Brain Tumor Segmentation with 3D-UNet

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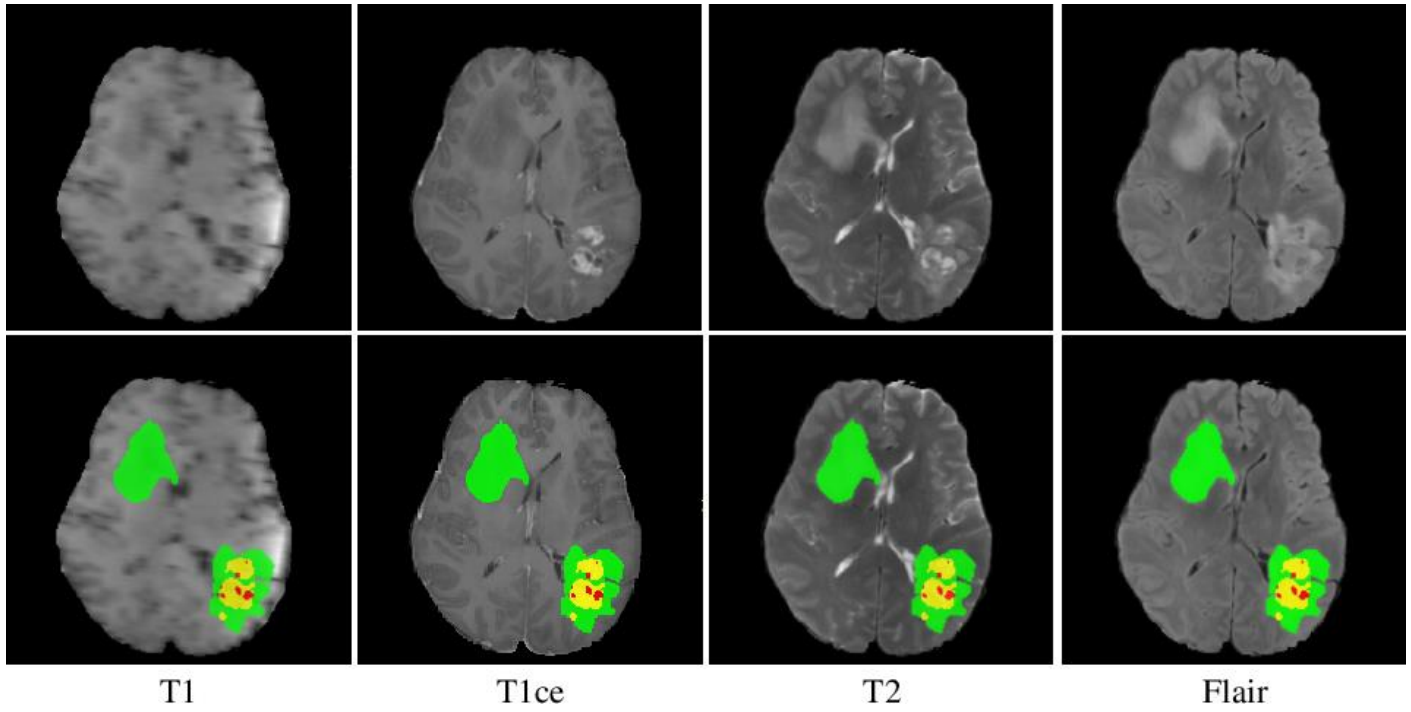
Brain Tumor Segmentation (BraTS) Challenge 2020

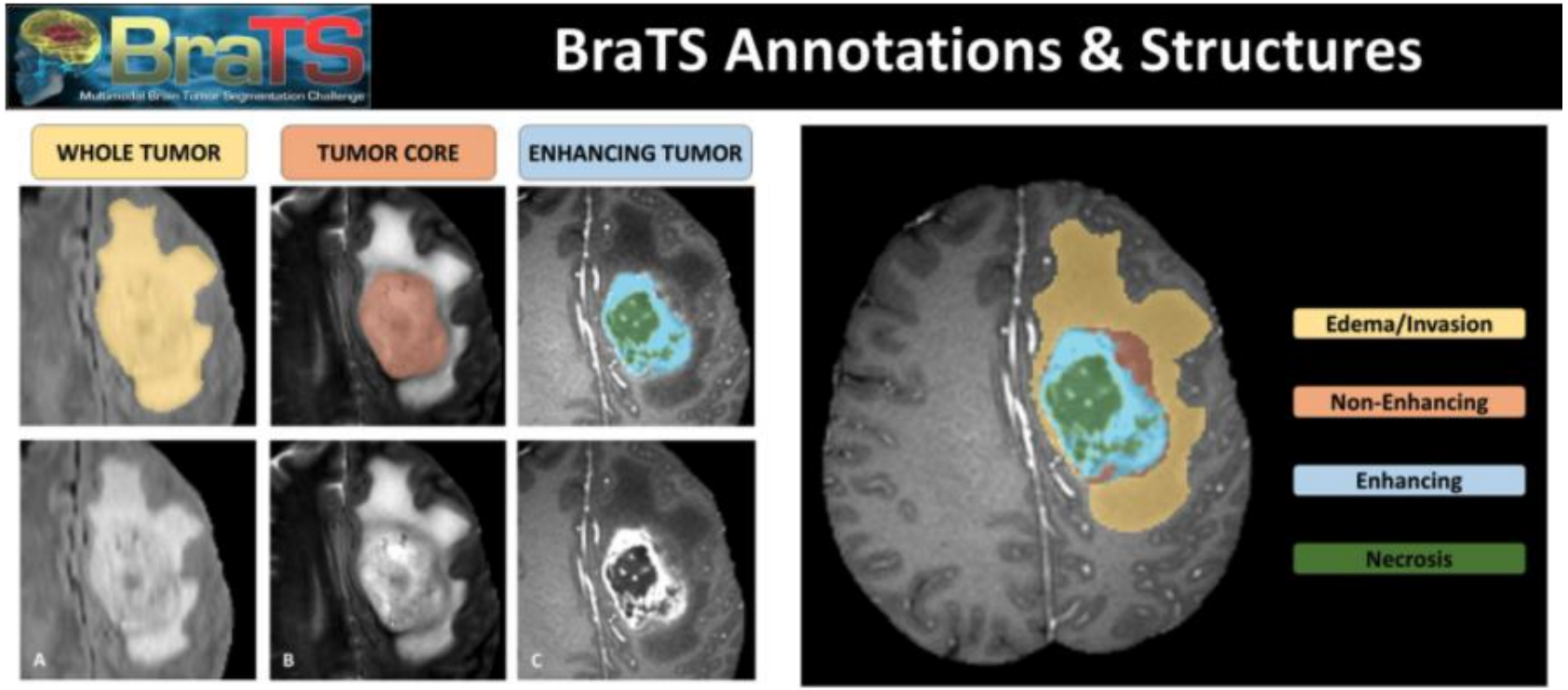
- Format: NIfTI files (.nii.gz)
- Modalities: T1, T1ce, T2, FLAIR
- Training set: 369 cases
- 4 images + 1 mask/case
- Image Size: 240x240x155
- HGG: 293 cases
- LGG: 76 cases



Source: https://arxiv.org/pdf/2012.15318.pdf

Brain Tumor sub-regions

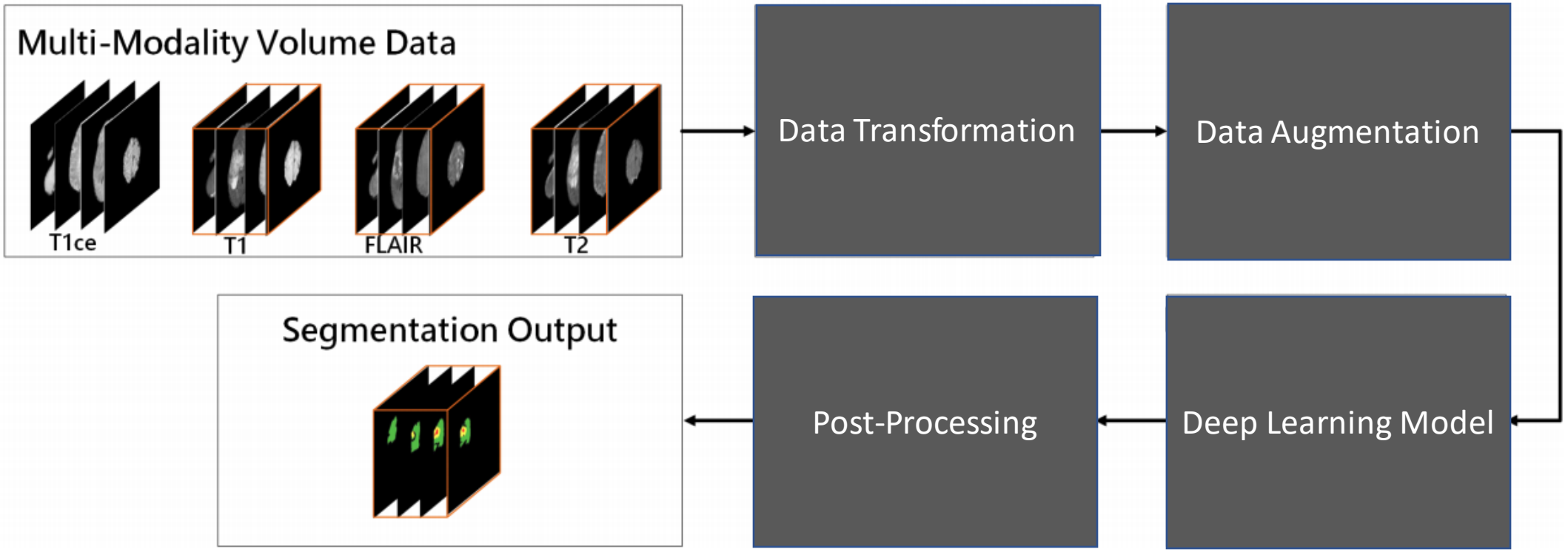
- Whole Tumor (WT): all four tumor structures
- Tumor Core (TC): all tumor structures except “edema”,
- Enhancing Tumor (ET): only containing the “enhancing core” structures that are unique to high-grade cases.



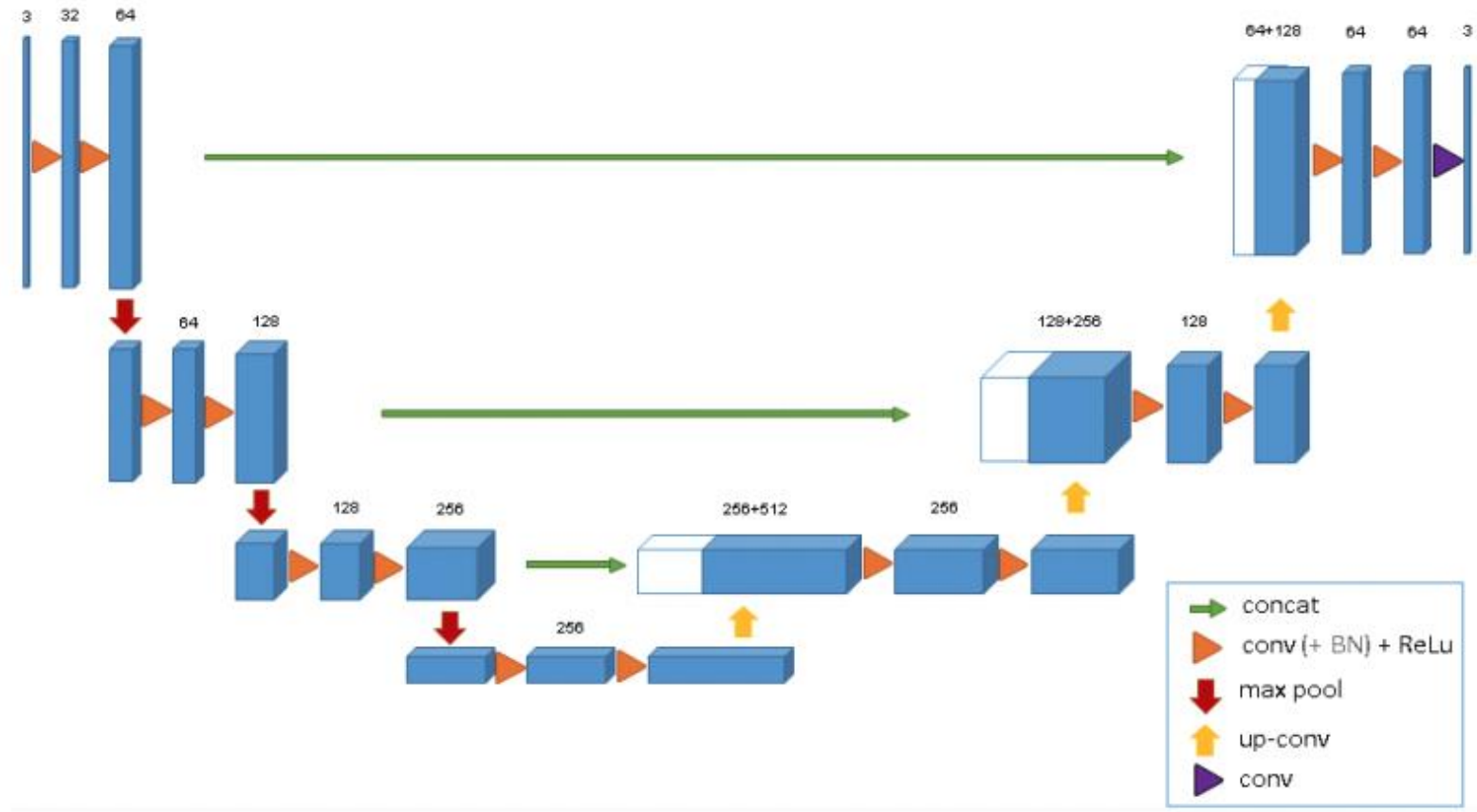
Glioma sub-regions. Image patches with the tumor sub-regions annotated in the different MRI modalities. The image patches show from left to right: the whole tumor (WT - yellow) visible in T2-FLAIR (Fig. A), the tumor core (TC - orange) visible in T2 (Fig. B), the enhancing tumor (ET - light blue) visible in T1-Gd, surrounding the cystic/necrotic components of the core (green) (Fig. C). The segmentations are combined to generate the final labels of the tumor sub-regions (Fig. D): edema/invasion (yellow), non-enhancing solid core (orange), necrotic/cystic core (green), enhancing core (blue). (Figure taken from the BraTS IEEE TMI paper.)

Source: https://ieeexplore.ieee.org/document/6975210/

Brain Tumor segmentation overview



3D U-Net



Source: https://arxiv.org/pdf/1606.06650.pdf

Plan

2nd Semester

- Analyse
  - State-of-the-art
  - Data
- Method (Approach)

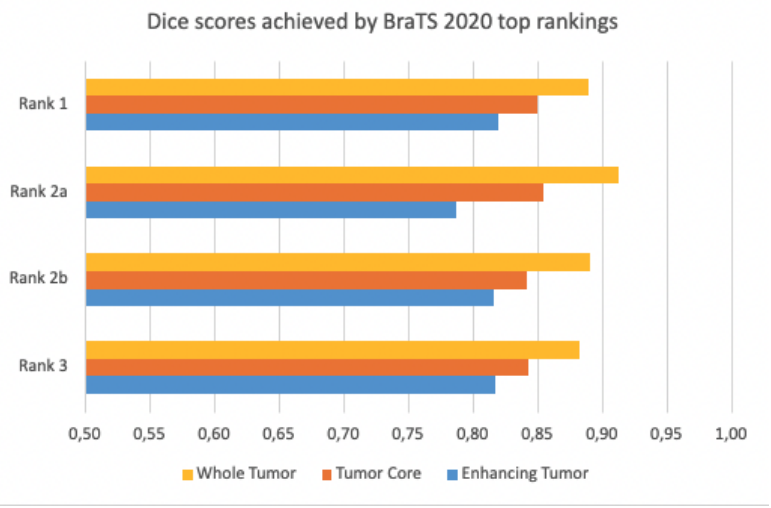
3rd Semester

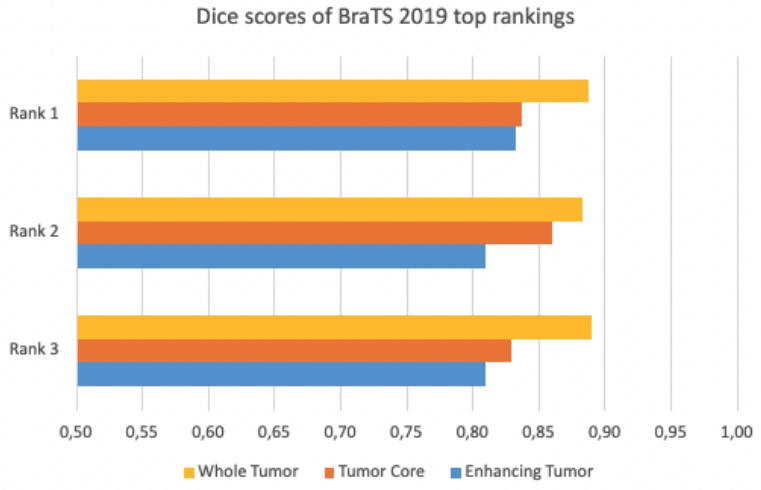
- Experiment

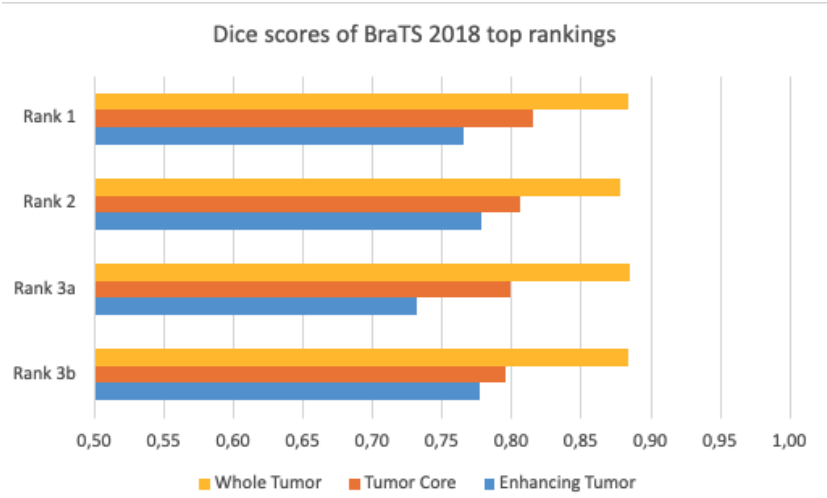
4th Semester

- Thesis

State-of-the-art solutions

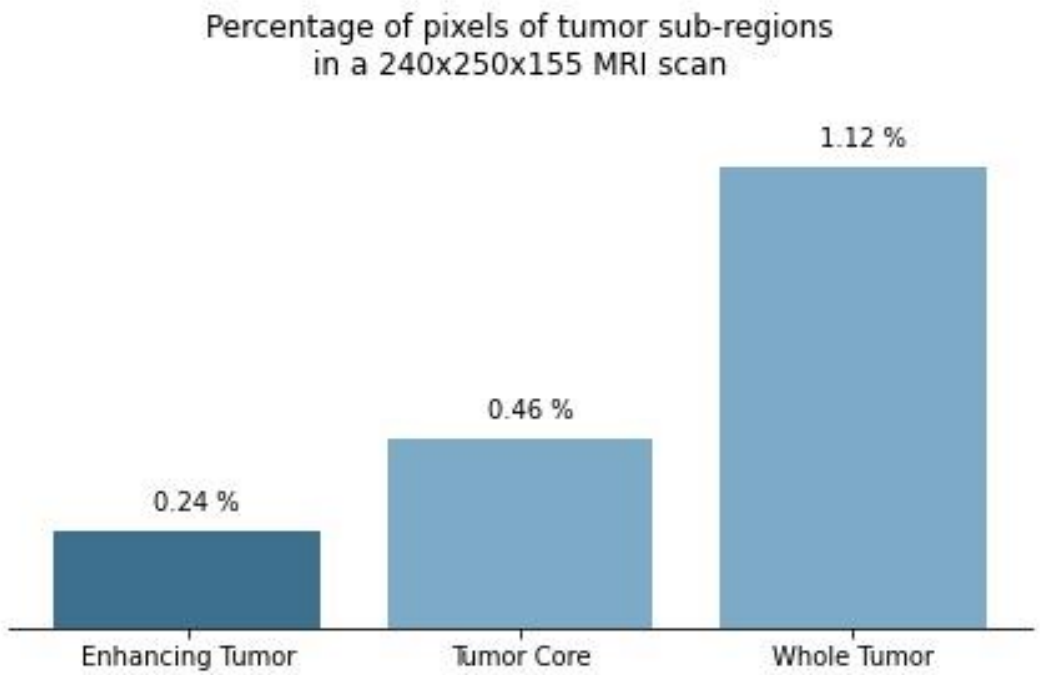


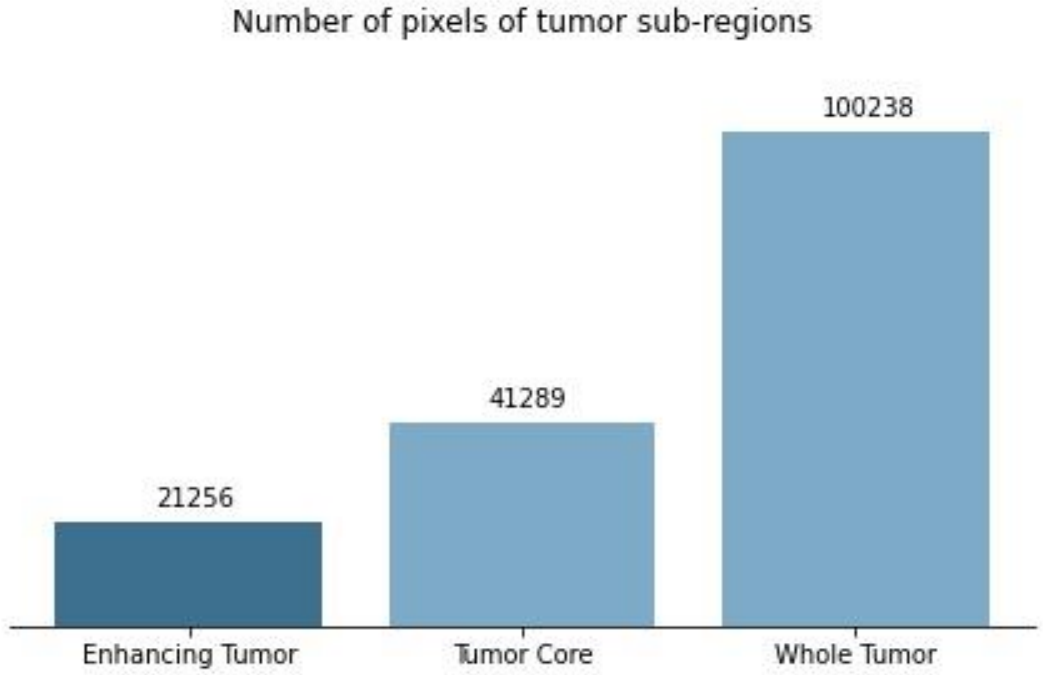




- U-Net-like models are common
- Images from 4 modalities are often stacked together as input
- The accuracy of tumor sub-regions are not balanced
- Enhancing Tumor has the lowest performance

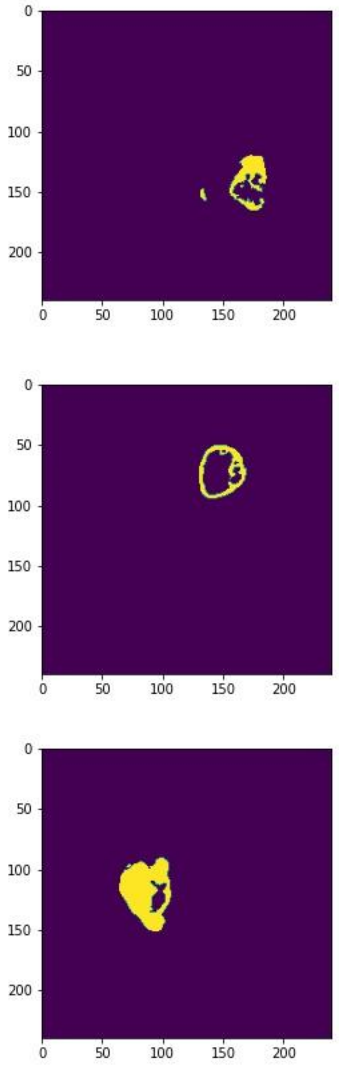
First round of data analysis



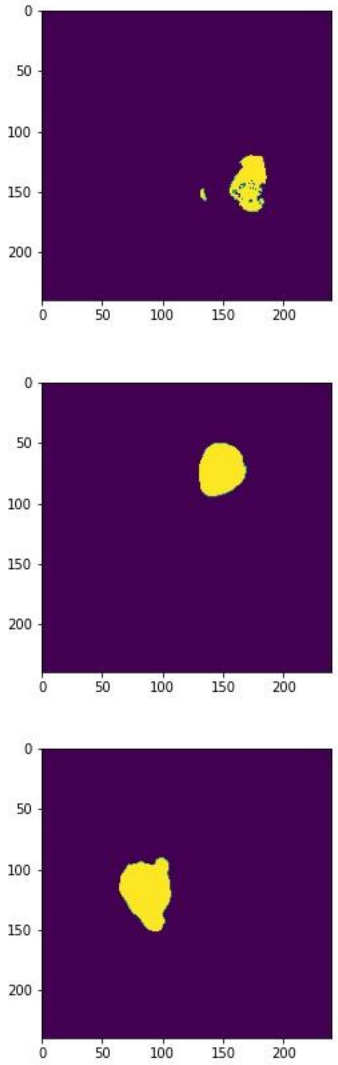


First round of data analysis

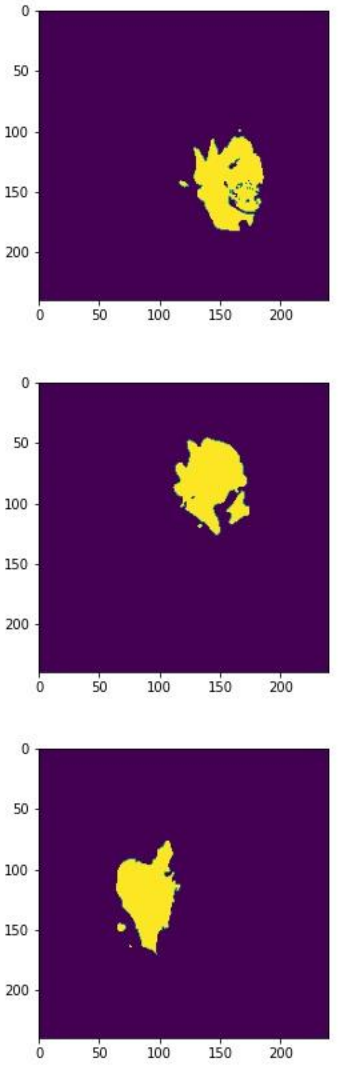
Enhancing Tumor



Tumor Core



Whole Tumor



Problem Refinement

Improve the performance of the deep learning model on Enhancing Tumor in the Brain Tumor Image Segmentation task

My approaches

- Error Analysis: Sensitivity, Specificity, over-segment, under-segment, etc.

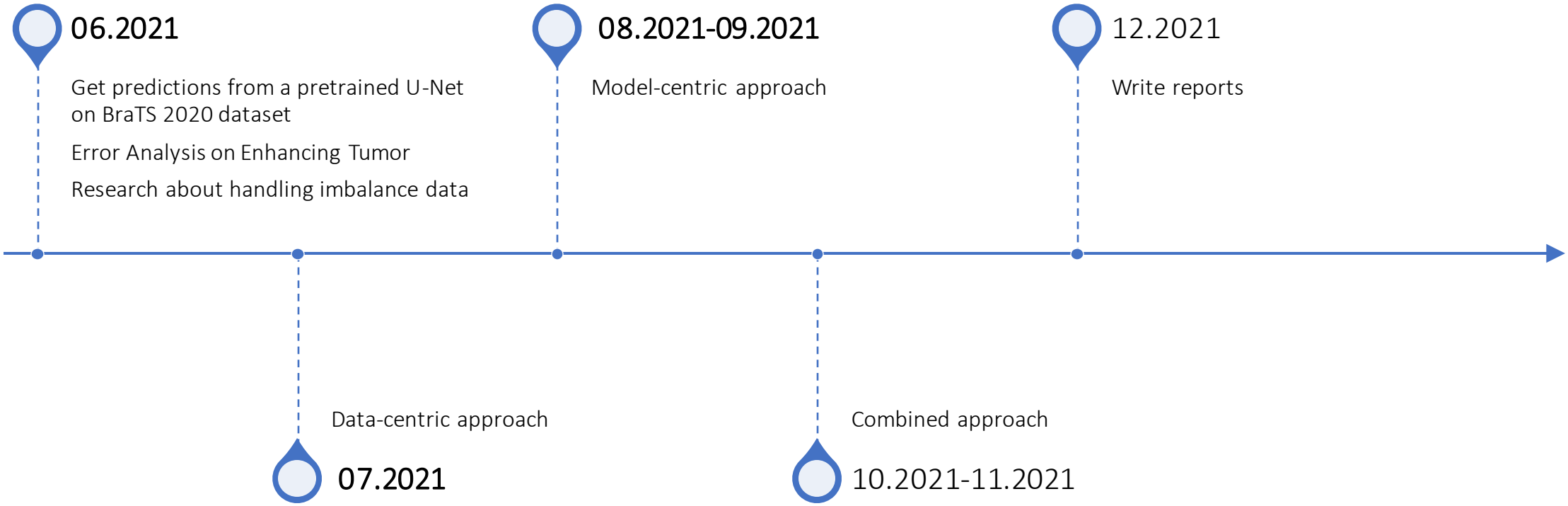
- 1st approach: Data-centric
  - Acquire more data: combine public datasets
  - Data augmentation: Radial Transform, elastic transformation, gamma correction (brightness augmentation)
  - Train on datasets with similar shape

My approaches

- 2nd approach: Model-centric
  - Modified 3D U-Net
  - Train modalities on different models, each has different hyperparameters and loss functions, then combine the results.
  - Techniques to handle imbalance data: customized loss function, etc.

- 3rd approach: Model + data
  - Best solution of the 1st approach + best solution of the 2nd approach

Timeline


06.2021
Get predictions from a pretrained U-Net on BraTS 2020 dataset
Error Analysis on Enhancing Tumor
Research about handling imbalance data
08.2021-09.2021
Model-centric approach
12.2021
Write reports
Data-centric approach
07.2021
Combined approach
10.2021-11.2021

Thank you!