



# HAD-Net: A Hierarchical Adversarial Knowledge Distillation Network for Improved Enhanced Tumor Segmentation Without Post-Contrast Images

By: Saverio Vadacchino, Raghav Mehta, Nazanin  
Mohammadi Sepahvand, Brennan Nichyporuk,  
James J. Clark, and Tal Arbel

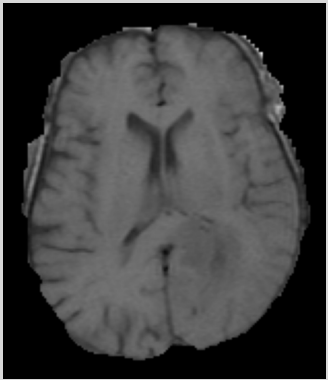


Presented by: Saverio Vadacchino

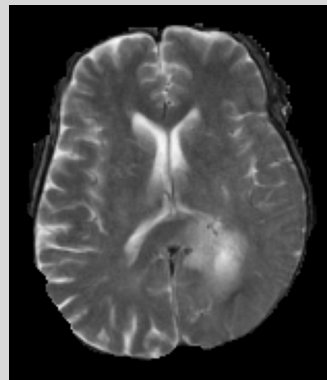
# Introduction

- Different MRI Sequences => Greatly improves tumour or lesion segmentation performance
- T1ce => Crucial for the segmentation of enhancing tumours or lesions

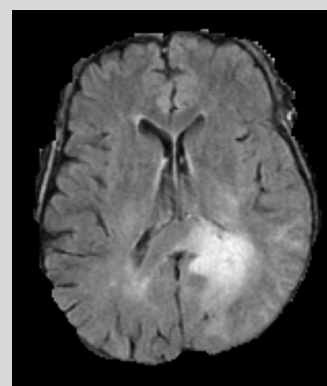
T1



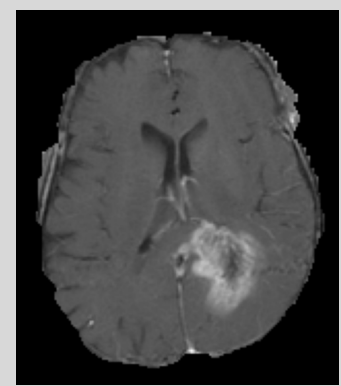
T2



FLAIR

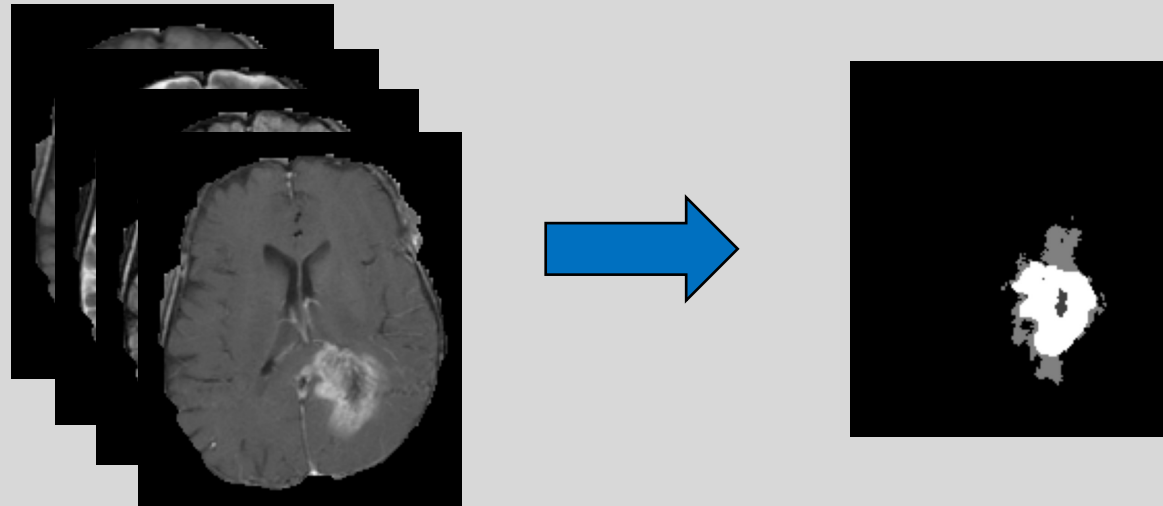


T1ce



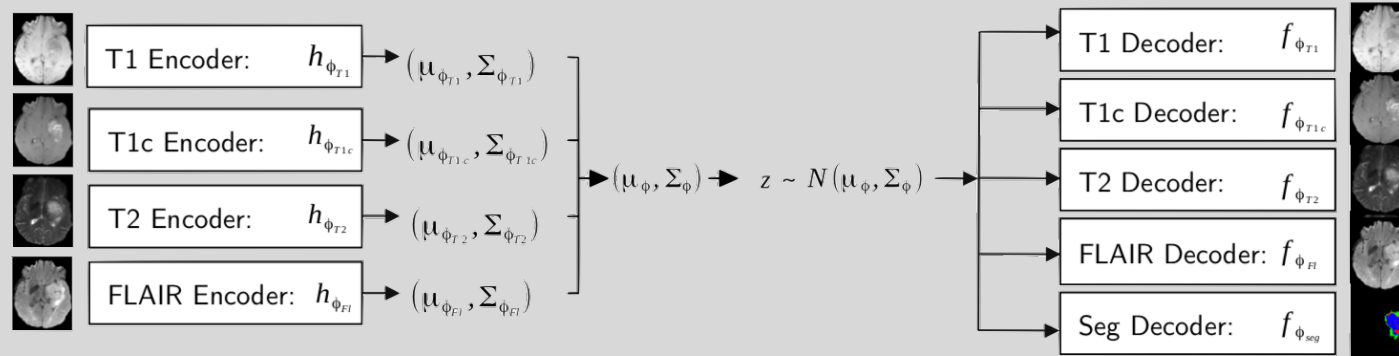
# Introduction

- Contrast agent injection (e.g., Gadolinium)
  - **No longer thought to be safe for patients**
  - **Increases invasiveness**
- Focus on developing a network capable of providing improved enhancing brain tumor segmentations when post-contrast images are unavailable.



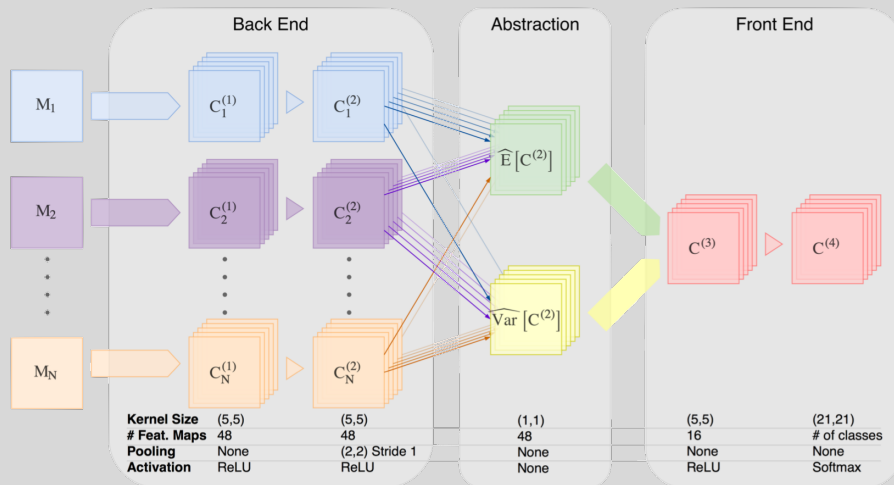
# Related Works

## U-HVED



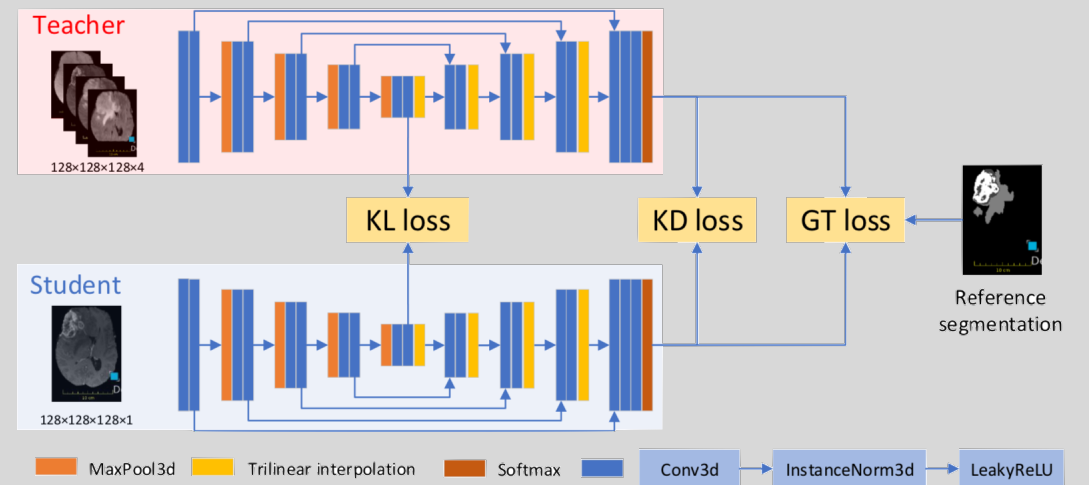
Dorent et al., 2019

## U-HeMIS



Havaei et al., 2016

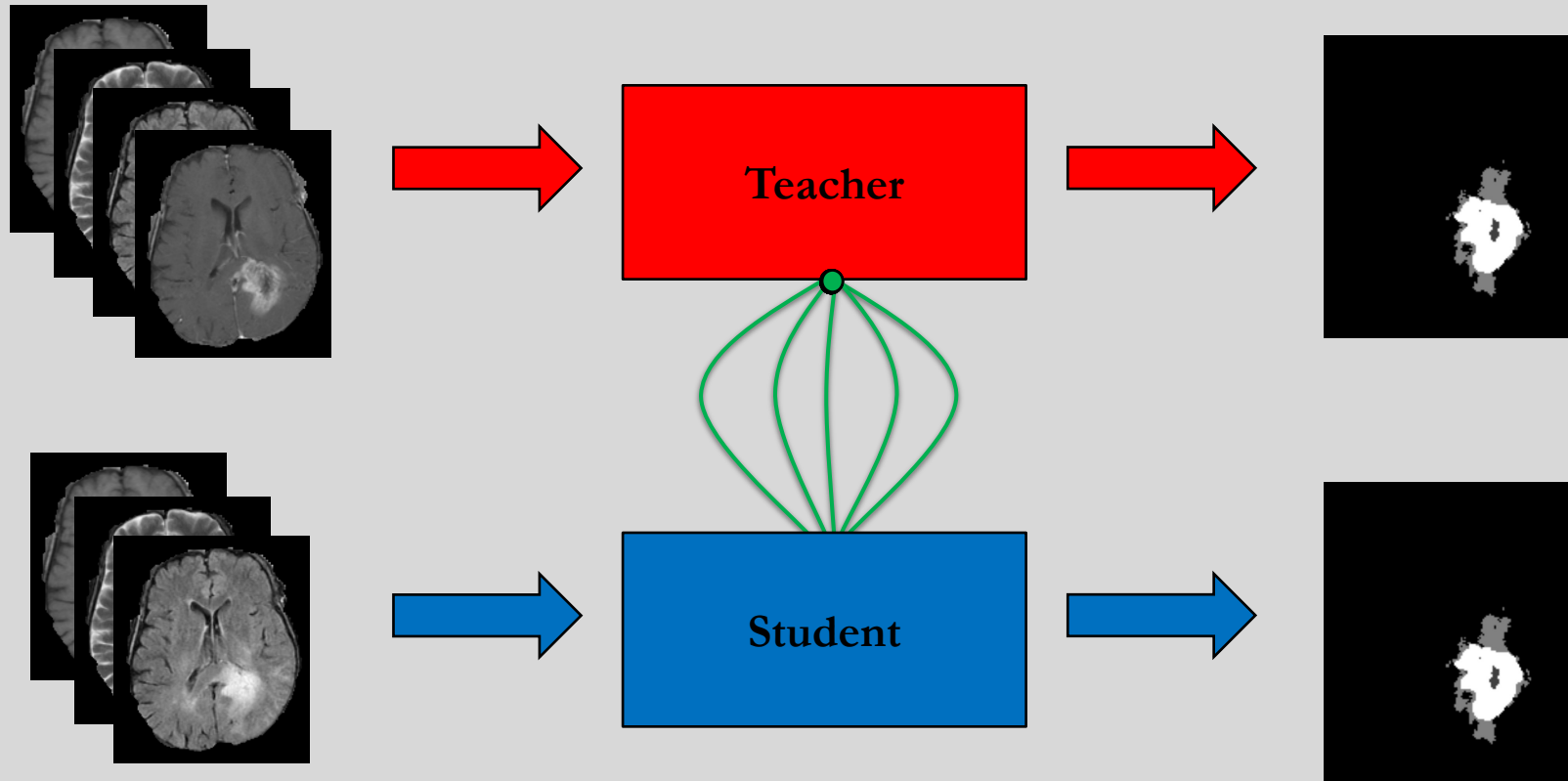
## KD-Net



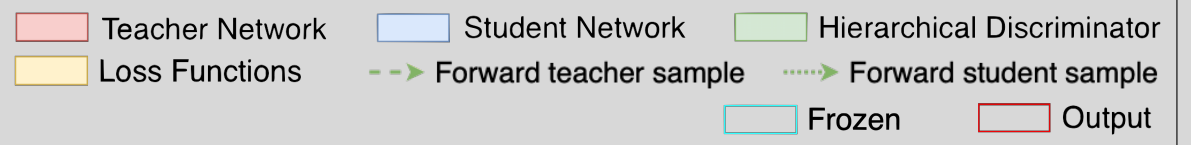
Hu et al., 2020

# HAD-Net

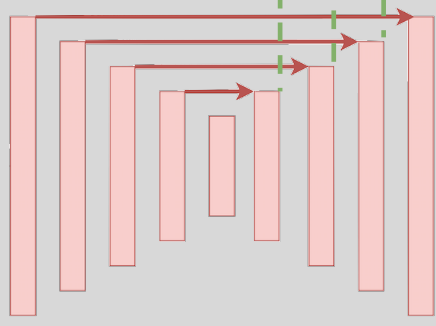
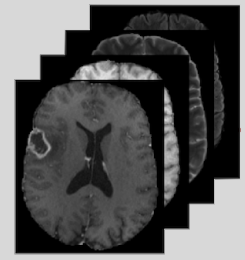
- Teacher network distills knowledge to a student network to produce better segmentations when crucial information is missing.



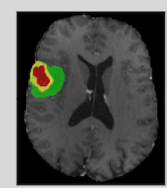
# HAD-Net



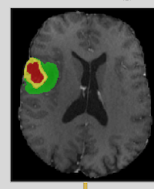
T1C, T1P, T2W, FLAIR



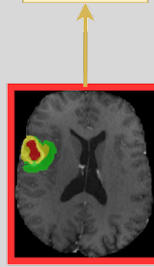
Teacher Seg



GT Seg



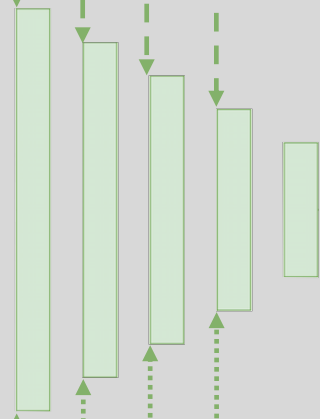
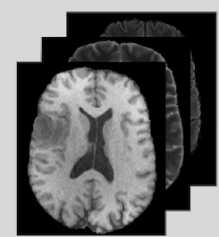
CE Loss



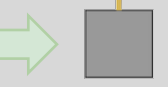
HAD Seg



T1P, T2W, FLAIR



Adversarial Loss



Patch Label

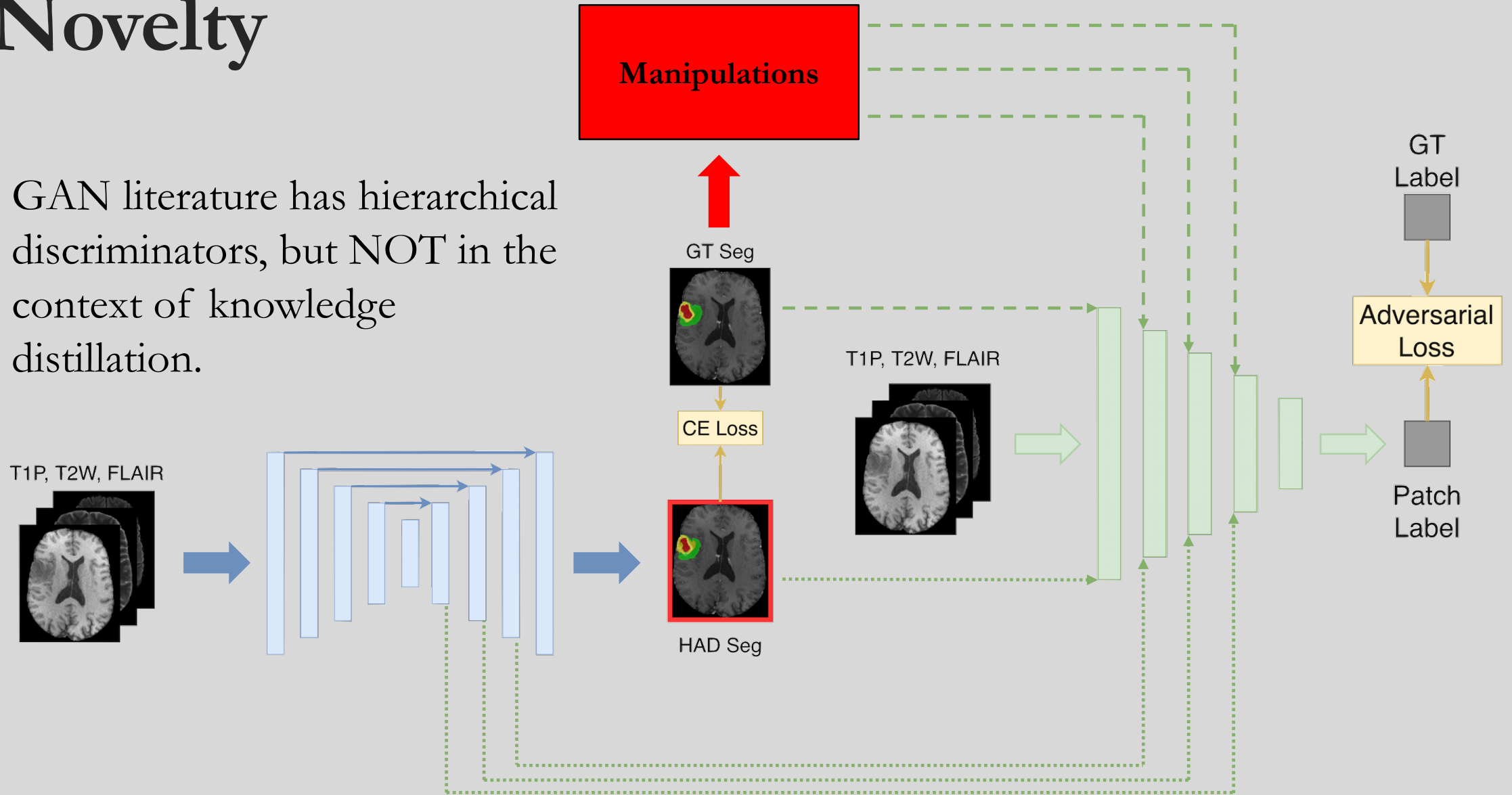


GT Label

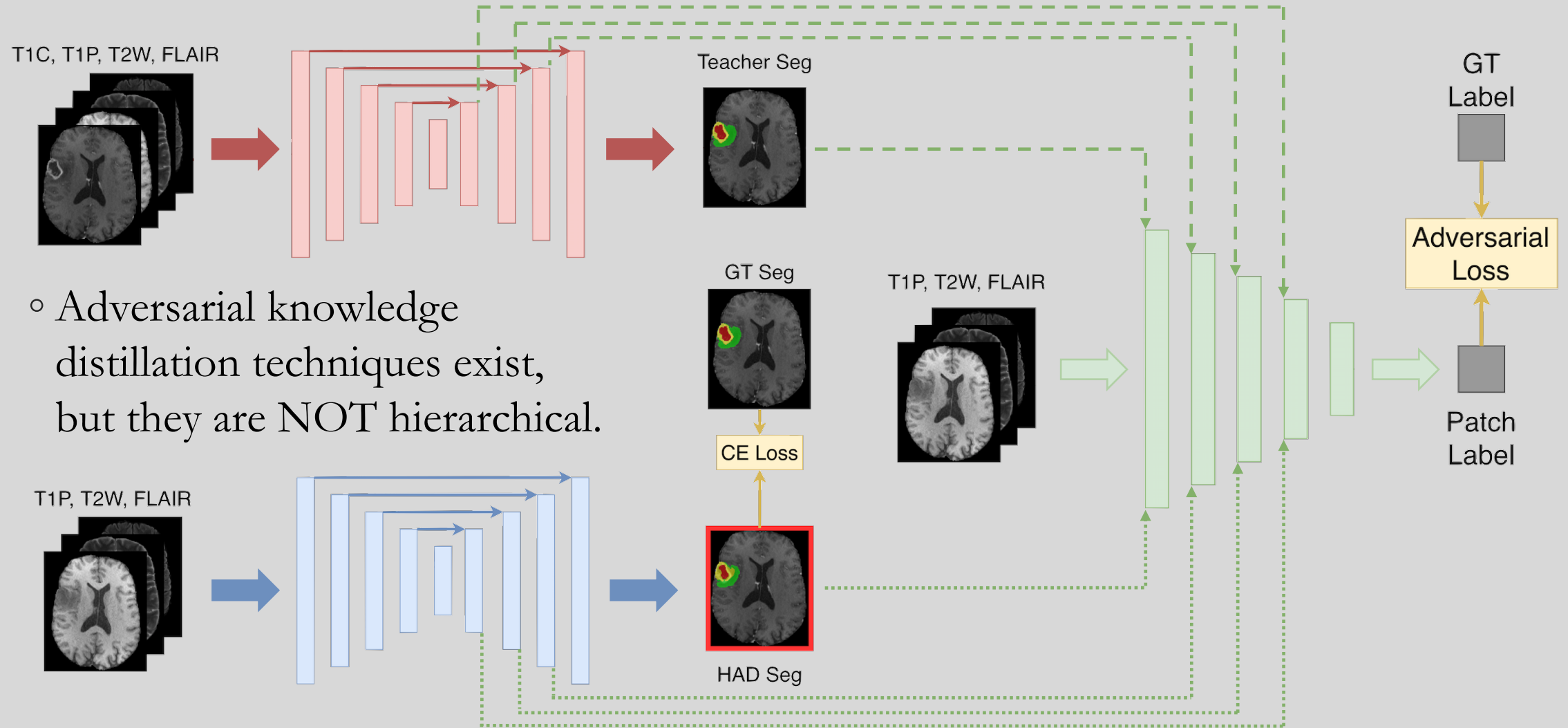


# Novelty

- GAN literature has hierarchical discriminators, but NOT in the context of knowledge distillation.



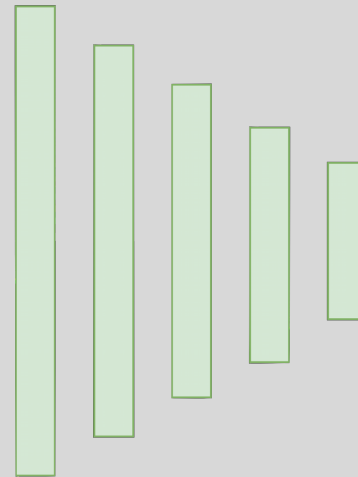
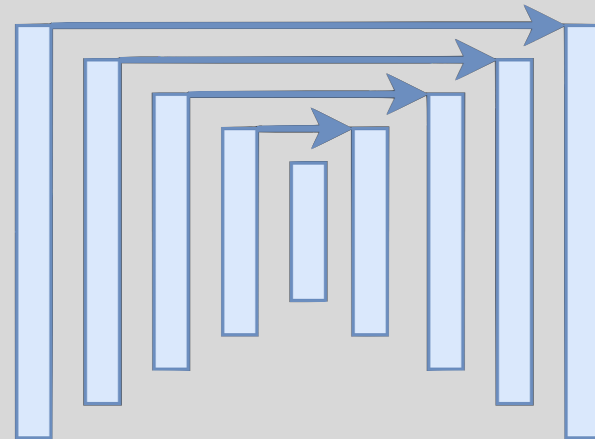
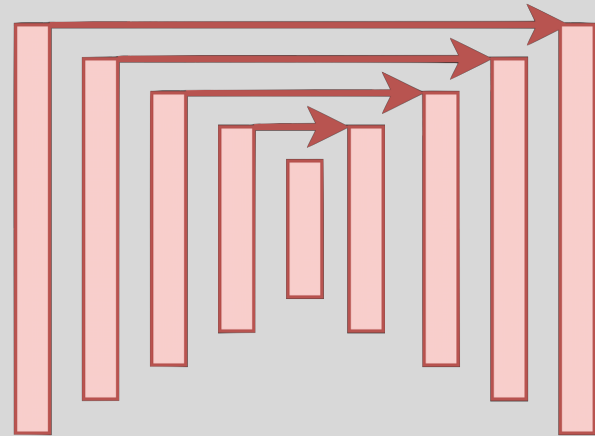
# Novelty




- Adversarial knowledge distillation techniques exist, but they are NOT hierarchical.



# HAD-Net



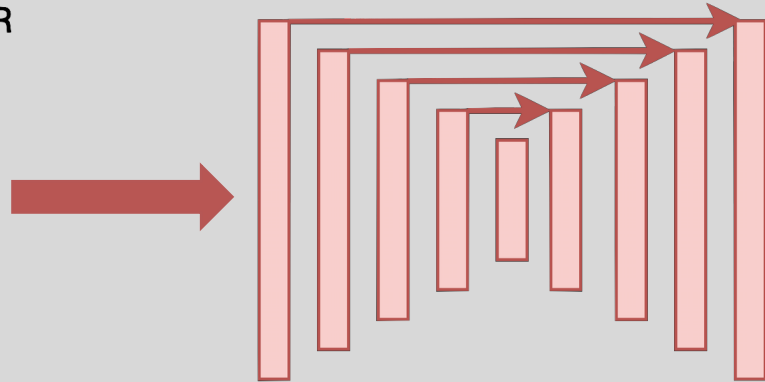
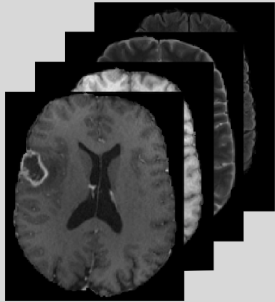
 Teacher Network

 Student Network

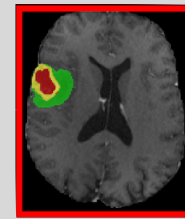
 Hierarchical Discriminator (HD)

# HAD-Net (Pre-) Training

T1C, T1P, T2W, FLAIR

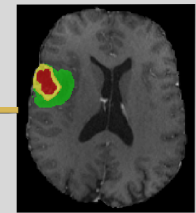


Teacher Seg

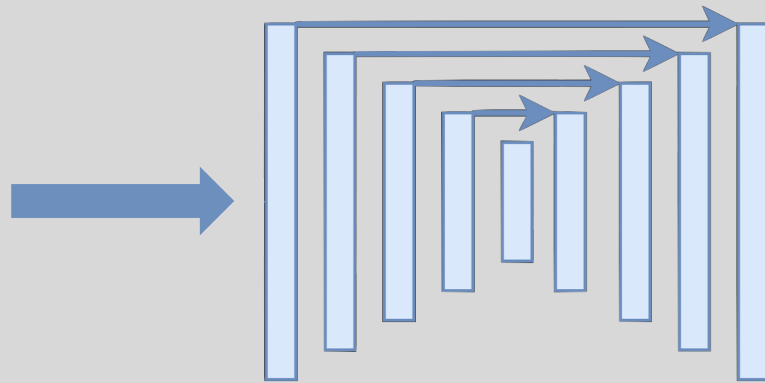
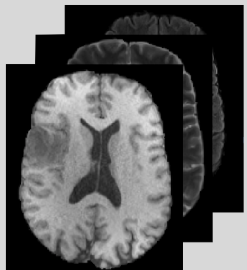


CE Loss

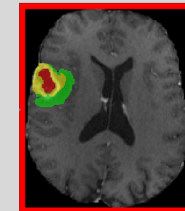
GT Seg



T1P, T2W, FLAIR

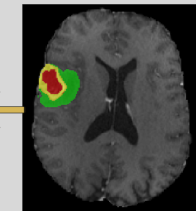


Student Seg



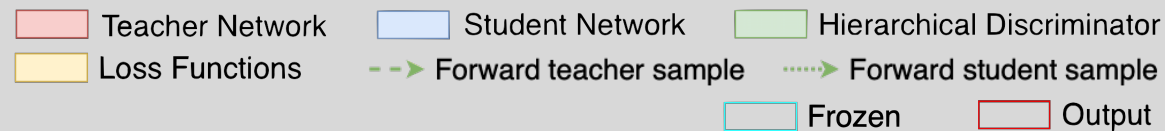
CE Loss

GT Seg

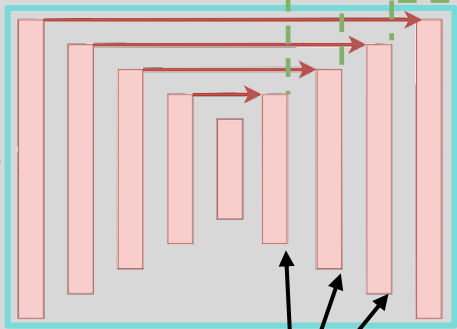
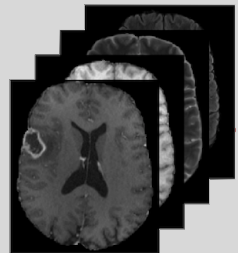


Teacher Network   Student Network   Hierarchical Discriminator   Loss Functions   Output

# HAD-Net Training

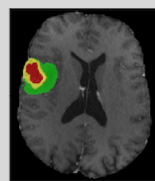


T1C, T1P, T2W, FLAIR

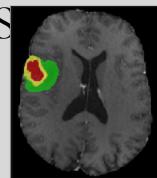


Teacher Multi-Scale Features  
Student Multi-Scale Features

Teacher Seg

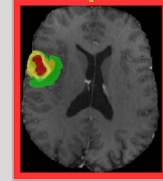


GT Seg

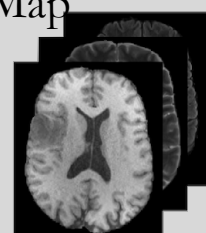


CE Loss

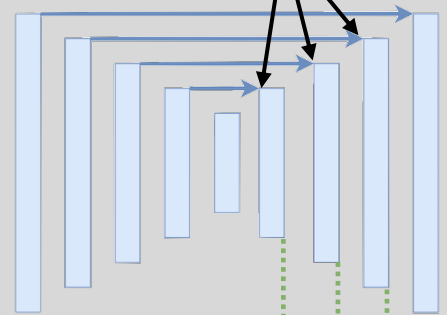
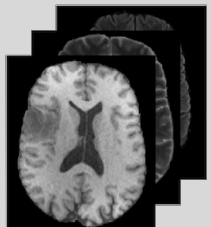
HAD Seg



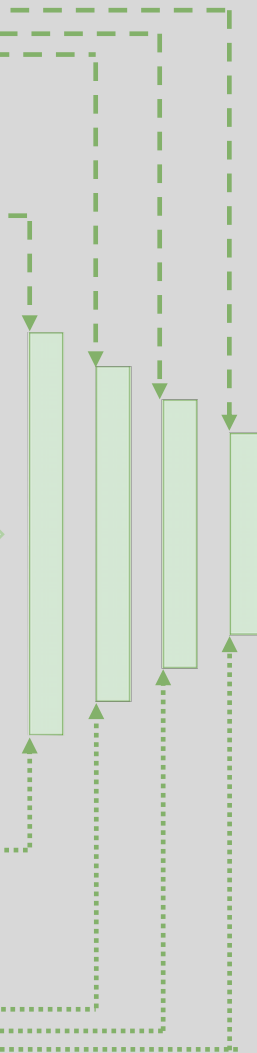
T1P, T2W, FLAIR



T1P, T2W, FLAIR



Student Segmentation Map

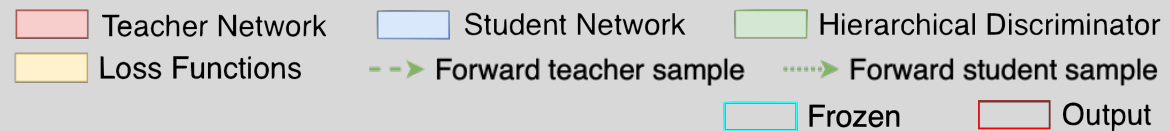


GT Label

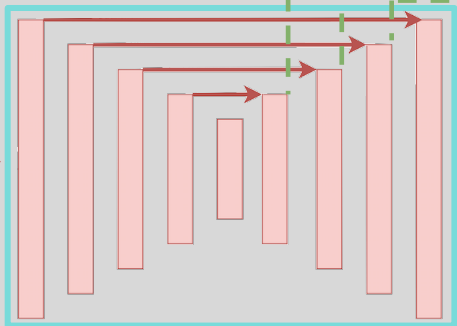
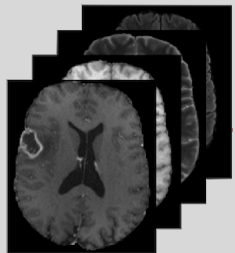
Adversarial Loss

Patch Label

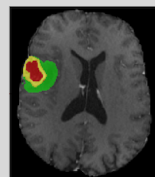
# HAD-Net Training



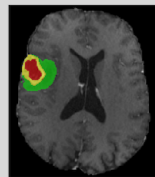
T1C, T1P, T2W, FLAIR



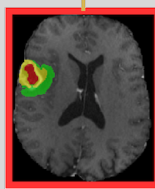
Teacher Seg



GT Seg

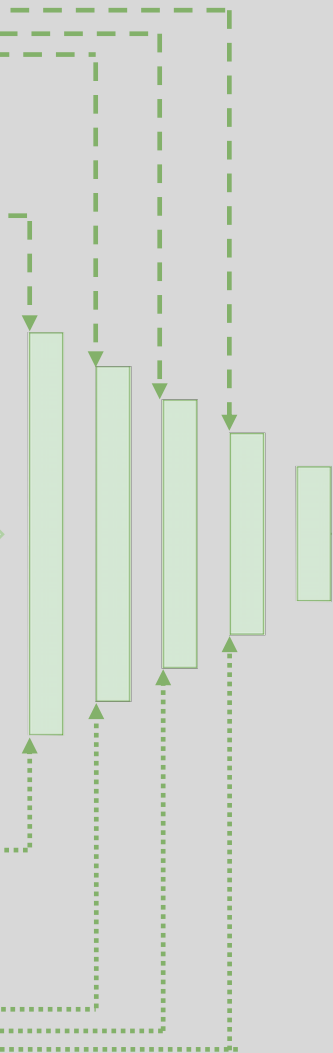
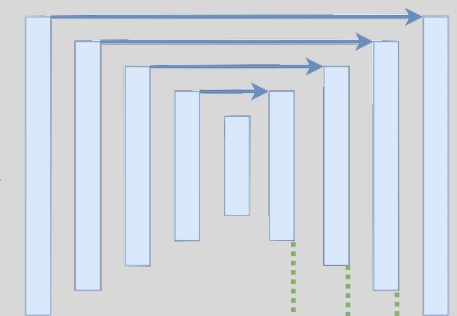
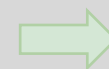
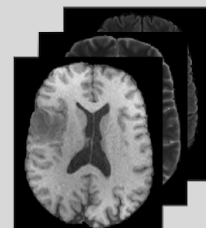


CE Loss



HAD Seg

T1P, T2W, FLAIR



Adversarial Loss

GT Label



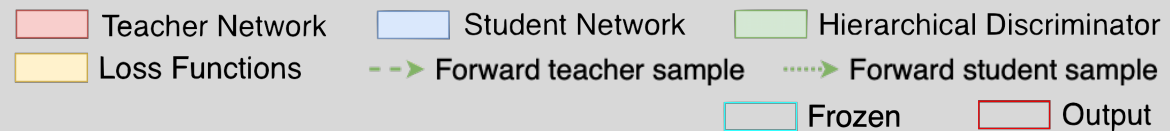
Adversarial Loss



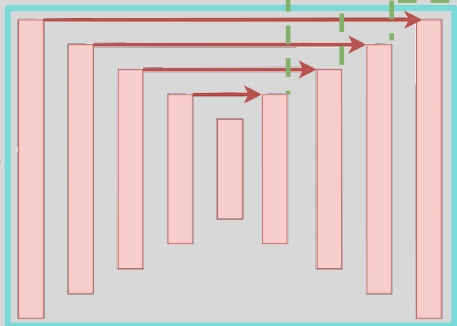
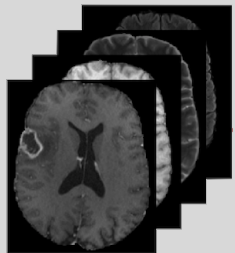
Patch Label



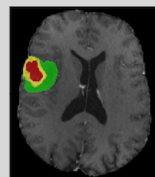
# HAD-Net Training



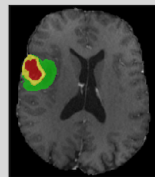
T1C, T1P, T2W, FLAIR



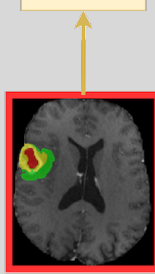
Teacher Seg



GT Seg



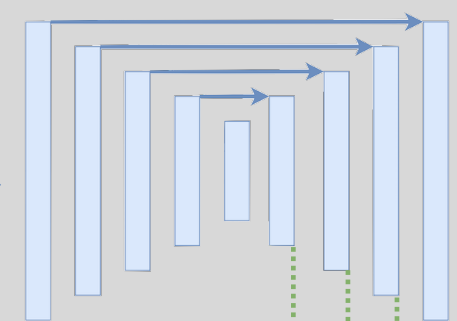
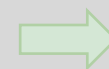
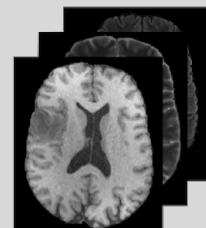
CE Loss



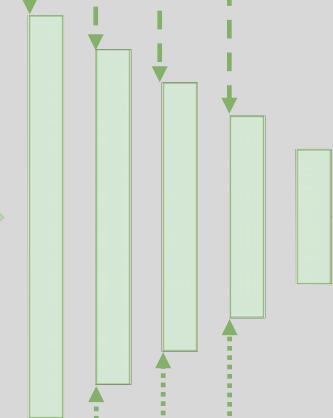
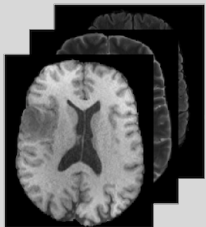
HAD Seg



T1P, T2W, FLAIR



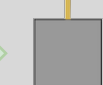
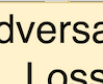
T1P, T2W, FLAIR



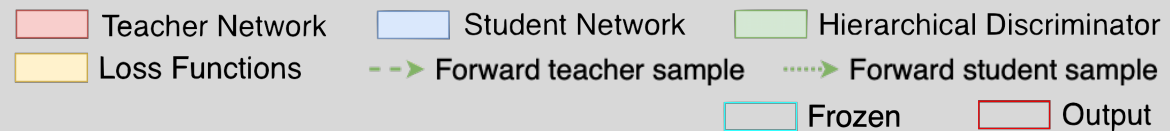
Adversarial Loss

Patch Label

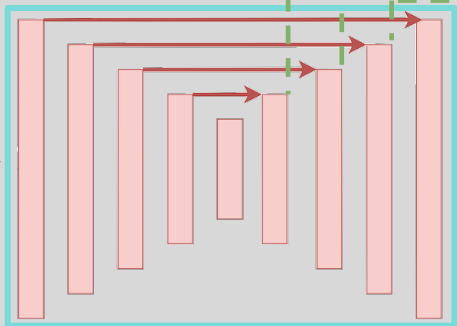
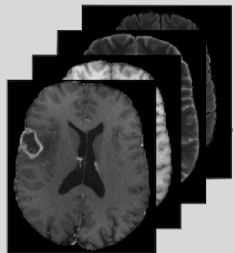
GT Label



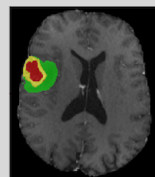
# HAD-Net Training



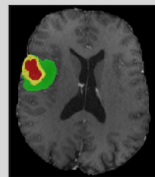
T1C, T1P, T2W, FLAIR



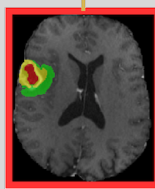
Teacher Seg



GT Seg

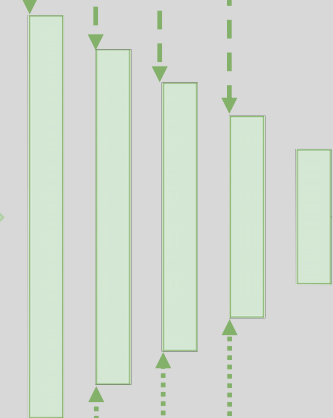
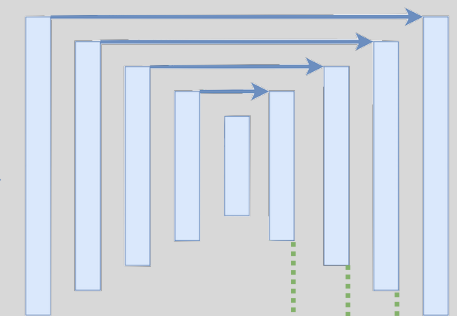
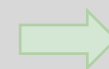
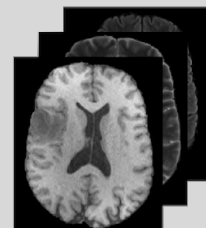


CE Loss



HAD Seg

T1P, T2W, FLAIR



Adversarial Loss

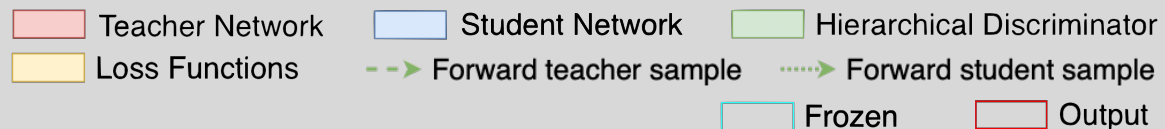
GT Label



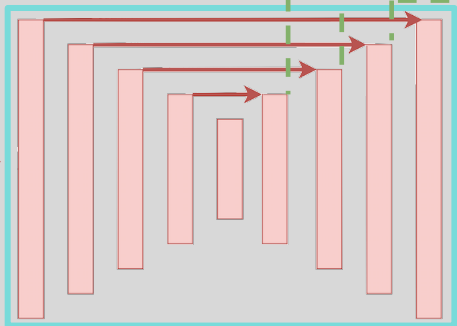
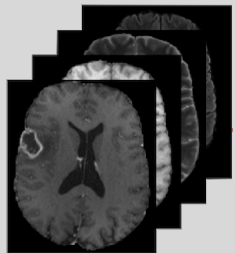
Patch Label



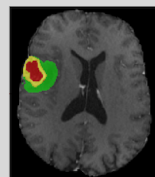
# HAD-Net Inference



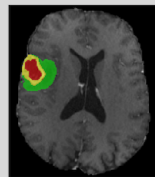
T1C, T1P, T2W, FLAIR



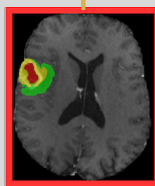
Teacher Seg



GT Seg

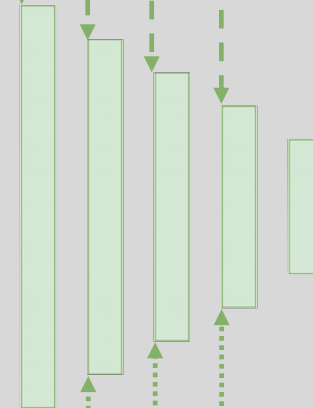
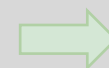
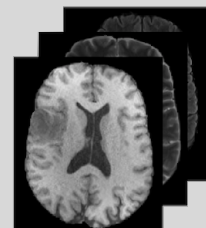


CE Loss



HAD Seg

T1P, T2W, FLAIR

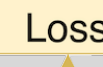


Patch Label

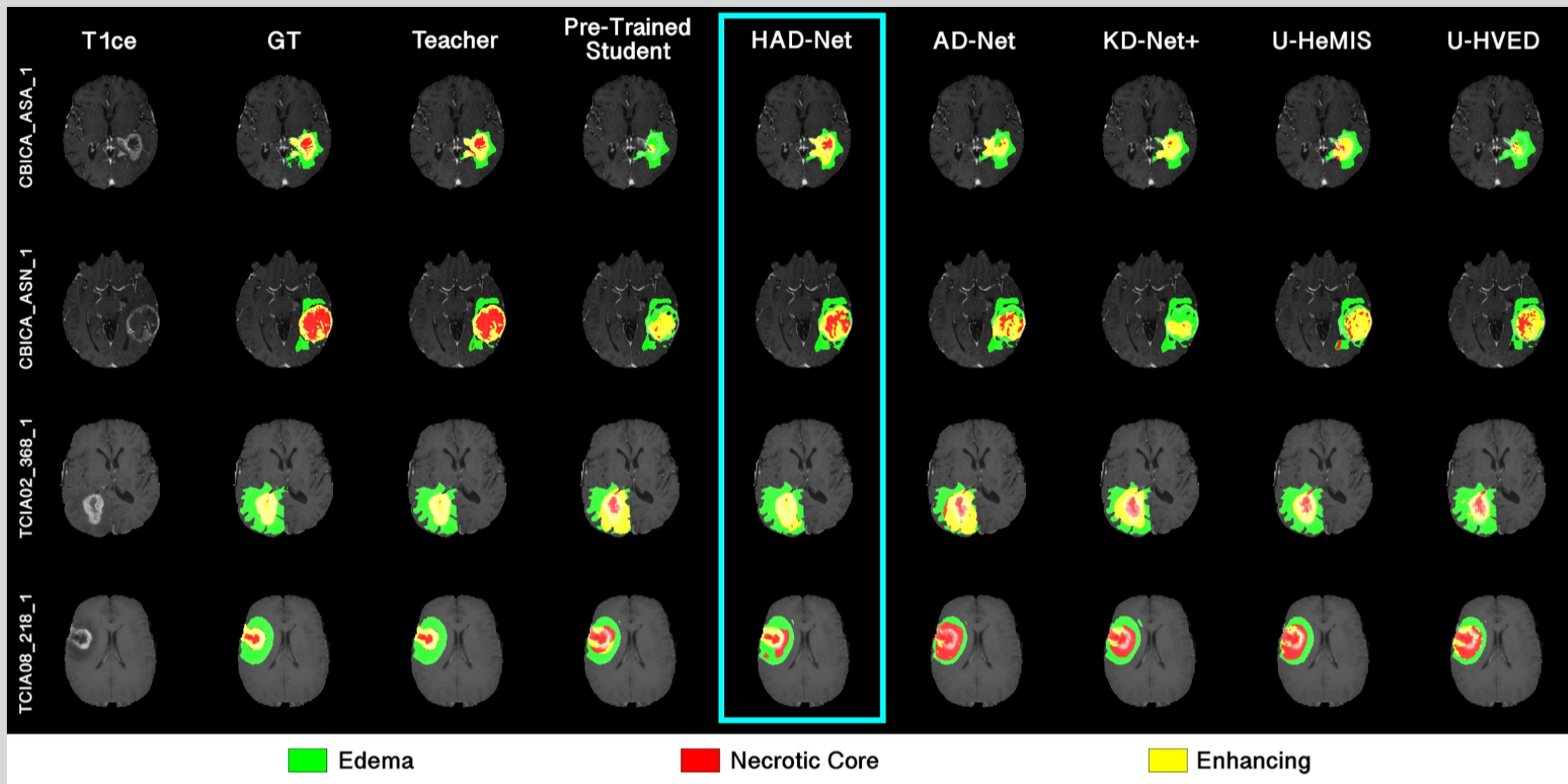
Adversarial Loss



GT Label

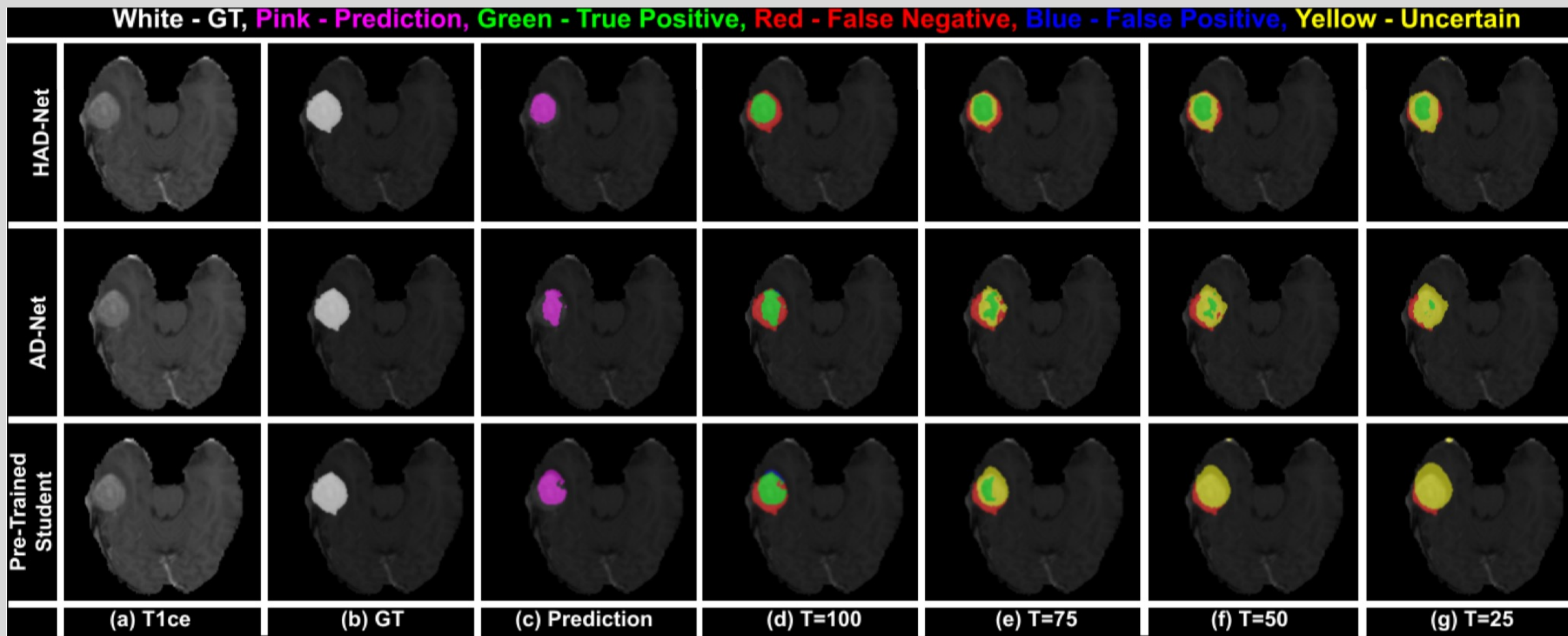


# Results





# Results



Thank you and please join us for our  
poster session (poster I8)!

