LESION SEGMENTATION FOR HYPOXIC ISCHEMIC ENCEPHALOPATHY

19
Jan 2024

Enrique Almazán[1], Guillermo Ots[2], Javier Villoldo[3]

1. Data preprocessing, and UNETR development.
2. Data preprocessing, and Random Forest development.
3. Data preprocessing, Data augmentation and UNET development.

INTRODUCTION

Hypoxic ischemic encephalopathy (HIE) is a significant brain injury affecting born neonates globally. Despite therapeutic hypothermia it presents:

- High mortality rates.
- High morbidity rates.

Thus, the segmentation of this lesion is a crucial step in clinical care of HIE, leading to a:

- more accurate estimation of prognosis;
- better understanding of neurological symptoms;
- and a timely prediction of response to therapy.

However, HIE lesion segmentation in MRI is challenging due to diffuse and small abnormalities. Current segmentation methods, yield lower accuracy (Dice overlap ~0.5) compared to other tasks, needing improvement for accurate prognosis.

The **BONBID-HIE** lesion segmentation challenge addresses this gap with public 3D MRI data, aiming to enhance diagnostic precision for HIE.

OBJECTIVES

- Apply our own U-NET structure and replicate results in SOTA.
- Try to improve the state of the art through two methods.
  - Convolutional filters + Random Forest
  - Transformer

METHODS

1 DATA PREPROCESSING

- Splitting in train, validation and test subsets.
- Normalization and resizing.
- Getting 2D slices from the 3D images.

DATA AUGMENTATION

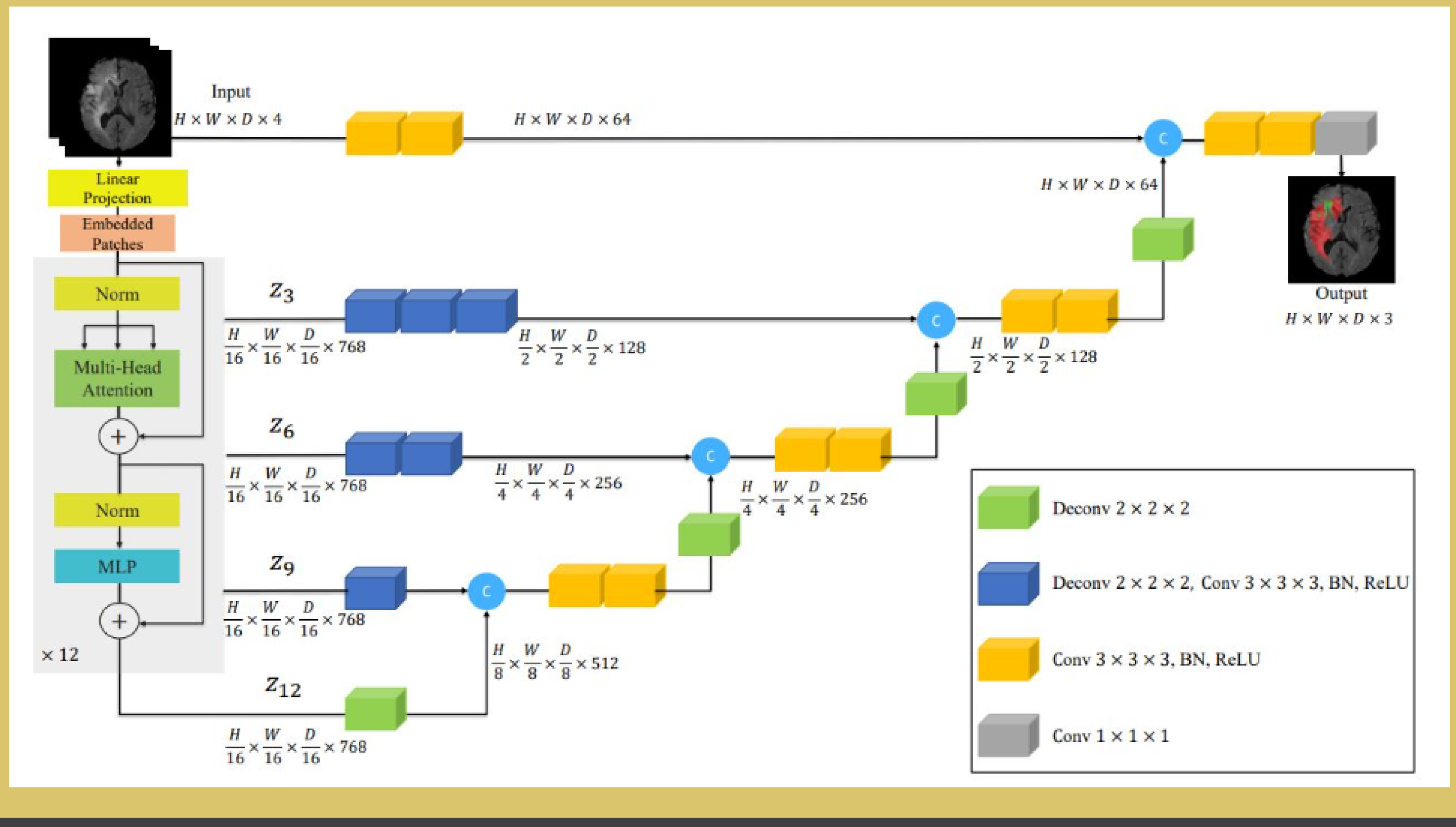
- Solve lack of samples limitations
- Add variability

2 MODELS

I. U-NET

II. RANDOM FOREST

III. U-NETR

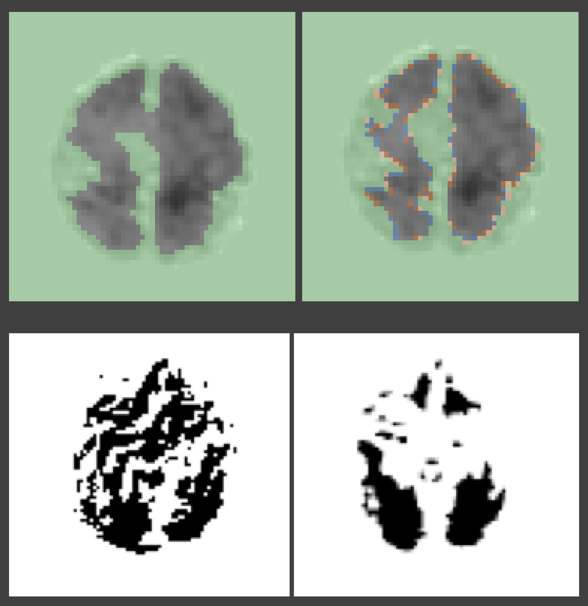


RESULTS

PREDICTED TRUTH

U N E T

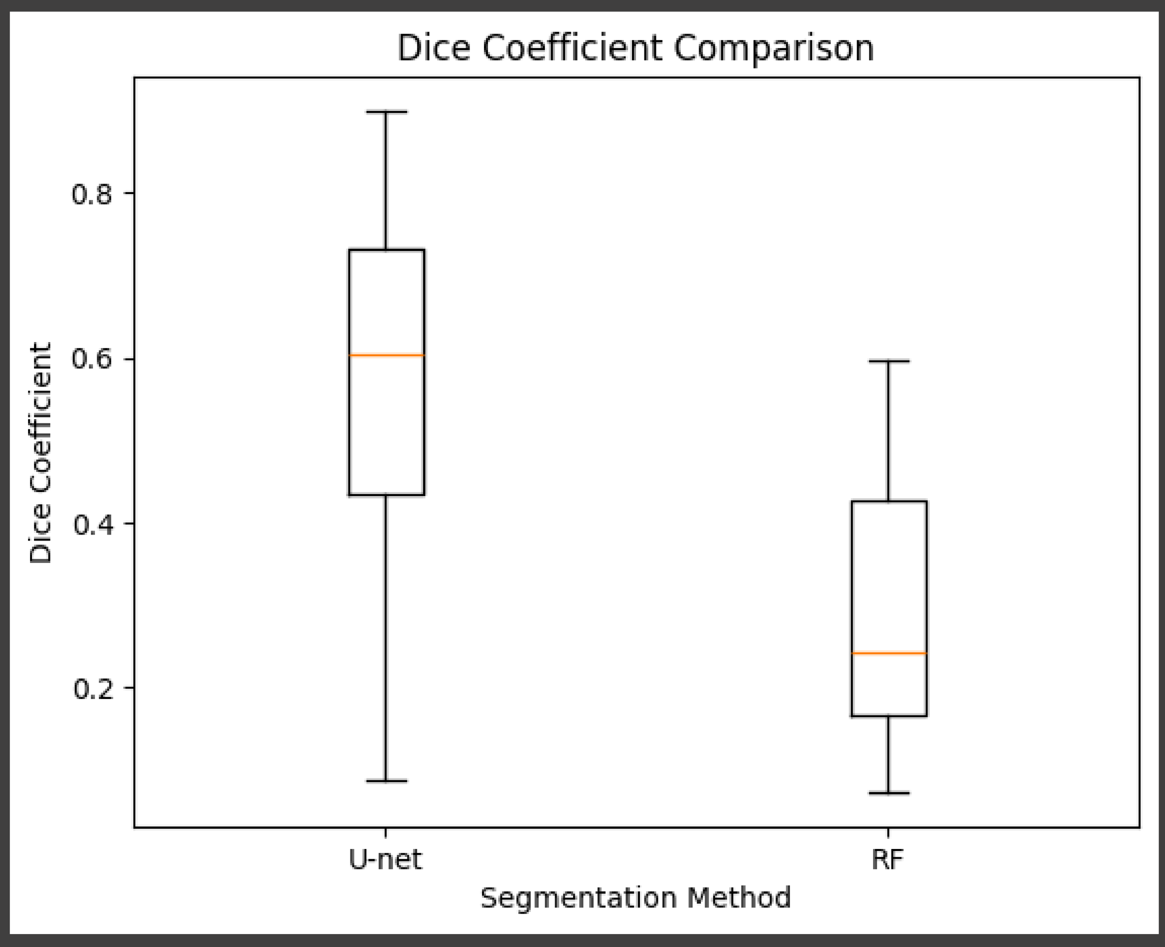
RF



By implementing a tailored benchmark UNET model, results from the state-of-the-art were successfully replicated. Our model achieved a Dice Coefficient of 0.41 training with original images and improved to 0.43 after further fitting augmented data. These results were obtained by using ZADC maps, that address anatomical variations in ADC values, and demonstrated superior segmentation accuracy.

With the goal of improving these results we attended to other methods of segmentation. For the random forest model we obtained a Dice Coefficient of 0.29. However, computation time must also be considered. UNET training time was approximately 4 hours whereas Random Forest training time were minutes. Thus, there is a major time/performance trade-off. Boxplots show that UNET has higher median scores than Random Forest but also higher variability of results.

Our final approach consist of UNETR model. It is believed that attention mechanisms combined with a traditional UNET would adapt much better to the HIE segmentation task. Unfortunately, we encountered computation limitations.



DISCUSSION

The research initially faced challenges due to limited computational resources, particularly in implementing and evaluating advanced models like UNETR for hypoxic ischemic encephalopathy (HIE) lesion segmentation from 3D MRI data.

Resource constraints led to the adoption of a practical approach, converting 3D images to 2D slices, and implementing both UNET and Random Forest in 2D for computational efficiency. Despite attempts, the practical implementation of UNETR was hindered by persistent computational errors related to memory and time limitations, emphasizing the impact of resource constraints.

While the BONBID-HIE challenge showcased promising results for UNETR, the inability to apply it practically underscores the essential need for additional computational resources in translating theoretical understanding into real-world applications.

CONCLUSION

Accurate segmentation is pivotal for addressing clinical challenges in hypoxic ischemic encephalopathy (HIE). Resource constraints led to 2D model adoption, yet the impractical implementation of UNETR underscores the need for enhanced computational capabilities.

Recognizing limitations in current models like UNET and suboptimal alternatives, there's an urgent call for further advancements. Developing sophisticated algorithms, particularly UNETR, and investing in computational infrastructure are imperative for precise medical image segmentation, promising improved diagnostics, enhanced patient care, and better outcomes for HIE.

Reed the complete article here