

A collage of kidney tissue images, likely from a histological slide. It features several large, circular tubules filled with pink-stained cells. Between these are smaller, irregularly shaped structures and a dense network of thin, red-stained vessels.

Vessel segmentation from kidney  
images using U-Nets

# Outline



Motivation



Dataset description



Approaches

SwinUnetR

MedSAM

Transfer learning



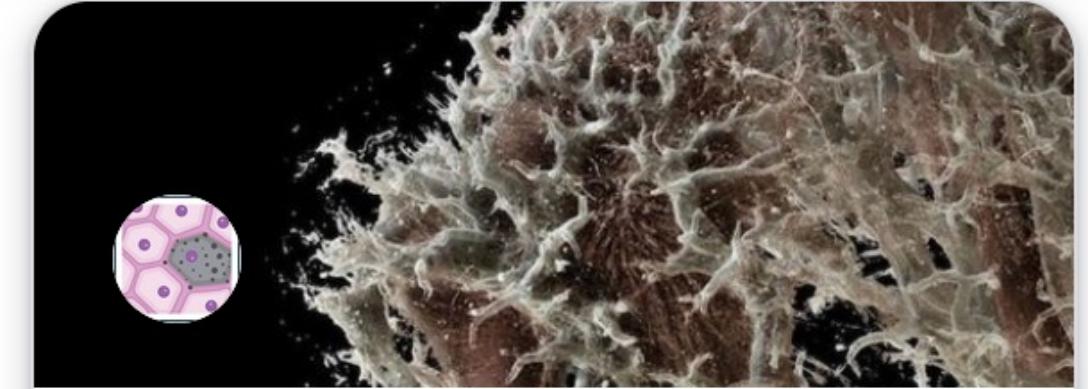
Winning solution



Comments &  
Questions

# Motivation and problem statement

- Kaggle competition: Hacking the human vasculature
  - Help researchers understand structure of vessels
  - Help in bulk and quick diagnosis of slices
    - Monitor vessel changes



## **SenNet + HOA - Hacking the Human Vasculature in 3D**

Segment vasculature in 3D scans of human ...

Research · Code Competition

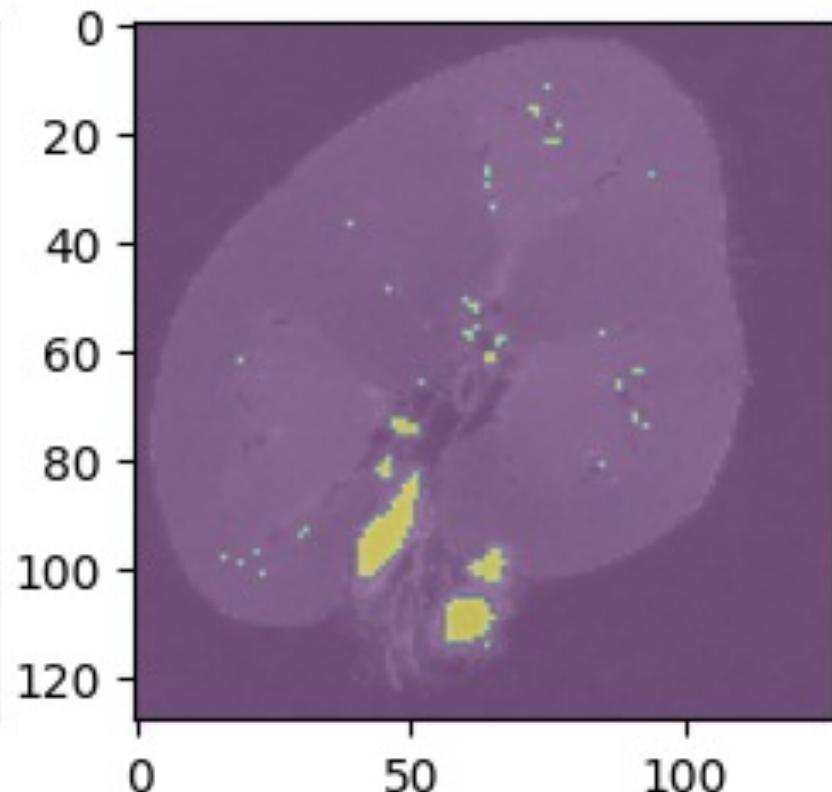
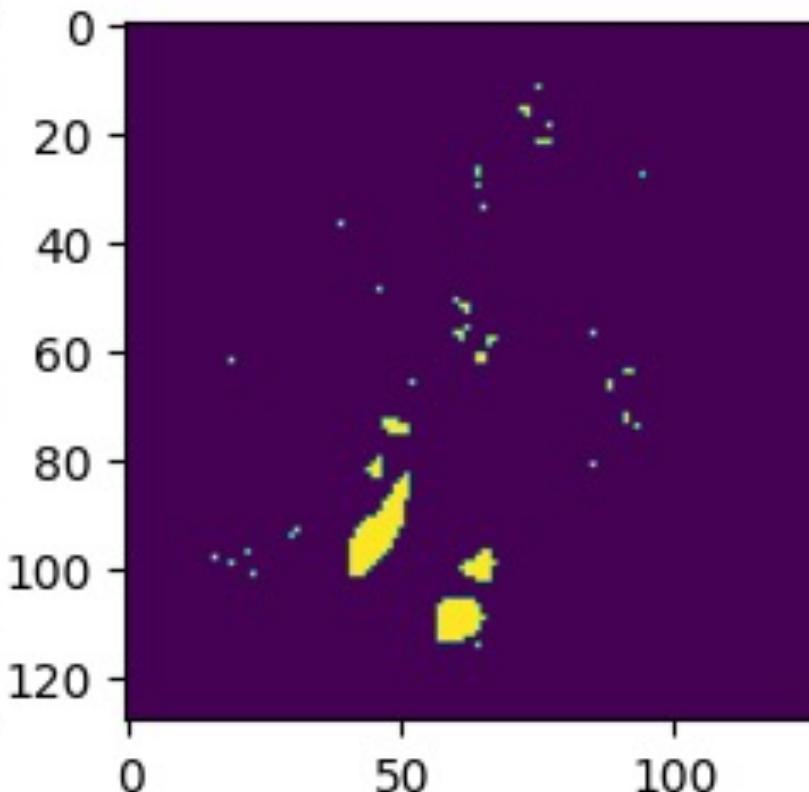
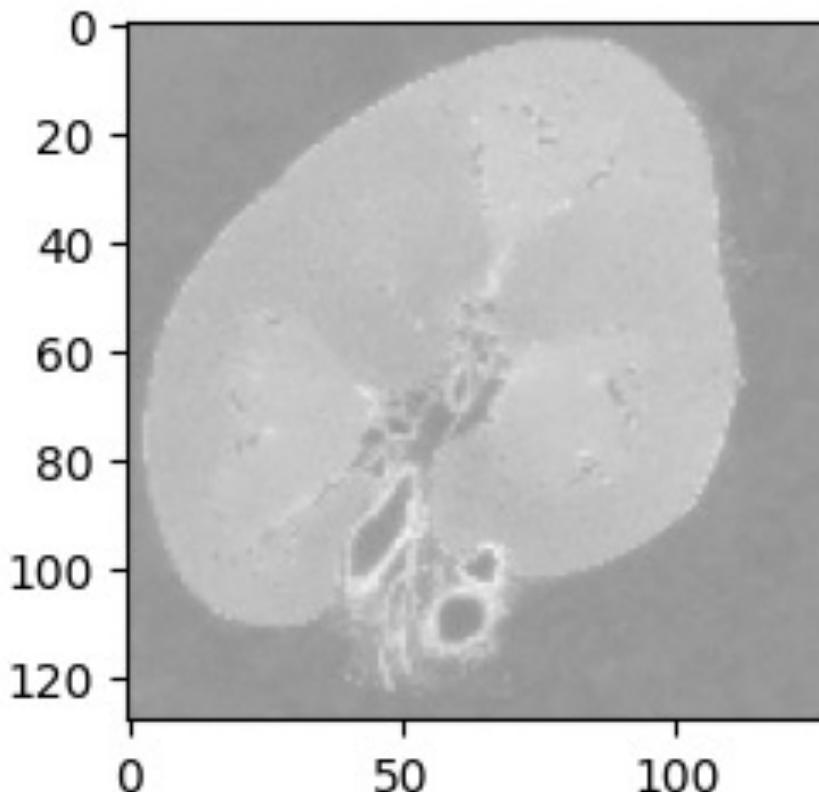
828 Teams

**\$80,000**

20 days to go

# Task and evaluation metric

- Given an RGB images of a kidney slice, predict a binary mask that's overlaid on the image.
  - Single class segmentation: blood vessels
  - Blood vessels are thin, so masks are sparse
  - Evaluated using DICE score



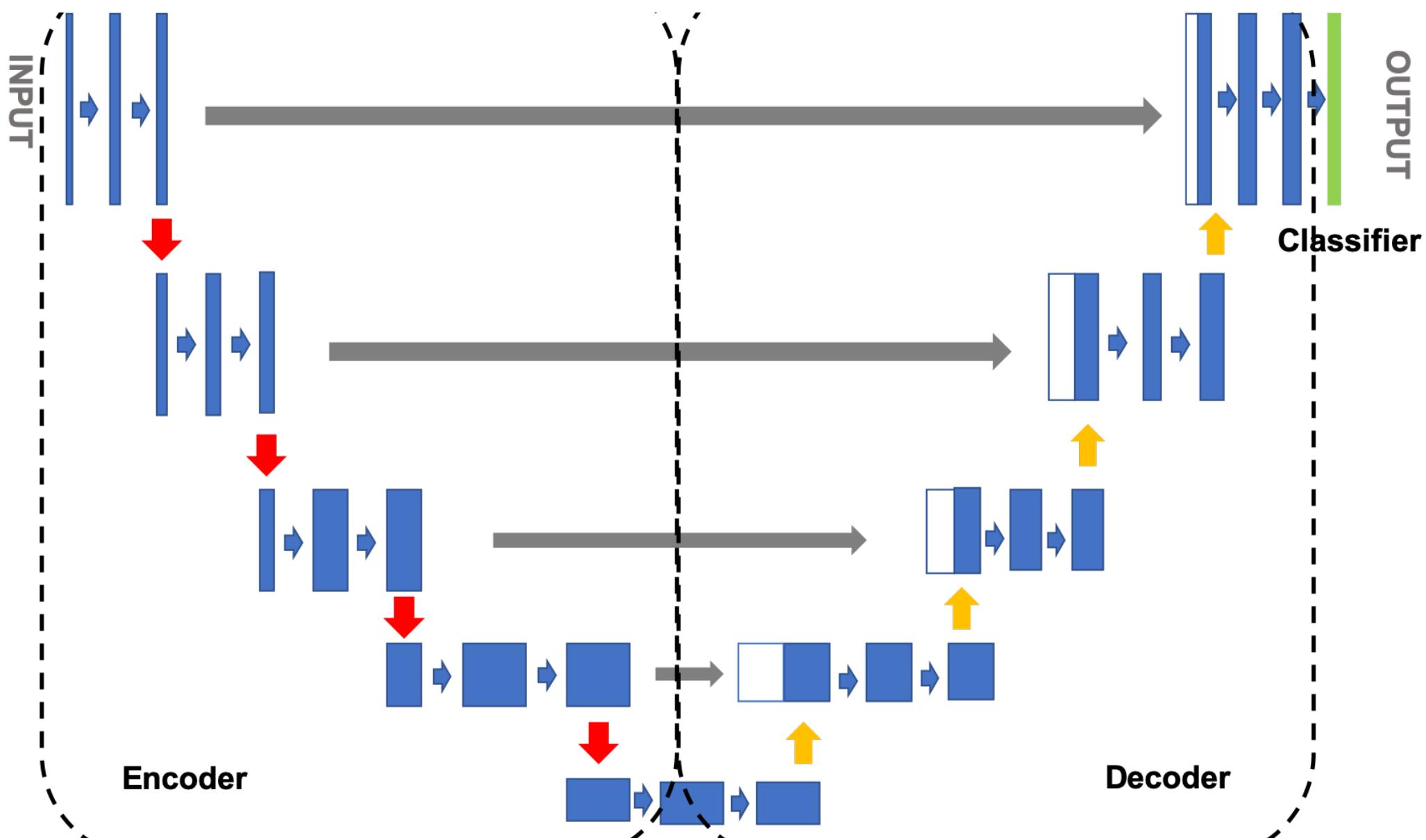


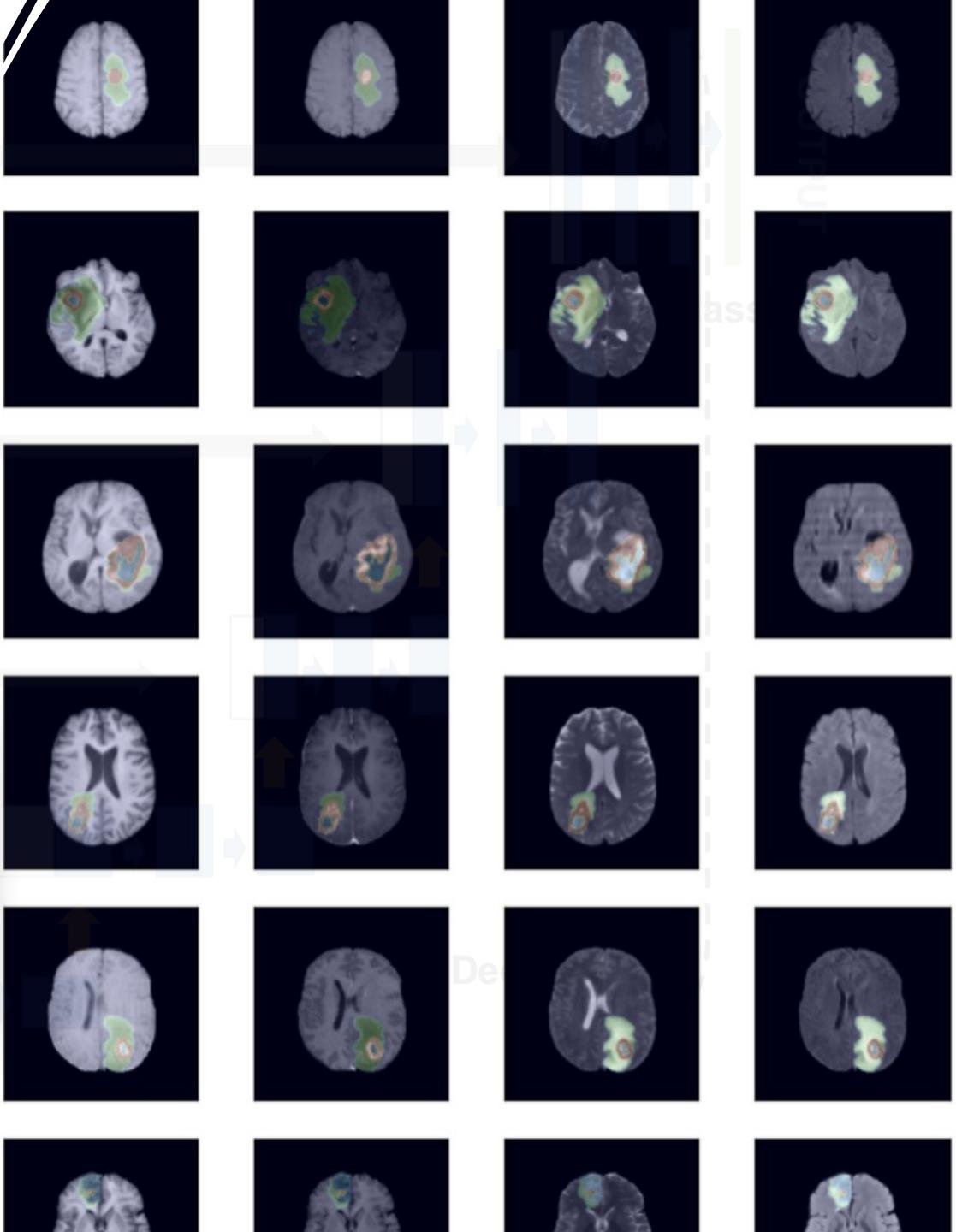
Image extracted from: <https://www.dounaite.com/article/627925a8ac359fc9132727f7.html>

# SwinUnetR

- UNet + Transformers
- Segmentation of brain tumors.
- Multi-class segmentation
  - Tumor core (blue)
  - Enhancing tumor (red)
  - Whole tumor (green)
- <https://arxiv.org/pdf/2201.01266.pdf>

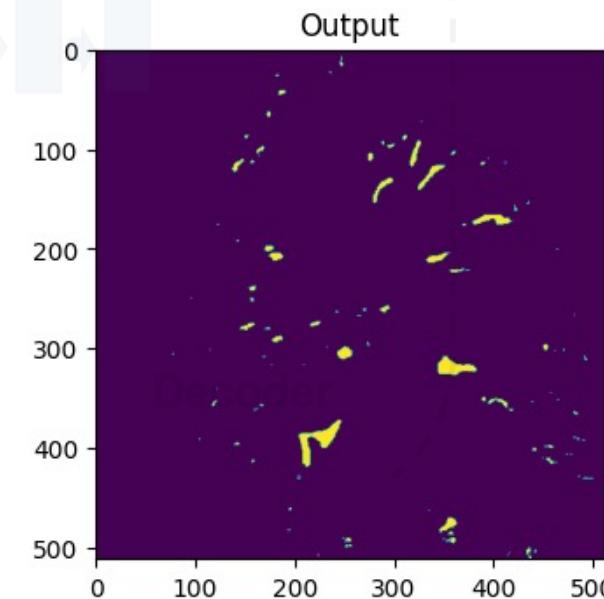
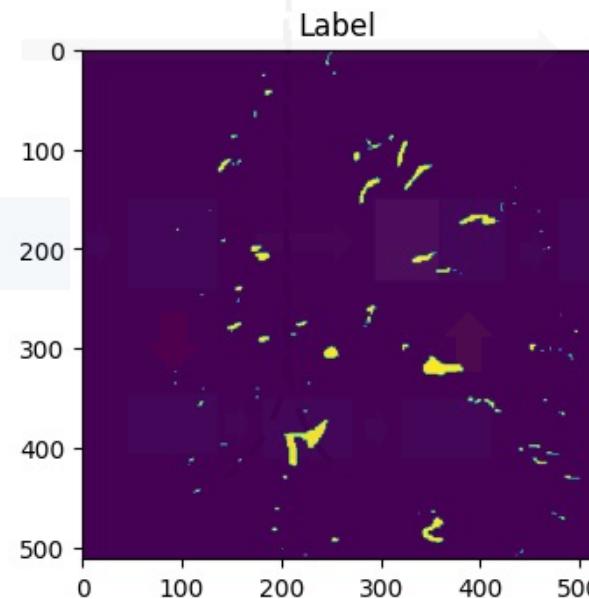
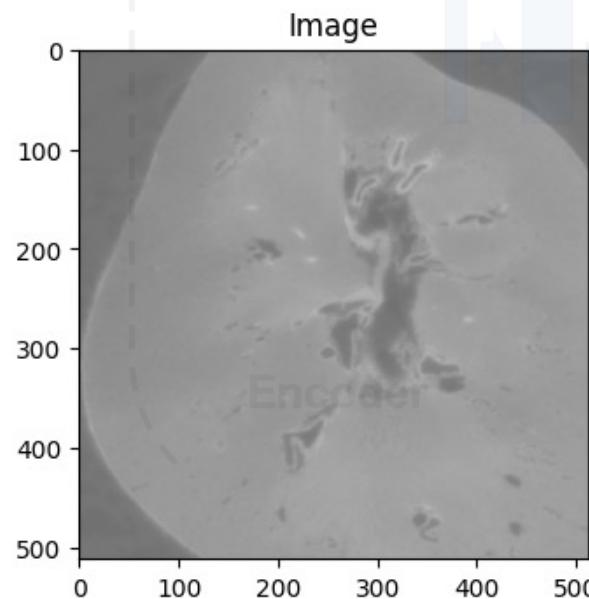
**Table 2.** Five-fold cross-validation benchmarks in terms of mean Dice score values. ET, WT and TC denote Enhancing Tumor, Whole Tumor and Tumor Core respectively.

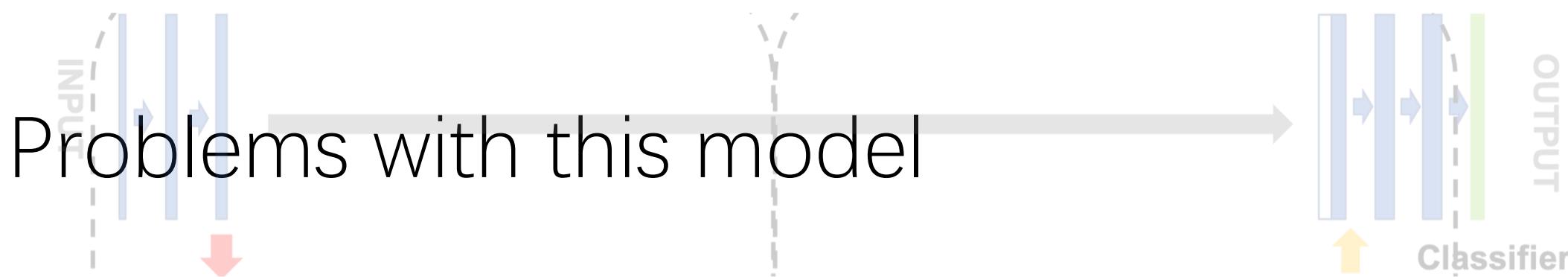
Dice Score	Swin UNETR				nnU-Net				SegResNet				TransBTS			
	ET	WT	TC	Avg.	ET	WT	TC	Avg.	ET	WT	TC	Avg.	ET	WT	TC	Avg.
Fold 1	<b>0.876</b>	<b>0.929</b>	<b>0.914</b>	<b>0.906</b>	0.866	0.921	0.902	0.896	0.867	0.924	0.907	0.899	0.856	0.910	0.897	0.883
Fold 2	<b>0.908</b>	<b>0.938</b>	<b>0.919</b>	<b>0.921</b>	0.899	0.933	<b>0.919</b>	0.917	0.900	0.933	0.915	0.916	0.885	0.919	0.903	0.902
Fold 3	<b>0.891</b>	<b>0.931</b>	<b>0.919</b>	<b>0.913</b>	0.886	0.929	0.914	0.910	0.884	0.927	0.917	0.909	0.866	0.903	0.898	0.889
Fold 4	<b>0.890</b>	<b>0.937</b>	<b>0.920</b>	<b>0.915</b>	0.886	0.927	0.914	0.909	0.888	0.921	0.916	0.908	0.868	0.910	0.901	0.893
Fold 5	<b>0.891</b>	<b>0.934</b>	<b>0.917</b>	<b>0.914</b>	0.880	0.929	<b>0.917</b>	0.909	0.878	0.930	0.912	0.906	0.867	0.915	0.893	0.892
Avg.	<b>0.891</b>	<b>0.933</b>	<b>0.917</b>	<b>0.913</b>	0.883	0.927	0.913	0.908	0.883	0.927	0.913	0.907	0.868	0.911	0.898	0.891



# Proposed solution |

- SwinUnetR
  - Trained it from scratch
  - We achieved 0.89 dice score in validation





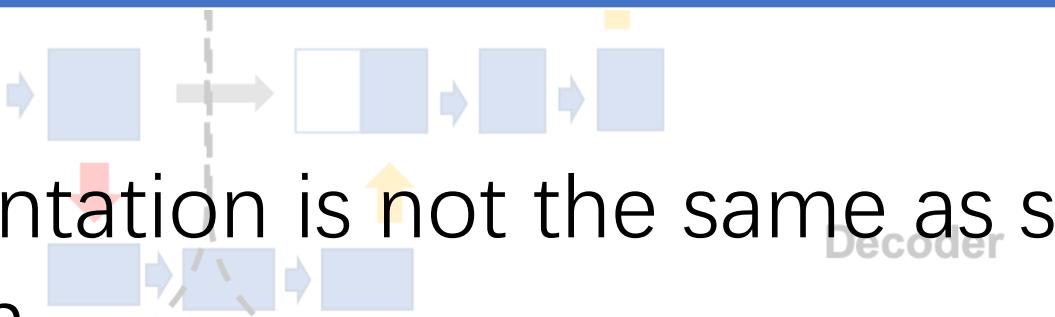
Poor performance on test set ( $\sim 0.21$ )

Potential issues:

- Overfitting



- Multi-class segmentation is not the same as single-class segmentation



970

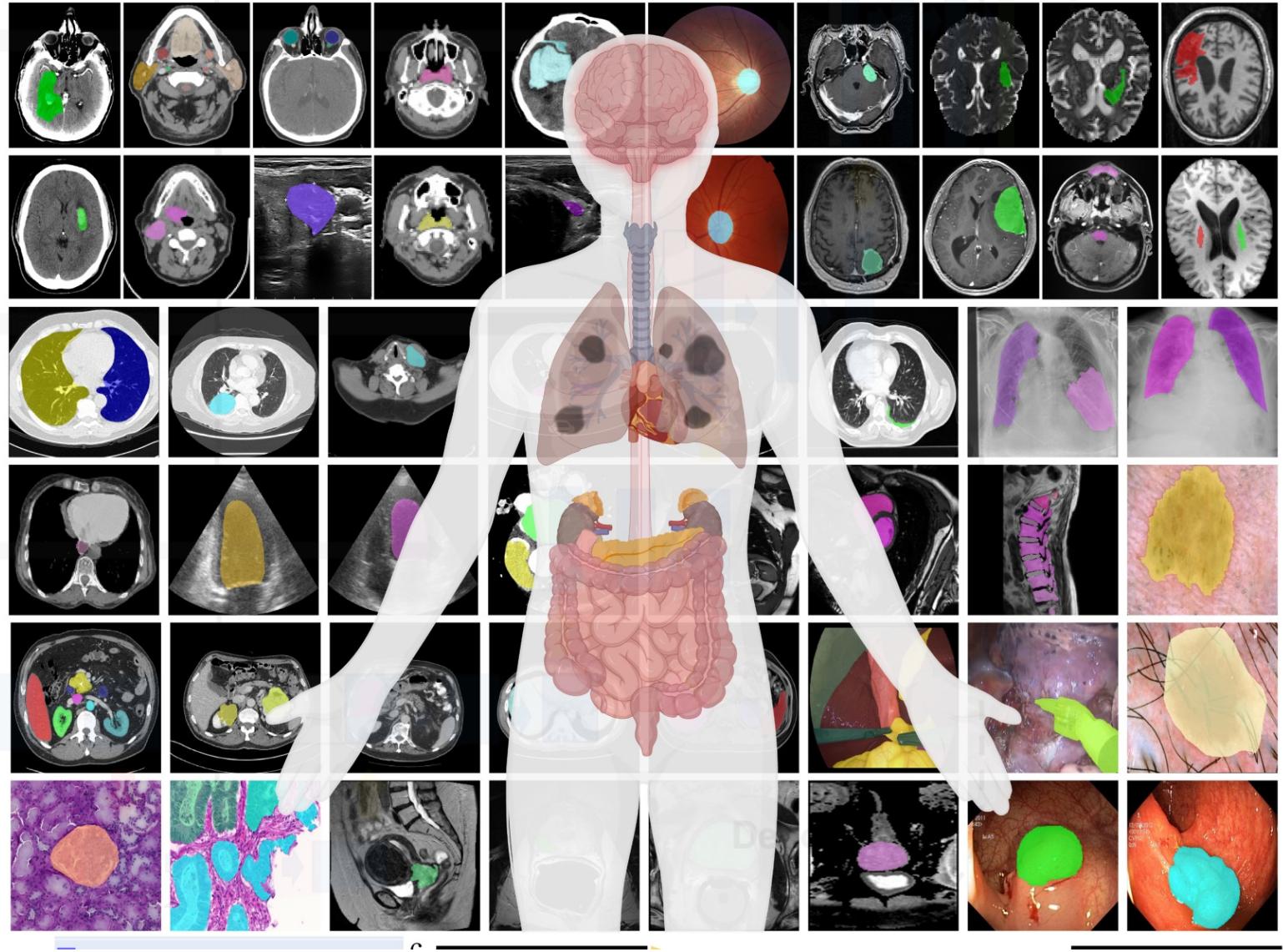
▲ 3

George Tang27



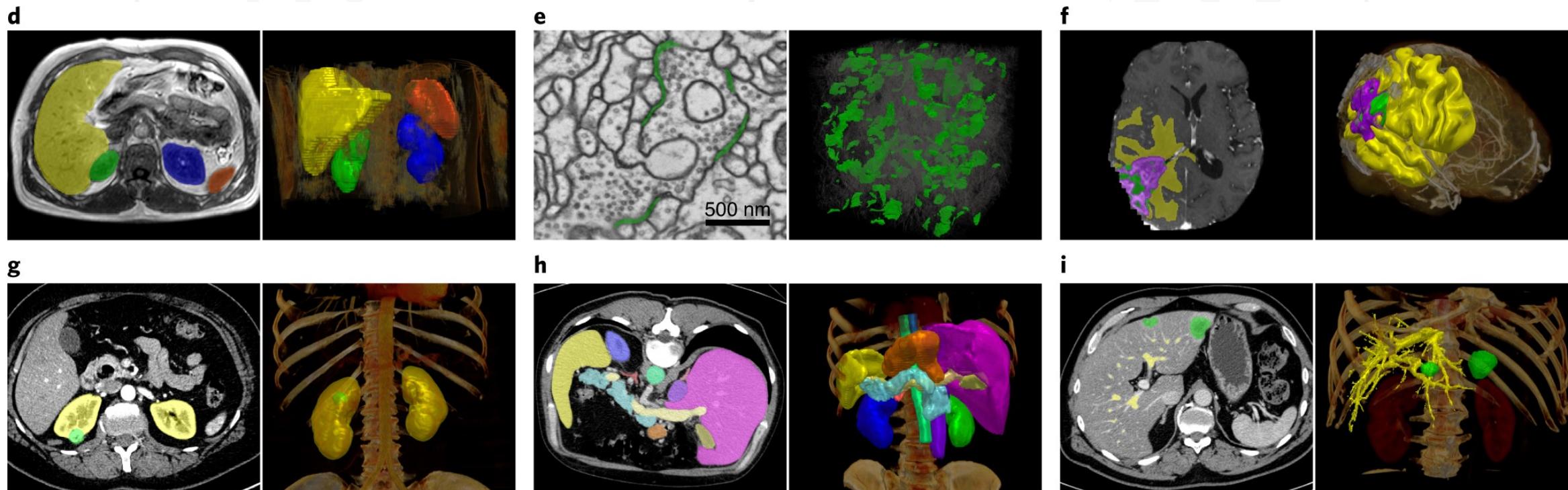
# Proposed solution II

- MedSAM: foundational model
  - Multi class segmentation
  - Organ segmentation
- <https://arxiv.org/pdf/2304.12306.pdf>
- Poor results
  - Stuck in low validation dice score of 0.11



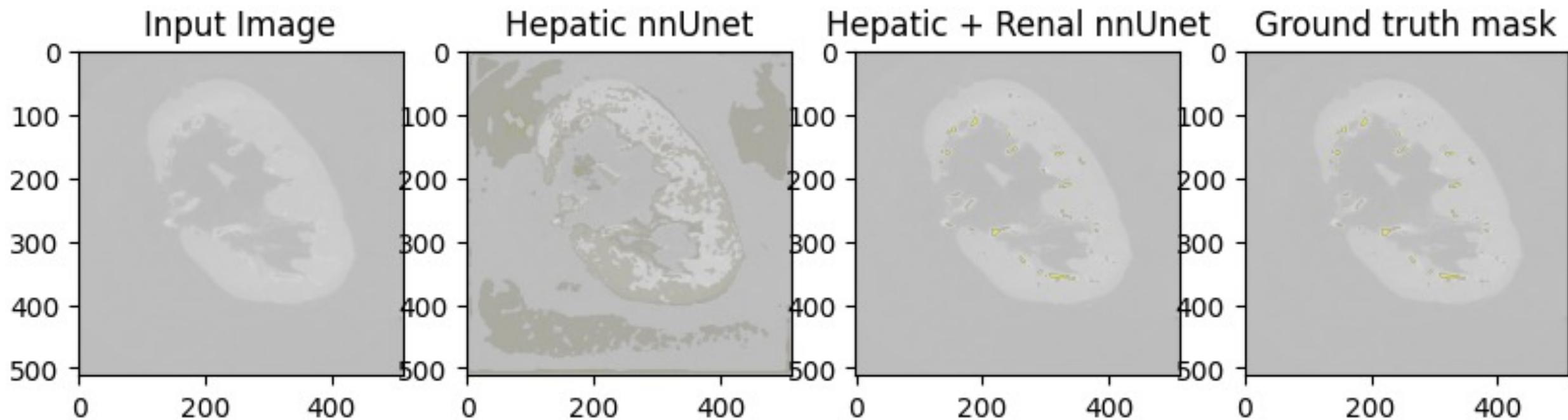
# Proposed solution III

- Transfer learning from nnUNet trained on liver vessel segmentation
  - Binary class segmentation
  - <https://www.nature.com/articles/s41592-020-01008-z>



# Proposed solution III

- nnUnet
  - Fine-tuned for 10 epochs
  - We achieved 0.87 dice score in validation



# Problems with this model

Poor performance on test set ( $\sim 0.013$ )



hack-vasculature-transfer-learning-inference - Version 3

Succeeded · awxlong · 1mo ago · Notebook hack-vasculature-transfer-learning-inference | Version 3

0.01332

Potential issues:

- Poor generalization

Encoder

Decoder



forcewithme

# ForcewithMe

- Student at kaggle
- Guangzhou, Guangdong Province, China
- Joined 3 years ago · last seen in the past day

Competitions Grandmaster  
29 of 199,858

A brief  
description of  
third place

1. Refining labels from sparse to dense
2. Emulating the magnification factor of the test set
3. Maintaining an appropriate resolution

...

<https://www.kaggle.com/competitions/blood-vessel-segmentation/discussion/475074>

# A small modification to threshold



[\*\*hack-vasculature-transfer-learning-inference - Vers...\*\*](#)

Succeeded (after deadline) · awxlong · 2d ago · Notebook hack-vasculat...

**0.676025**

**0.670039**





Questions &  
Feedback?

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