_{pixels} y_{pred}^2}$$

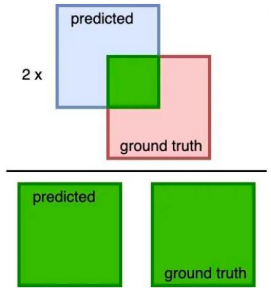
This scoring is repeated over all **classes** and averaged

y_{true} = ground truth

y_{pred} = output

- **Metric to measure accuracy: Dice coefficient:**

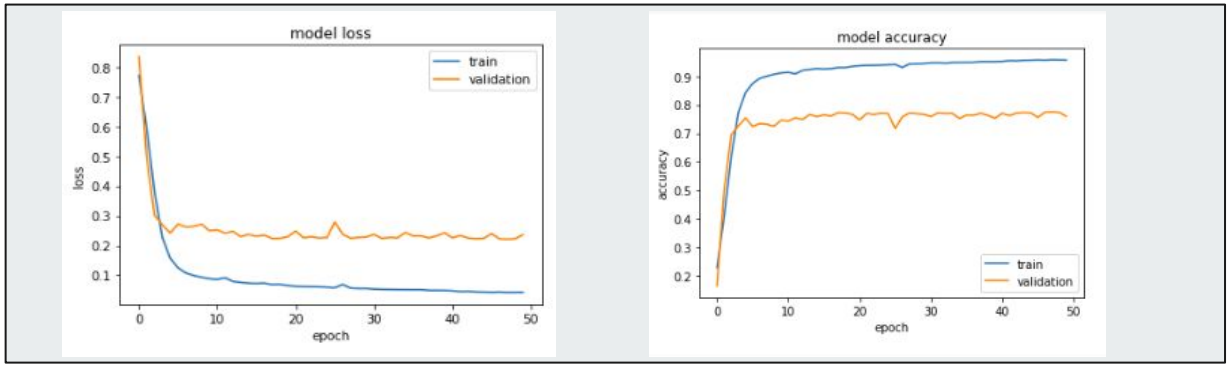
Dice co-eff=1-Dice loss=



Results: (for whole tumor segmentation)

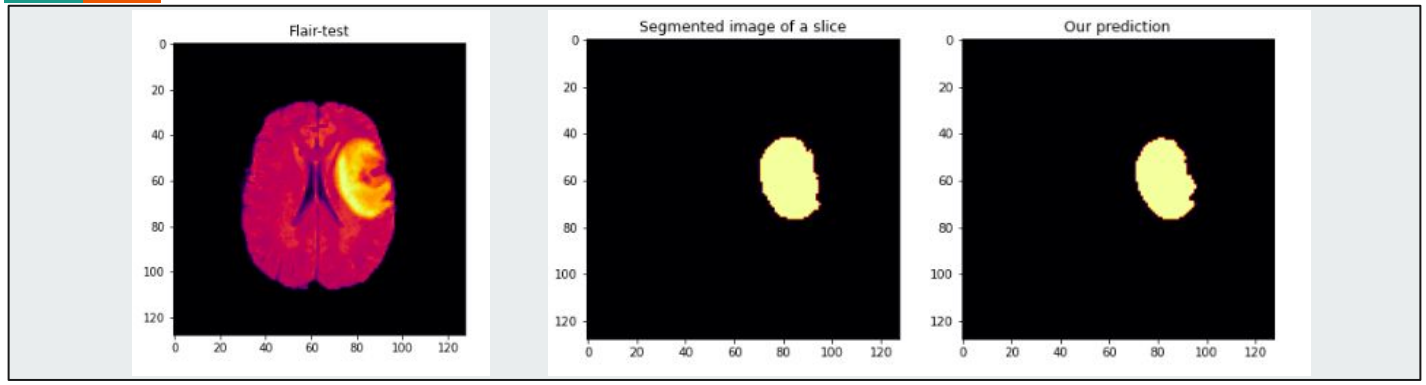
Validation_loss=0.25, Validation dice coefficient=0.75

Model loss & accuracy:

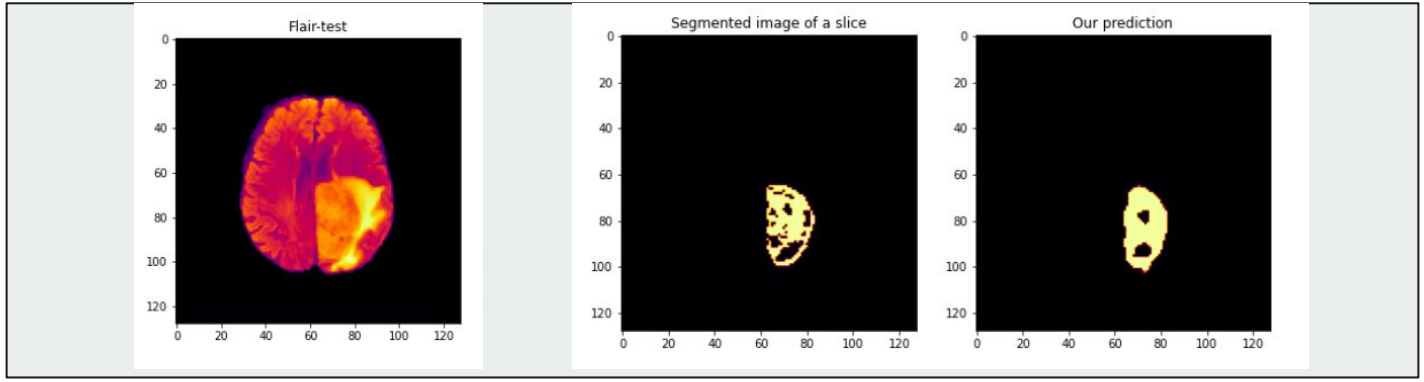


Predictions:

For whole tumor:



For enhancing tumor only: Validation dice coeff=0.3 :(

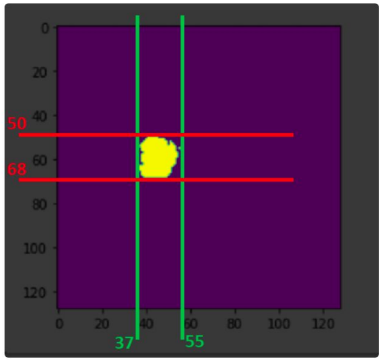


Why so!!

May be because in the whole image the enhancing tumor occupies too little space

Strategy:

removing the useless area and center the images by cropping and train using cropped images.



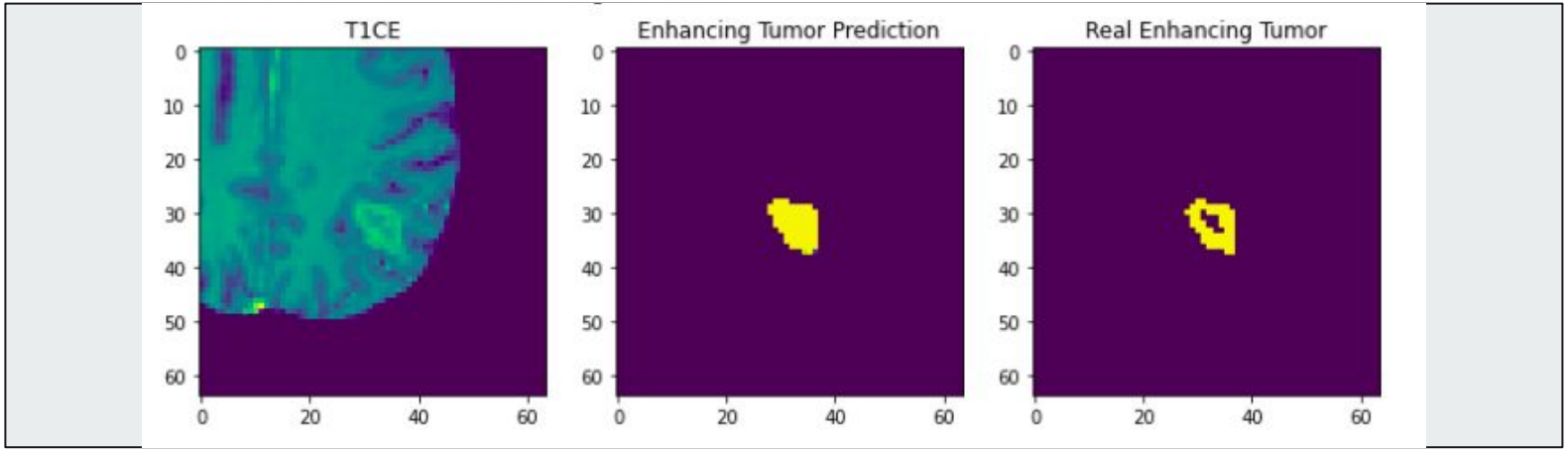
makes the tumor clearer!!!

Training:

40 images to train, 10 images for validation.

With SAME ARCHITECTURE

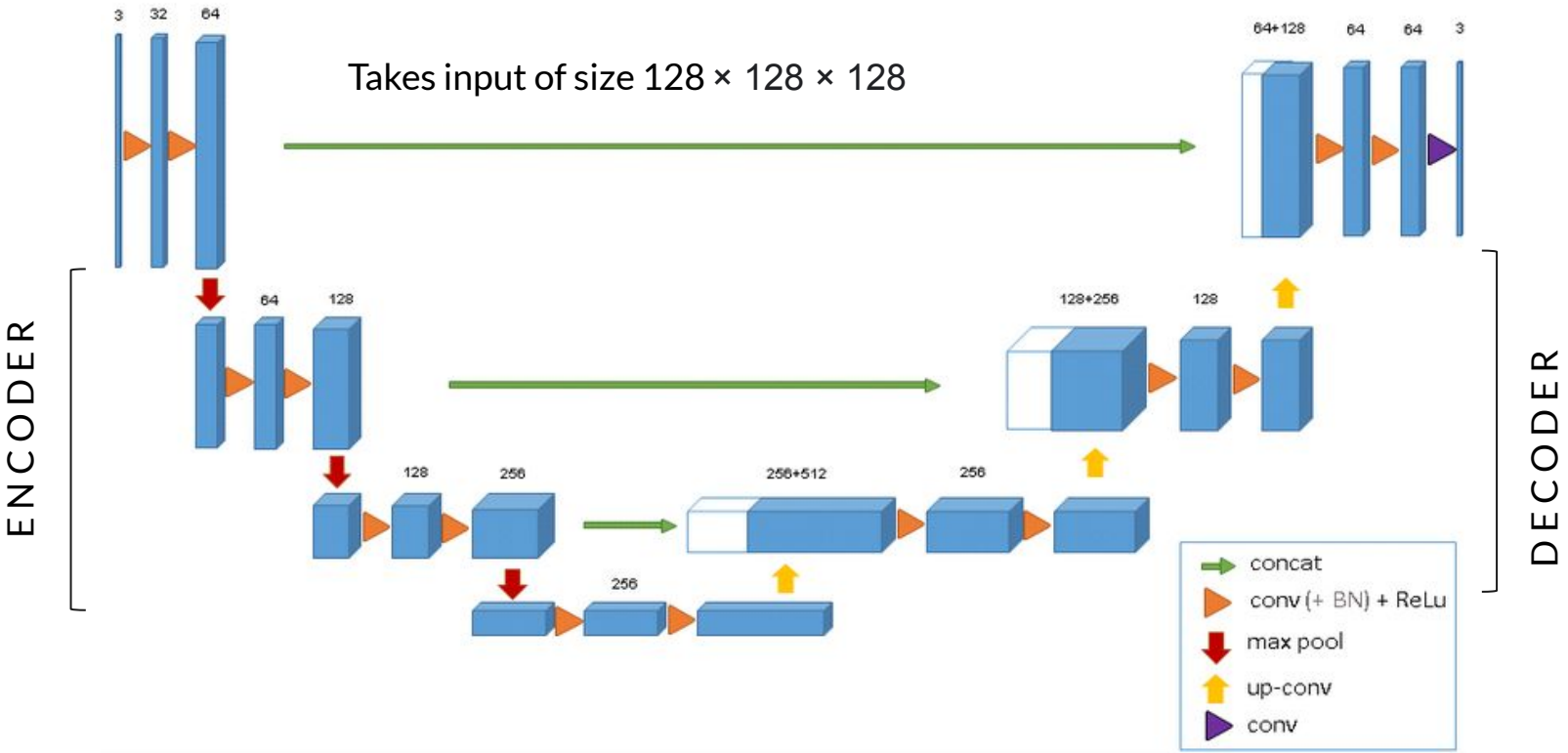
Results after cropping:



Validation dice coeff=0.6 !!!

Clear improvement :)

Another architecture: UNet 3D

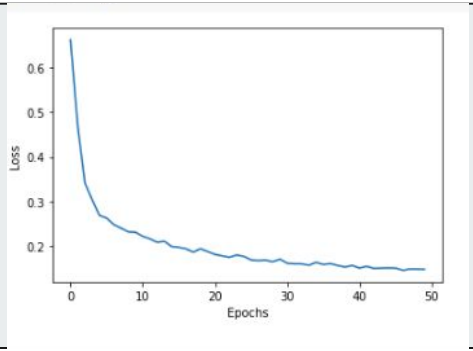


Training:

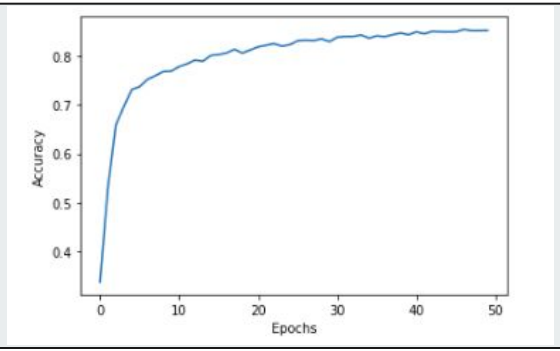
- 180 images for training, 30 images for validation
- epochs=60
- learning_rate=0.001, decay_rate=0.0000001
- Optimizer: Adam
- Loss: Dice Loss
- Metric: Dice Co efficient

Results:

Training Loss

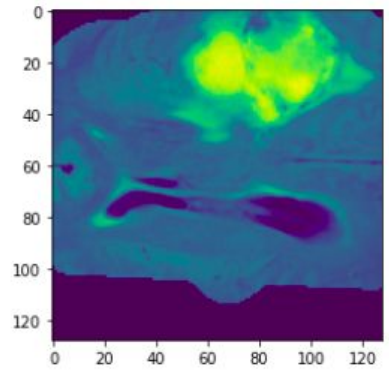


Training Accuracy

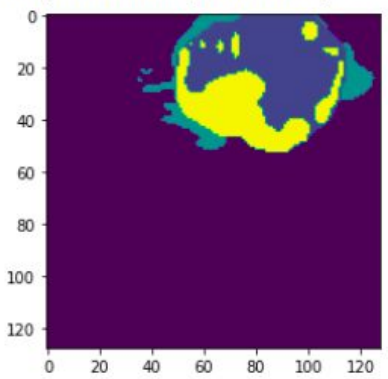


However Validation dice coeff=0.05 !! A disaster :(

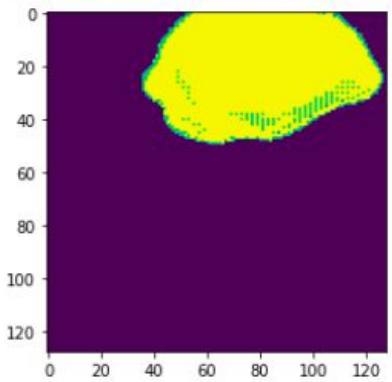
Very poor predictions:



Flair modality of test image



Ground Truth



Prediction

TO BE IMPROVED...

Summary of the results:

Name of the method	Number of training images	Number of Validation images	Loss function	Metric	Validation Loss	Validation Accuracy
UNet 2D	150	50	Dice Loss	Dice Coefficient	0.25	0.75
UNet 2D with cropped images	40	10	Dice Loss	Dice Coefficient	0.4	0.6
UNet 3D	180	30	Dice Loss	Dice Coefficient	0.95	0.05

Citations:

- https://www.cse.iitb.ac.in/~shalabhgupta/Report.pdf
- https://arxiv.org/pdf/2011.01118.pdf
- https://www.jeremyjordan.me/semantic-segmentation/
- https://arxiv.org/pdf/1802.10508v1.pdf

Link to dataset:

Click here for the dataset

OR, paste the below link in your browser

https://drive.google.com/file/d/1gfLZlHaqTDeSKt7zDEIIWJydt_eR7uay/view?usp=sharing

THANK YOU FOR YOUR PATIENCE !