

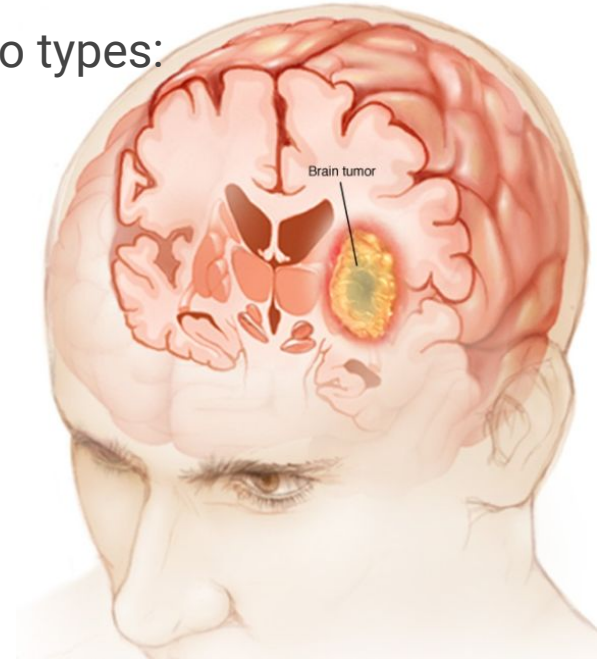
Brain Tumor Segmentation using MRI Image

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Introduction

- Brain tumor is of two types:
 - Primary brain tumor
 - Secondary brain tumor
- Gliomas are primary brain tumors and they are of two types:
 - HGG = High Grade Glioma
 - Malignant brain tumor
 - Requires surgery and radiotherapy
 - LGG = Low Grade Glioma



Introduction

- Deep learning models have been used for segmentation task
- Each MRI image contains 3 types of tumor:
 - Enhancing Tumor
 - Non-Enhancing Tumor
 - Edema Tumor

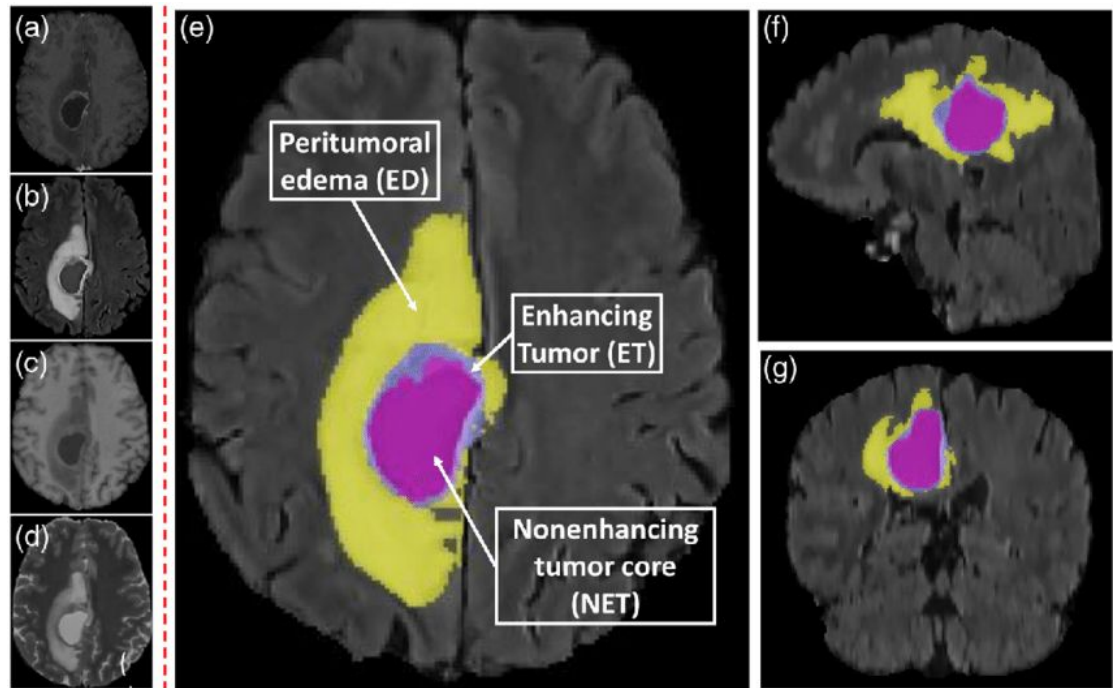
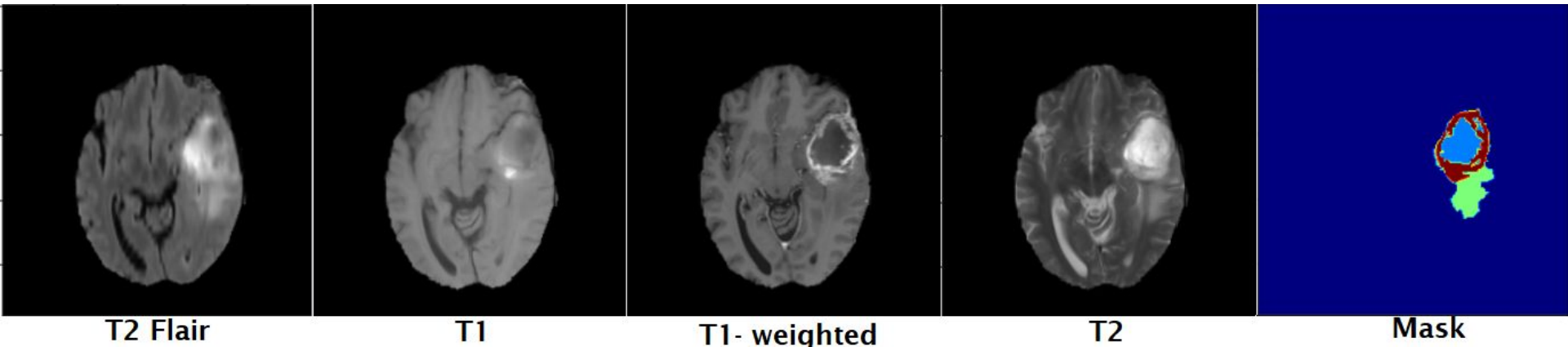


Fig: (a)T1 (b) T1-weighted (c) T2 Flair (d) T2 (e) axial view of Segmented Brain Tumor MRI Image (f) sagittal view (g) coronal view

BraTS'19 Dataset

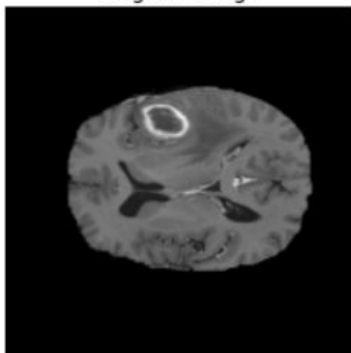
- The dataset contains 259 MRI scans of patients with high-grade gliomas (HGG).
- Each MRI image is of size 240x240x155.
- The dataset contains MRI image of 4 different modalities.
- Each image contains three types of tumor: Non-enhancing Necrotic tumor (NET), enhancing tumor (ET), and edema (ED) tumor.



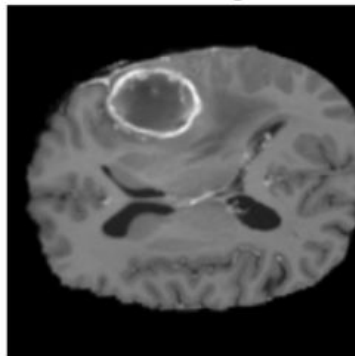
Preprocessing data

- In biomedical field, the dataset is not freely available
 - Images can only be annotated by experts.
- BraTS'19 dataset contains only 259 MRI images along with their labelled mask.
- For data augmentation, the 3D MRI image is scaled, rotated and translated.

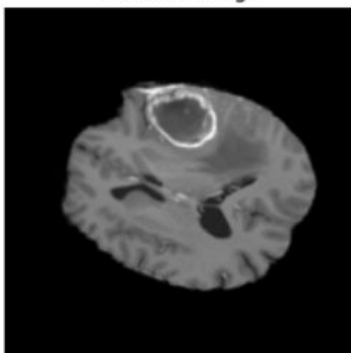
Original Image



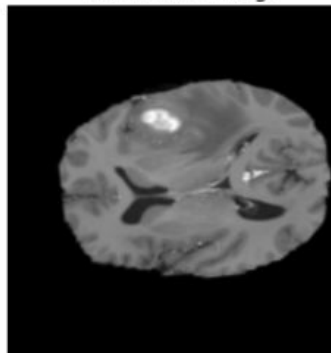
Scaled Image



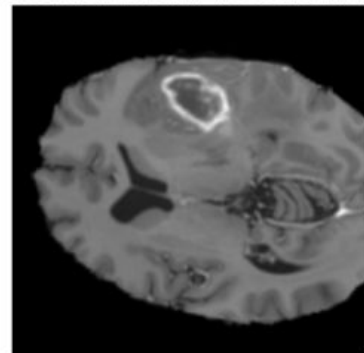
Rotated Image



Translation Image



Scaled, Rotated and Translated Image

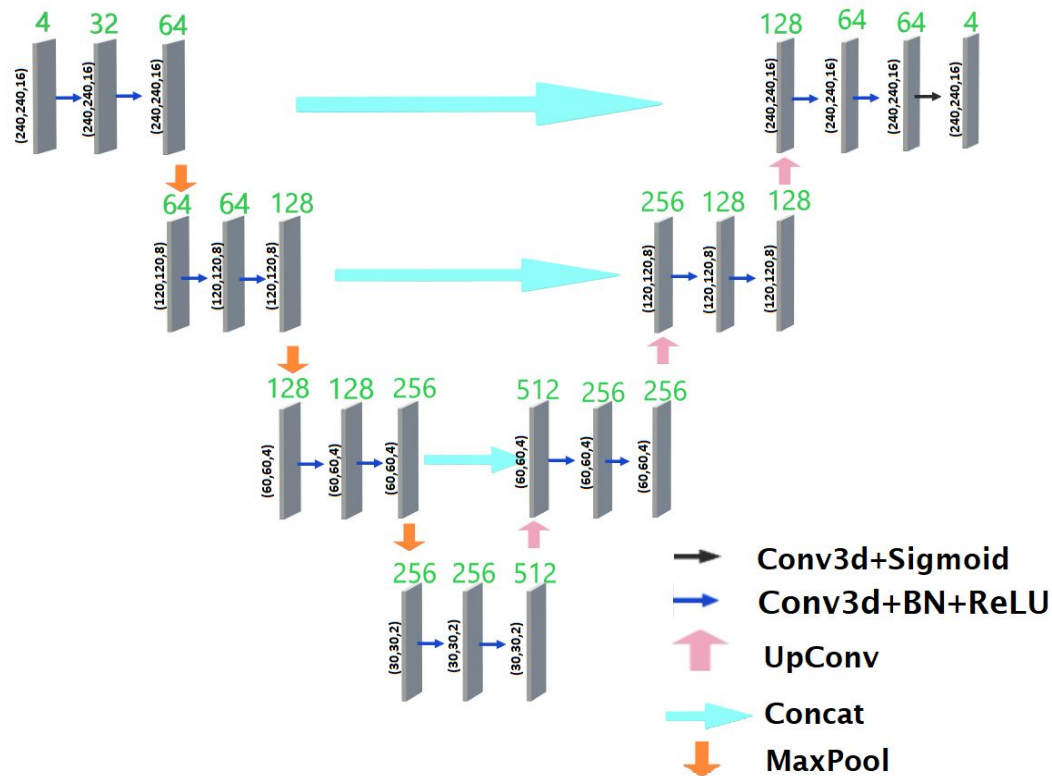


Segmentation Models

UNet 3D

Two parts

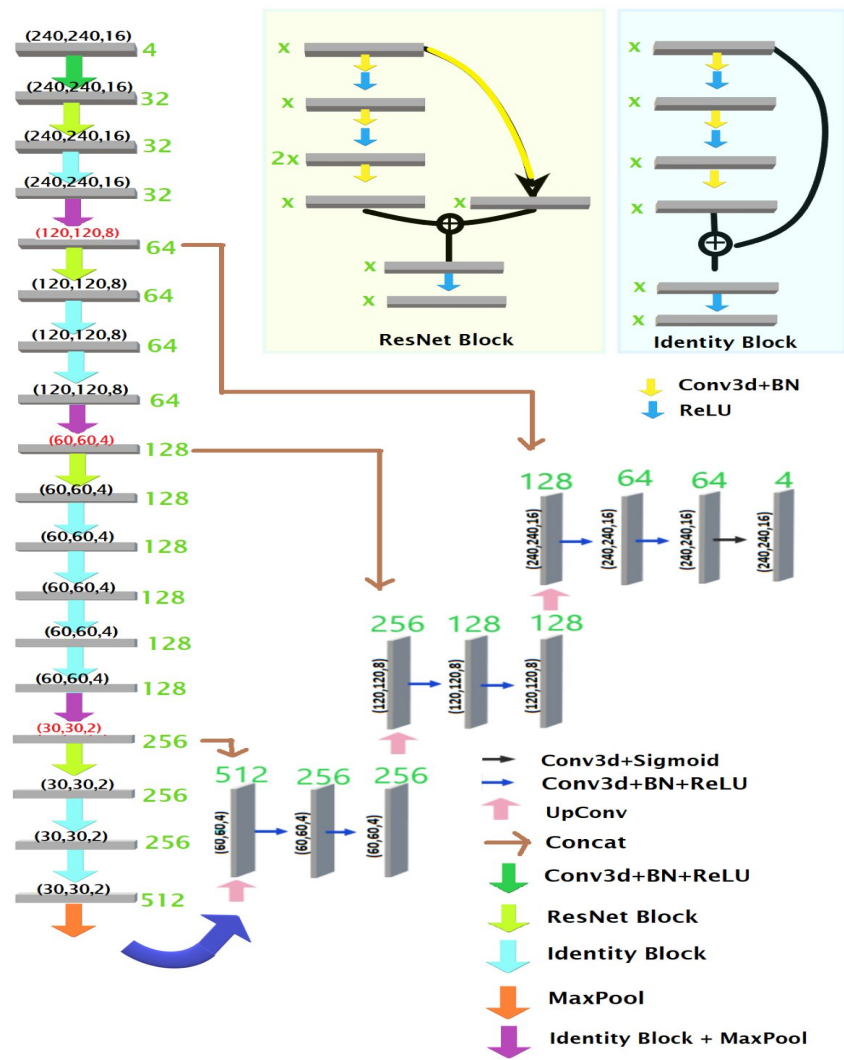
- Downsampling part
 - Feature channels doubled
 - Decreasing the Image size
- Upsampling part
 - Upconvolution of image
 - Concatenation of feature maps
 - Localizing information
 - Final layer: 1x1 convolution
 - 64-feature maps -> 4-feature maps



ResUnet

Two parts

- Downsampling path => ResNet
 - Skip connections used
 - Overcome vanishing gradient problem
 - Max Pooling done for concatenation
 - 3x3x3 Convolutional layer + BN + ReLU
- Upsampling path => Unet 3D
 - Upconvolution of image
 - Concatenation of feature maps
 - Localizing information
 - Final layer: 1x1 convolution
 - 64-feature maps -> 4-feature maps



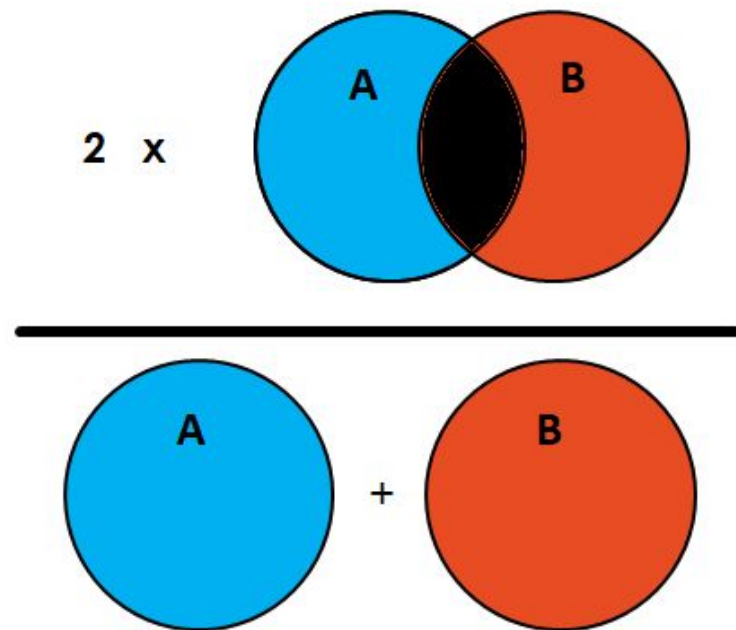
Loss Function

Dice Coefficient

- Measures similarity between 2 images
- Range of dice coefficient => [0,1]
 - 1 => completely similar
 - 0 => completely different
- Loss = (1- Dice Coefficient)

$$DSC(f, x, y) = \frac{2 \times \sum_{i,j} f(x)_{ij} \times y_{ij} + \epsilon}{\sum_{i,j} f(x)_{ij} + \sum_{i,j} y_{ij} + \epsilon}$$

$$DSC(A,B) =$$



where,

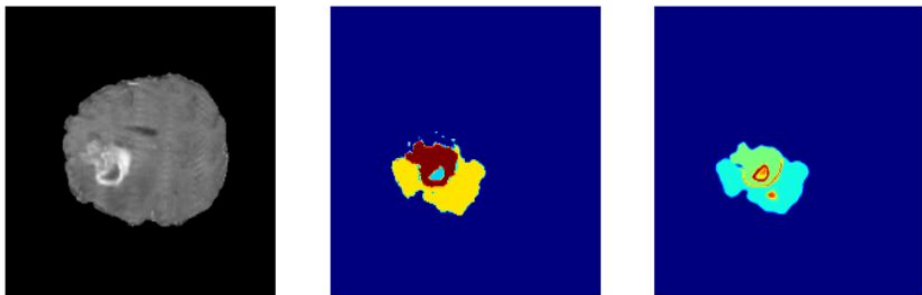
x = input image

f(x) = predicted image

y = ground truth

ϵ = small number added to avoid division by zero error

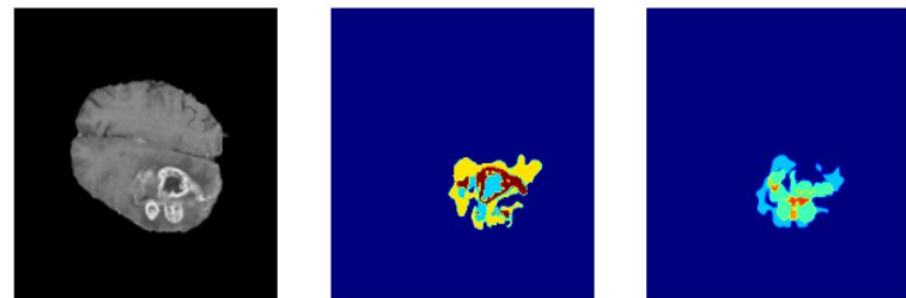
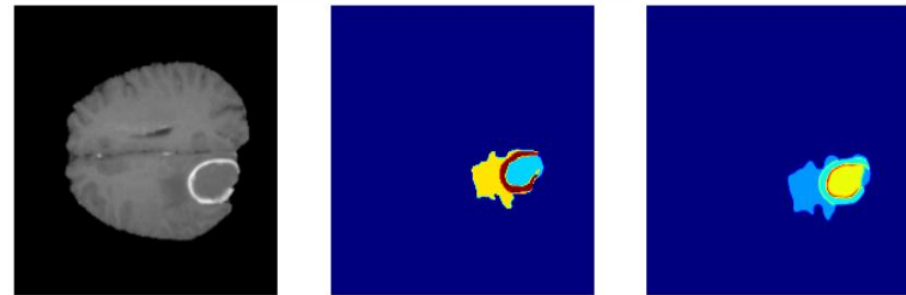
Result: For Unet-3D



Input Image

Ground Truth

Predicted Mask

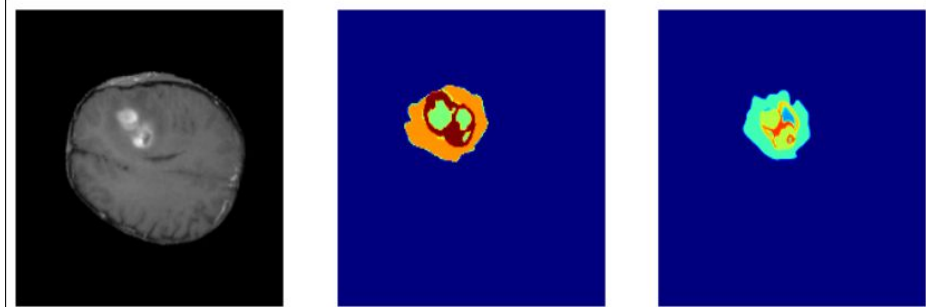
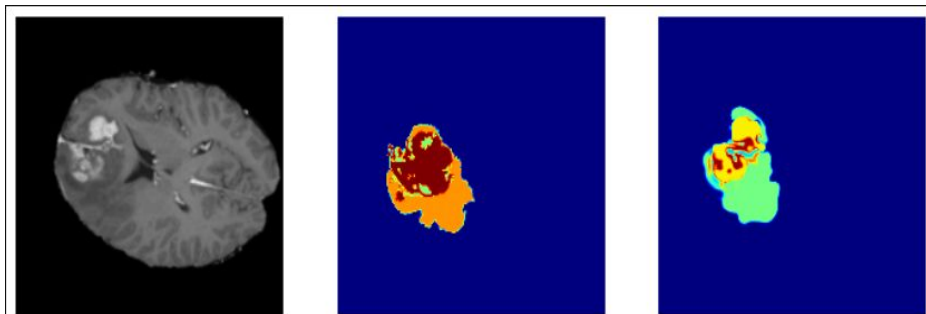


Input Image

Ground Truth

Predicted Mask

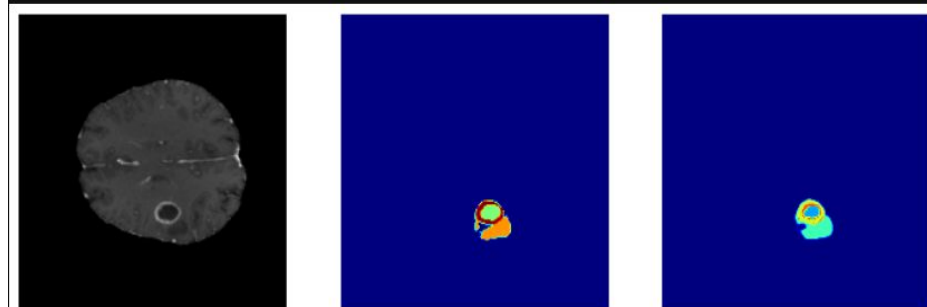
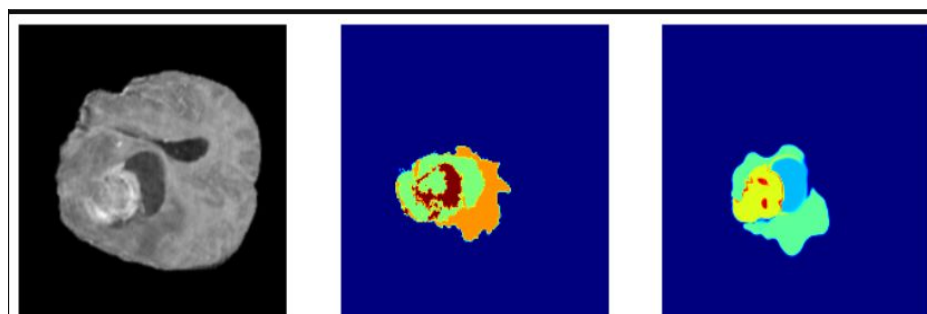
Result: For ResUnet-3D



Input Image

Ground Truth

Predicted Mask

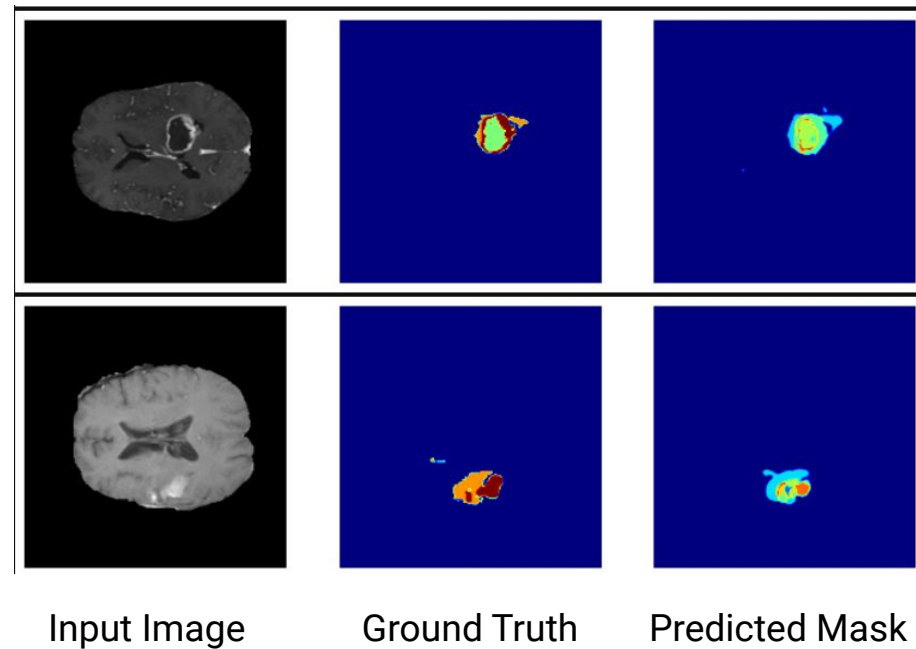
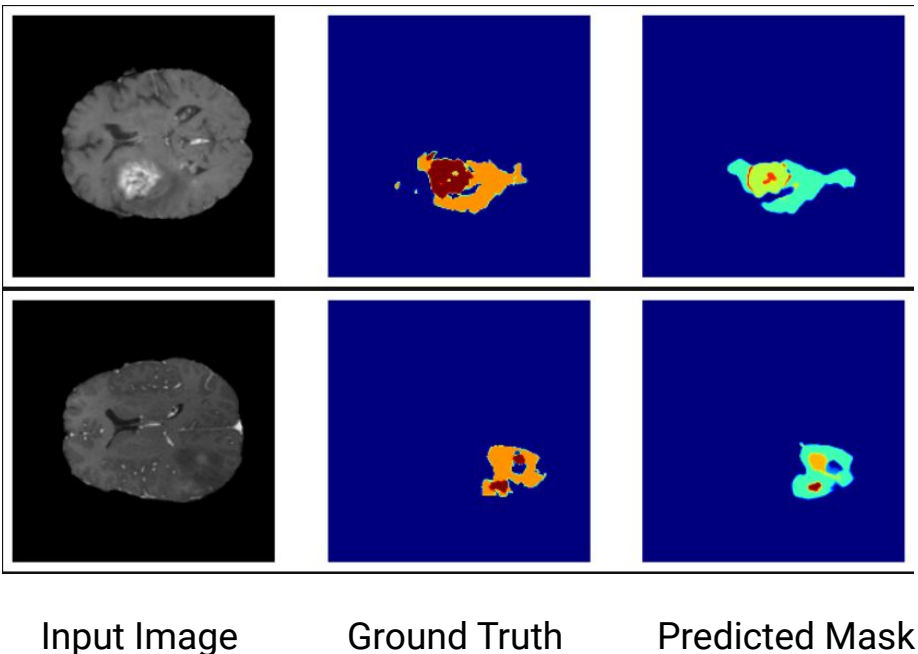


Input Image

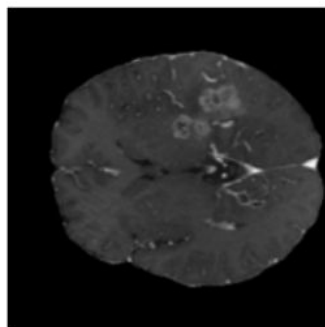
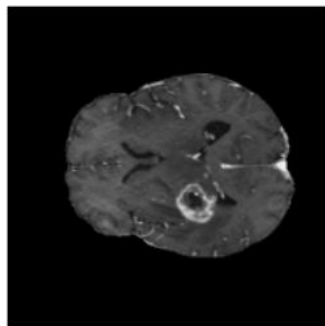
Ground Truth

Predicted Mask

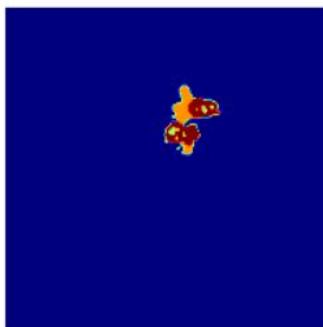
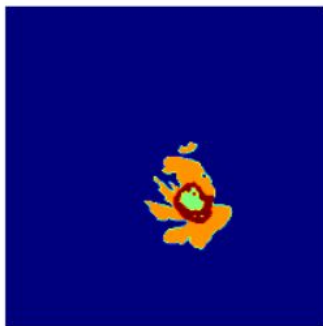
Result: For Unet-2D



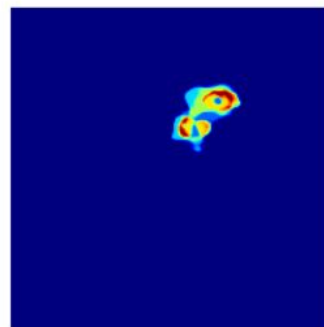
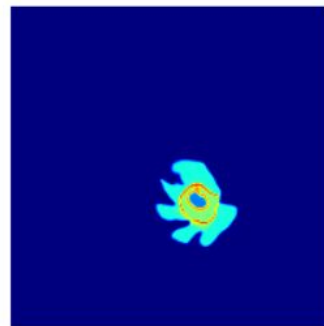
Result: For ResUnet-2D



Input Image



Ground Truth



Predicted Mask

Result: Quantitative

- Dice Tumor Core(TC)
 - $\text{Dice TC} = (\text{NET} + \text{ET})/2$
- Dice Enhancing Tumor(ET)
 - Dice ET
- Dice Whole Tumor
 - $\text{Dice WT} = (\text{NET} + \text{ET} + \text{ED})/3$

Model	Epochs	Dice TC	Dice ET	Dice WT
UNet-3D	15	0.35395	0.4332	0.3940
ResUnet-3D	10	0.37995	0.4729	0.4300
Unet-2D	40	0.7510	0.7201	0.7466
ResUnet-2D	30	0.6663	0.6781	0.6815

Table 1: Dice Coefficient on Training Set

Model	Epochs	Dice TC	Dice ET	Dice WT
UNet-3D	15	0.37485	0.457	0.4089
ResUnet-3D	10	0.30785	0.3881	0.3614
Unet-2D	40	0.7212	0.7090	0.7166
ResUnet-2D	30	0.6443	0.6981	0.6622

Table 2: Dice Coefficient on Test Set

Thank You!!

Github Link: [swapnilmalviya-git/BrainTumorSegmentationUsingBratsDataset \(github.com\)](https://github.com/swapnilmalviya-git/BrainTumorSegmentationUsingBratsDataset)