

BRAIN TUMOR SEGMENTATION



INSTANT X ORANGE AI HACKATHON

SMS TEAM

MOHAMED AYOUB

SALMA SHREIF

...

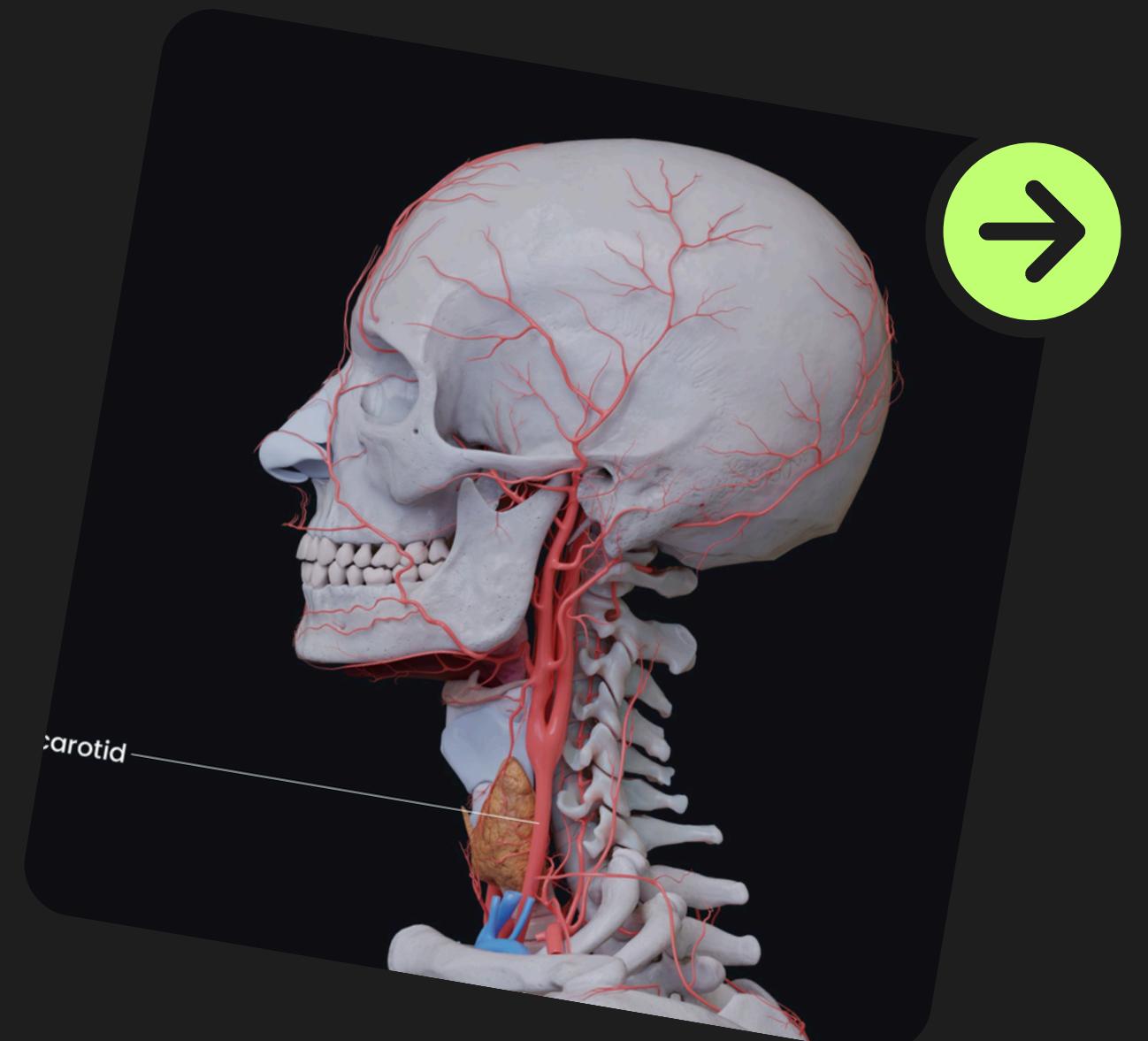
SARA SELIMA

...

PROBLEM OVERVIEW

- Brain tumor is from the most aggressive types that could result to brain cancer. Early segmentation is critical for surgery.
- Manual MRI segmentation takes hours and varies between radiologists.

Goal: Automate segmentation of 3 sub-regions (Necrotic, Edema, Enhancing) in seconds.



...

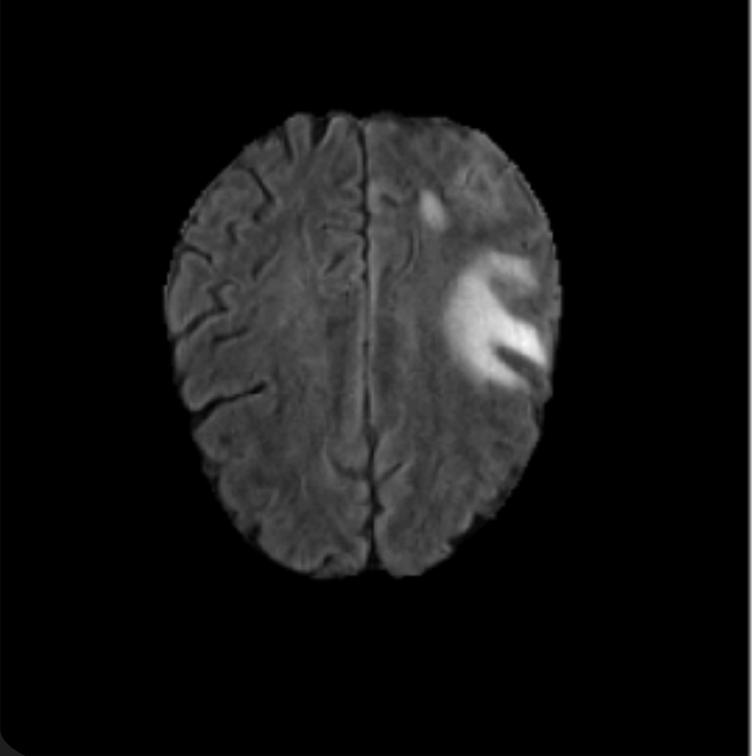
WHY IS THIS PROBLEM HARD

3D Complexity: Processing full 3D volumes requires massive computational power (VRAM).

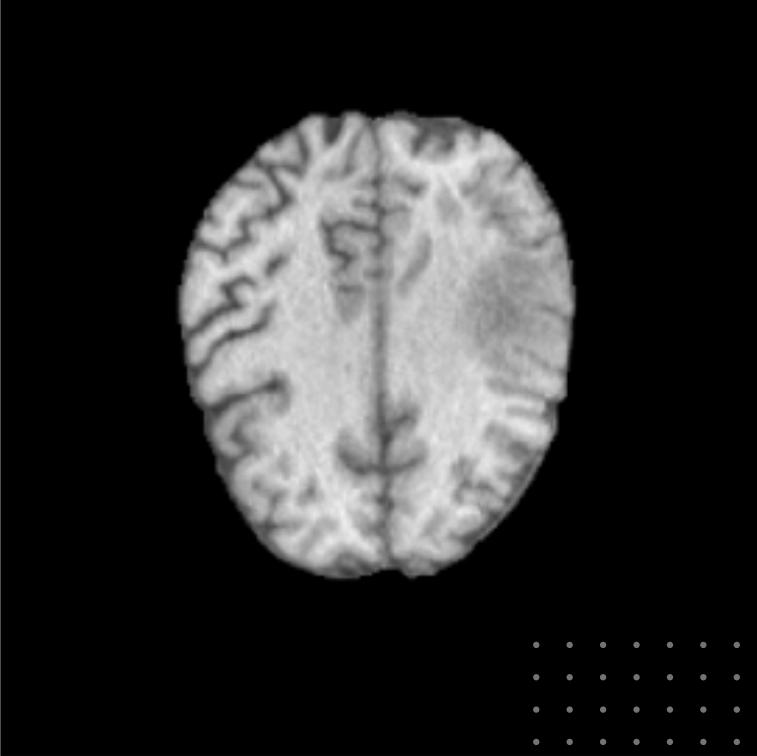
Multi-Modal Data: We must fuse information from 4 different MRI channels (T1, T1CE, T2, FLAIR).

Input MRI Modalities: BraTS2021_01354

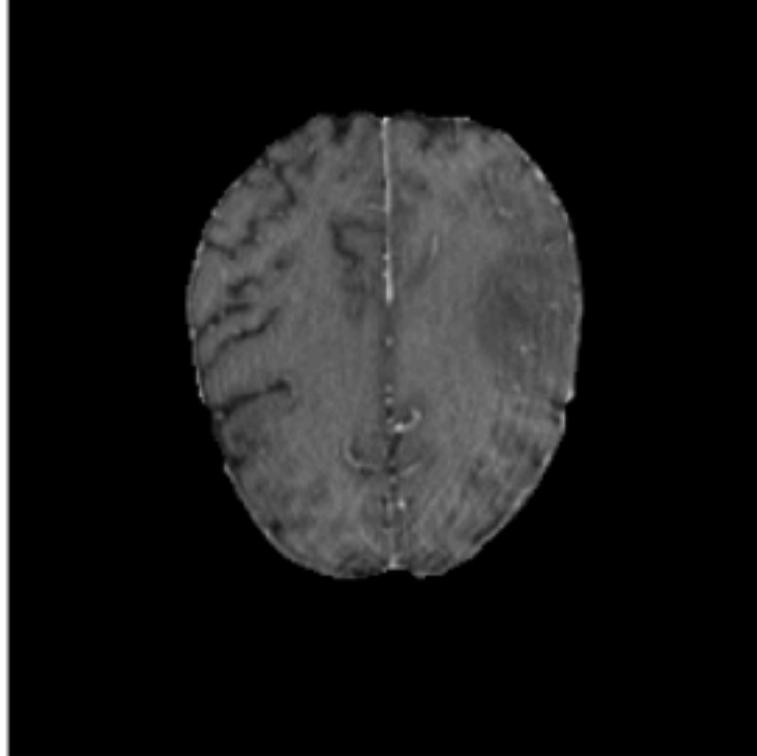
FLAIR (Edema)



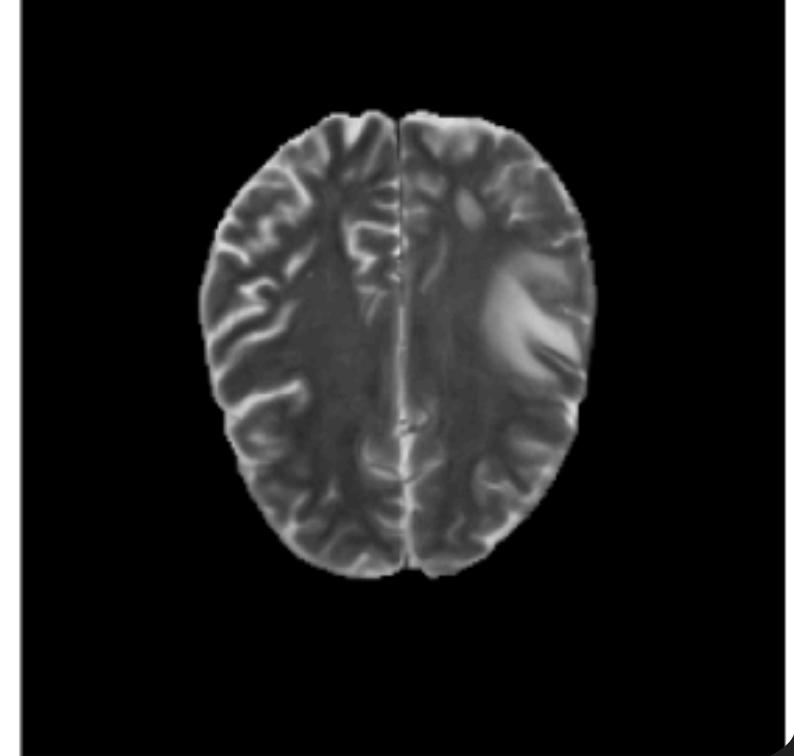
T1 (Structure)



T1CE (Active)



T2 (Necrosis)



...

PROBLEM FORMULATION

Multi-Class Segmentation

- Identifying 3 overlapping regions:
- Necrotic Core (Red)
- Peritumoral Edema (Green)
- Enhancing Tumor (Yellow)

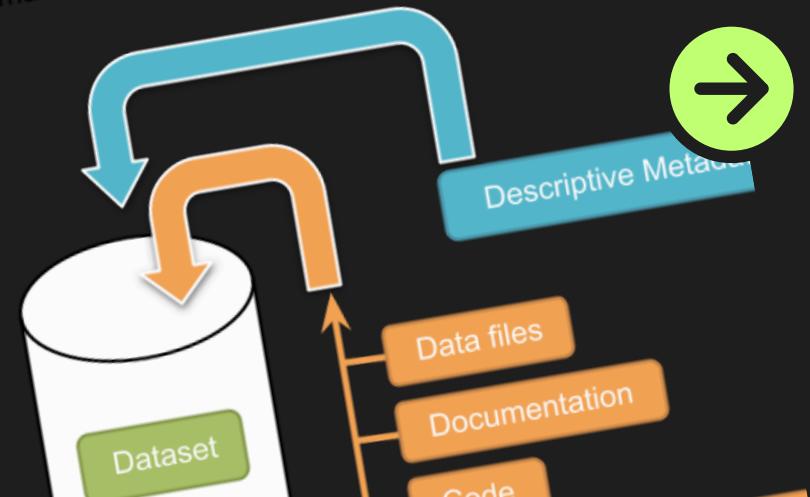
...

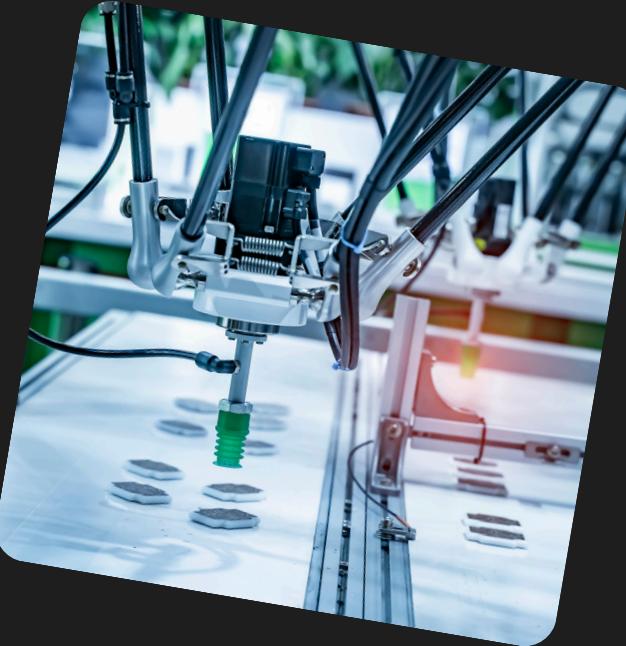


3D Volumetry:

Reconstructing the 2D slices into a 3D block
to calculate tumor volume in cm³

Schematic Diagram of a Dataset in Dataverse 4.0





METHODOLOGY

Proposed Approach

- Multi-Modal Input Strategy:
 - Instead of processing one view, we fuse 4 MRI Modalities (T1, T1CE, T2, FLAIR) to capture distinct tumor characteristics (edema, necrotic core, active ring).
 -
- Efficient 2D Backbone:
 - Model: 2D SegResNet (Encoder-Decoder + Residual Blocks).
 - Process: The 3D brain volume is sliced into 155 axial 2D images.
 - Benefit: Reduces computational cost (VRAM) by ~70% compared to full 3D models, allowing deployment on standard hardware.
- 3D Reconstruction Module:
 - Algorithmic stacking of 2D predictions to reform the clinically relevant 3D Patient Volume.

WHY SEGRESNET MODEL?



- achieved the highest Mean Dice Score (~80%+), significantly outperforming standard 3D U-Nets and Vision Transformers (UNETR).
- The "Residual" Advantage: Unlike standard U-Nets, SegResNet uses residual connections that allow for a deeper network without losing fine details. This was critical for segmenting small, complex regions like the "Enhancing Tumor."
- Noise Resistance: Other models struggled with false positives, mistaking background artifacts (skull base noise) for tumor tissue in early MRI slices. SegResNet's architecture learned to effectively filter out this noise, producing clean, focused masks.

QUANTITATIVE RESULTS

...

...

...



Validation Results

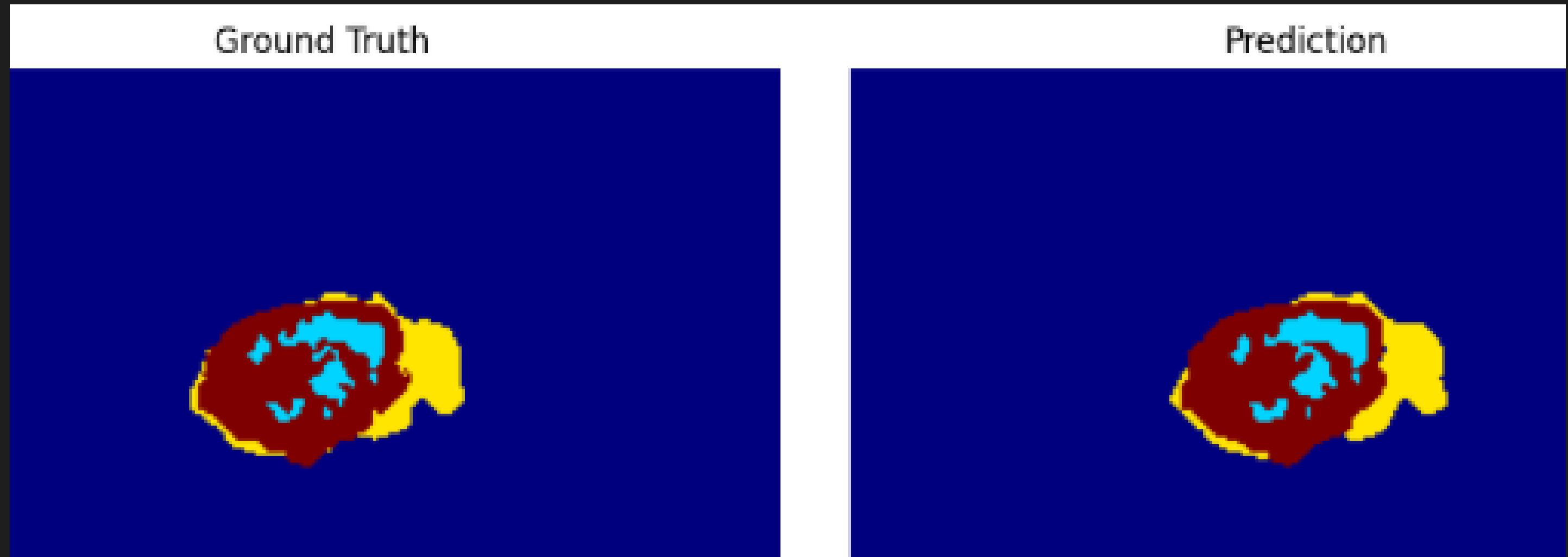
- Dice coefficient: 0.80



Submission Results

- Dice coefficient: 0.68526

QUALITATIVE RESULTS



...

WEBSITE OVERVIEW

...

...

...



A specialized web dashboard helping clinicians analyze MRI scans using Deep Learning (MONAI/PyTorch) to automatically segment and measure brain tumors in real-time.

KEY FUNCTIONALITIES:



- Automated AI Segmentation: Instantly processes 4 MRI sequences (FLAIR, T1, T1CE, T2) to identify Necrosis, Edema, and Enhancing Tumor regions.
- Interactive Visualization:
 - Slice Explorer: Scrollable 2D heatmaps to inspect the tumor slice-by-slice.
 - 3D Reconstruction: Rotatable 3D isosurfaces to visualize tumor shape and depth.
- Precision Volumetrics: specific volume calculations (cm^3) for each tumor sub-region.
- Automated Reporting: One-click generation of professional PDF reports for surgical planning.

Drag and drop file here

Limit 200MB per file • NII...

Browse files

00000014_b... X
17.0MB

T1 Image

Drag and drop file here

Limit 200MB per file • NII...

Browse files

00000014_b... X
17.0MB

T1ce Image

Drag and drop file here

Limit 200MB per file • NII...

Browse files

00000014_b... X
17.0MB

T2 Image

NeuroScan 3D

Advanced AI Brain Tumor Analysis Dashboard

Analysis Complete in 32.03s

Automated Volumetrics Report

Necrotic Core (Red)

Peritumoral Edema (Green)

Enhancing Tumor (Yellow)

Total Tumor Volume

12.51 cm³

67.93 cm³

12.39 cm³

92.83 cm³

Slice Explorer

Select Slice Depth (Z-axis)

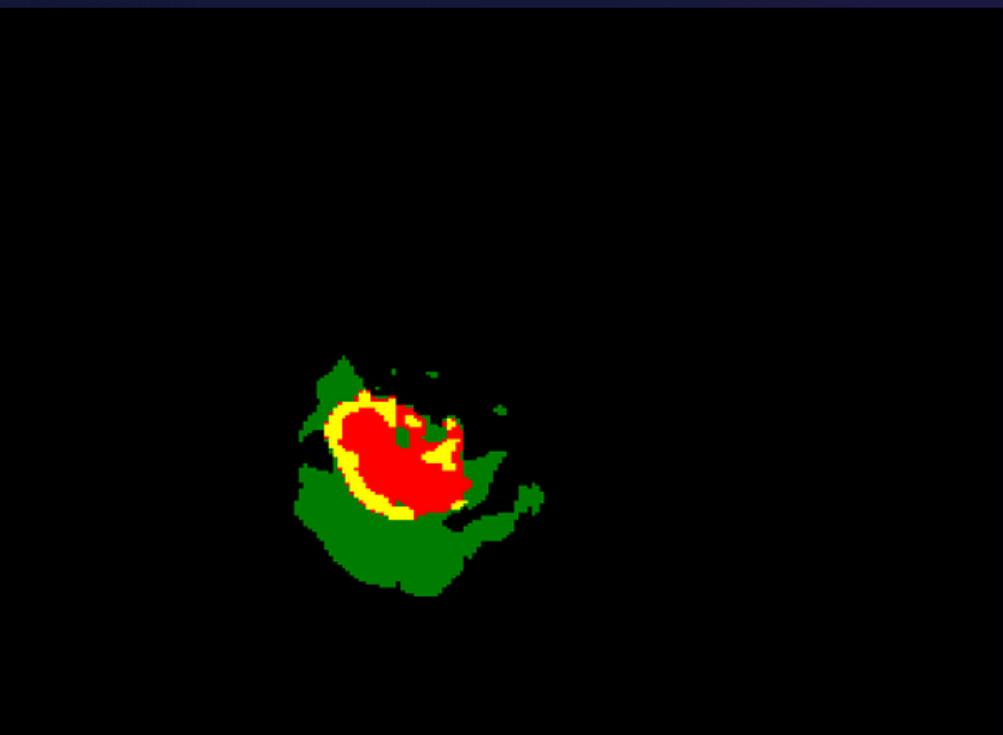
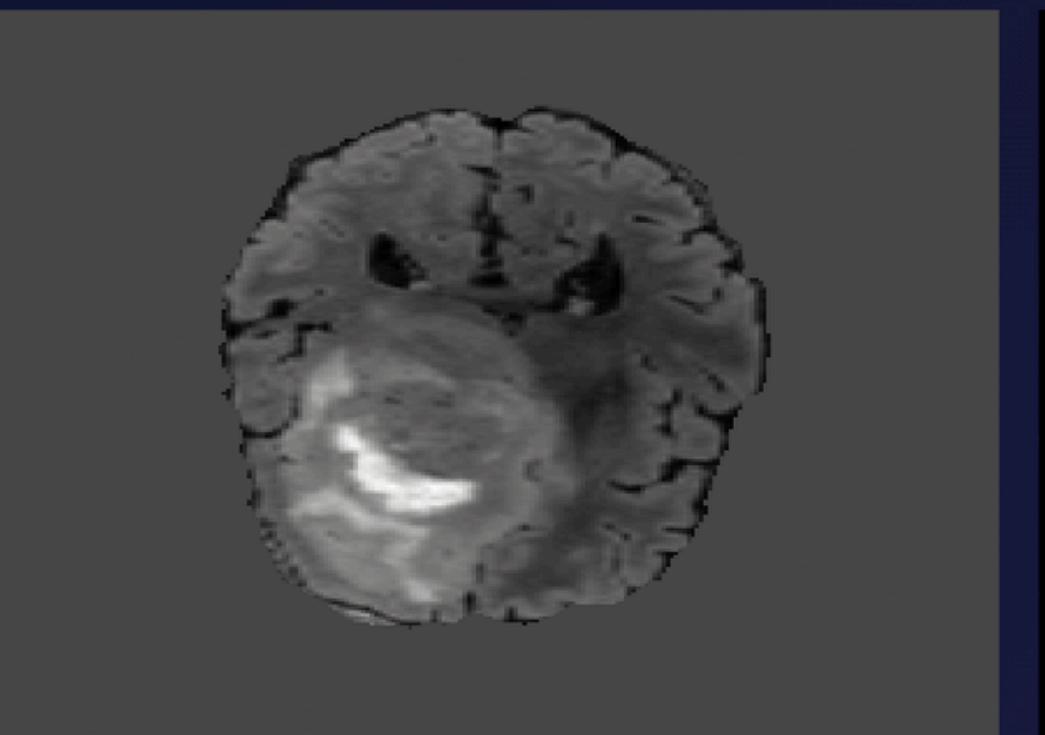
Slice Explorer

Select Slice Depth (Z-axis)

77

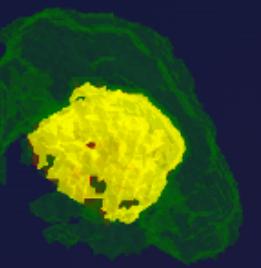
MRI (FLAIR Sequence)

AI Segmentation Overlay



3D Tumor Reconstruction

Interactive 3D model. Drag to rotate, scroll to zoom.



Export Results

Download Professional PDF Report

NeuroScan 3D

Advanced AI Brain Tumor Analysis

Date of Analysis: 2026-02-04 12:12:24

Volumetric Analysis Report

Tumor Region	Volume (cm3)
Necrotic Core (Red)	12.51
Peritumoral Edema (Green)	67.93
Enhancing Tumor (Yellow)	12.39
Total Tumor Volume	92.83

IMPORTANT INTERPRETATION NOTICE:

This report is automatically generated by an experimental AI algorithm. The segmentation and volumetric calculations have not been verified by a radiologist. This document should NOT be used for direct clinical diagnosis or treatment.

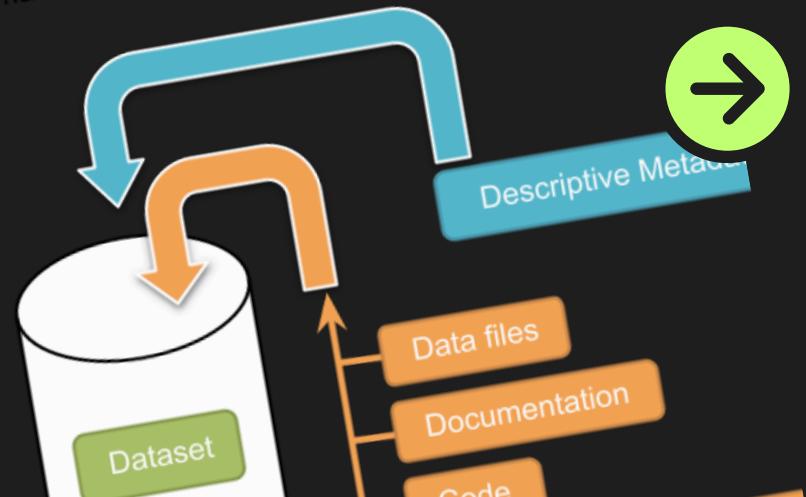
FUTURE WORK

- Ensemble with transformer-based models
- Faster inference for clinical use
- Add explainability & uncertainty maps

...



Schematic Diagram of a Dataset in Dataverse 4.0





THANK
YOU

...