Tumor and Brain Segmentation From Medical Images For Guided-Surgery

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Introduction

Brain surgery requires doctors to study the brain beforehand with medical imaging technologies such as MRI. Traditional segmentation methods often rely on either user-defined constraints or automated algorithms, each with its own limitations. However, recent advancements in interactive segmentation techniques have sought to bridge this gap by combining user input with computational algorithms to achieve more accurate and efficient results. This project aims to segment a given brain into its components and to segment tumor for guided surgery.

Methodology and Usage

Grow From Seeds

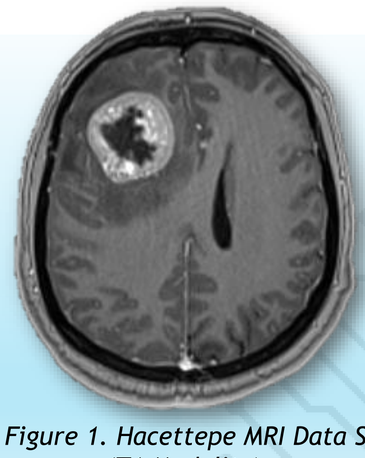


Figure 1. Hacettepe MRI Data SET (T1 Modality)

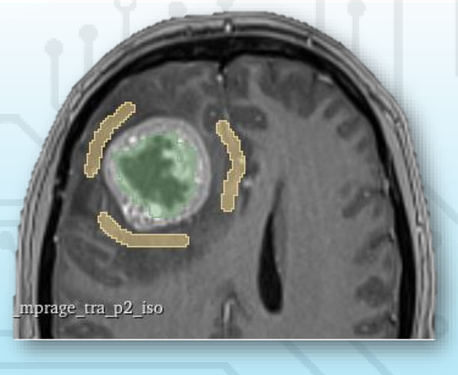
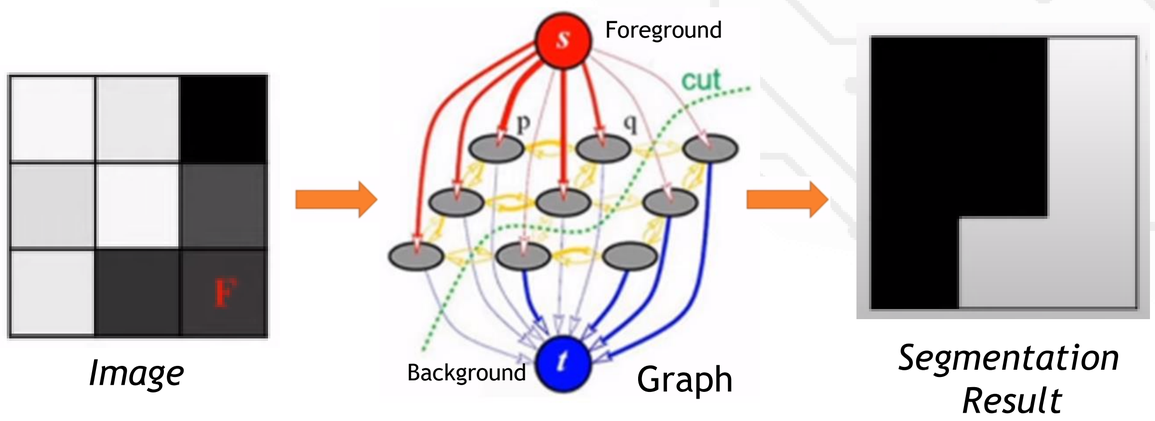


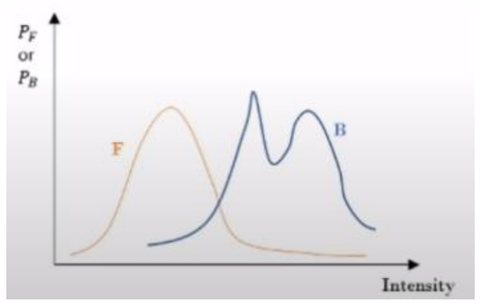
Figure 2. Process of Labelling Foreground and Backgorund

- Grow from seeds enable user to label multiple object to be segmented.
- The grow from seeds algorithm operates semi automatically. It relies on pixel feature similarities. The algorithm works well with T1, T2 and Flair MRI images. Therefore, we can work with multimodel images.

Graph Cut

- It fundamentally constructs a graph with edge weights based on pixel intensity differences.





Itensity Distribution of Foreground and Background

Equations:

$$\omega_{ij} = e^{\frac{-|f(x_i,y_i)-f(x_j,y_j)|}{2\sigma^2}}$$

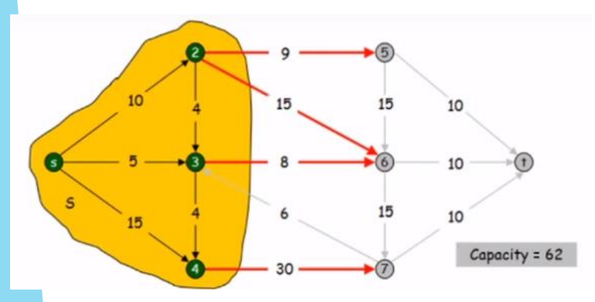
$$\omega_{iF} = -\lambda \log P_B(i)$$

$$\omega_{iB} = -\lambda \log P_F(i)$$

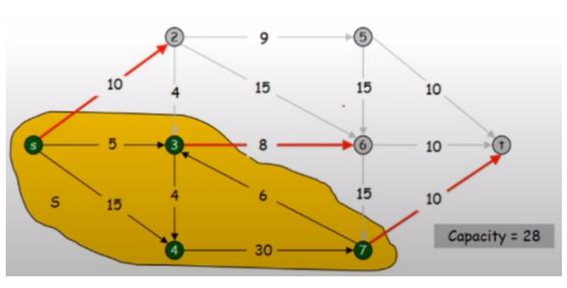
i: ith Node
j: jth Node
ω : weight
P: probability

What is the criteria of cutting graph ?

Capacity(FG, BG) = The sum of the weights of the cut edge between the foreground and backgorund.



Example Cut 1



Example Cut 2

- The tumor is segmented by selecting the cut that minimizes the capacity value.

Results

Confusion Matrix

		SEGMENTATION: TUMOR	SEGMENTATION: NOT TUMOR (BRAIN)
GROUND TRUTH	TUMOR	TRUE POSITIVE %0.469616	FALSE NEGATIVE %0.0496091
GROUND TRUTH	NOT TUMOR (BRAIN)	FALSE POSITIVE %0.006499	TRUE NEGATIVE %99.4743

Evaluation Metrics

F1 Score	%94.3
Precision	%98.6
Recall (Sensivity)	%90.4
Intersection over Union (IoU)	%89.3
Accuracy	%99.9

- **Dataset:** The T1 modality ground truth tumor and brain MRI images were provided by Hacettepe Medical School.

Visual Output

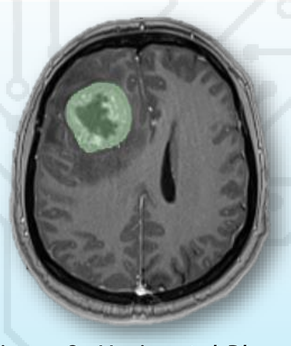


Figure 3. Horizontal Plane

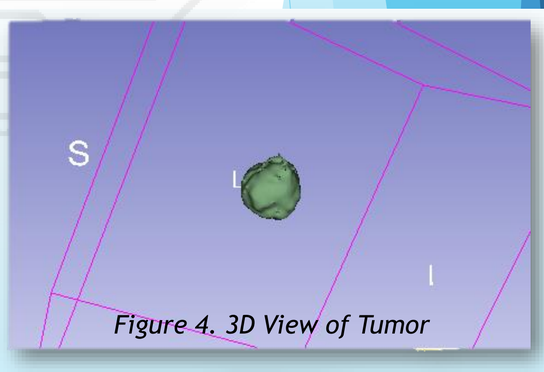


Figure 4. 3D View of Tumor

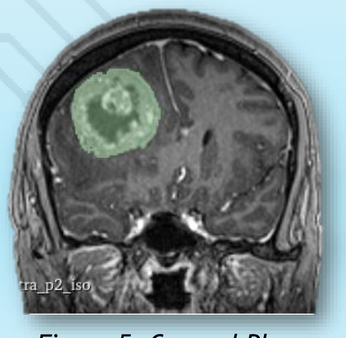


Figure 5. Coronal Plane

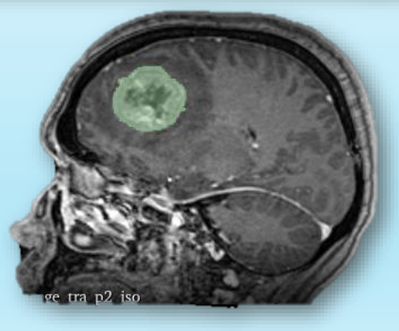


Figure 6. Saggital Plane

- The segmentation results can be viewed in sagittal, coronal and axial planes.

References

- Zhu, L., Kolesov, I., Gao, Y., Kikinis, R., & Tannenbaum, A.R. (2014). An Effective Interactive Medical Image Segmentation Method Using Fast GrowCut.
- 3D Slicer. http://www.slicer.org/

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