U-Net
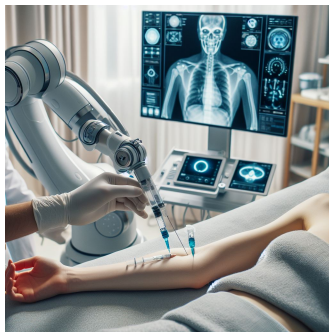
December 14, 2023

The need for automation

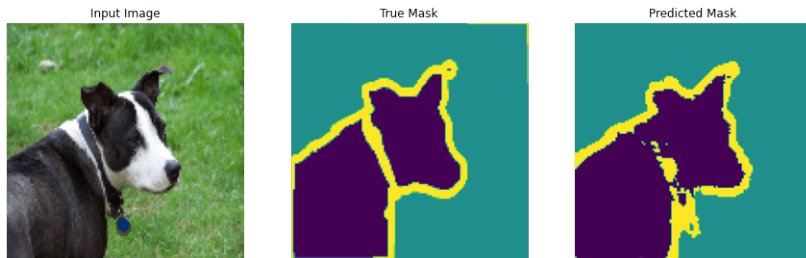# Segmentation techniques

Figure: Segmentation example from Tensorflow
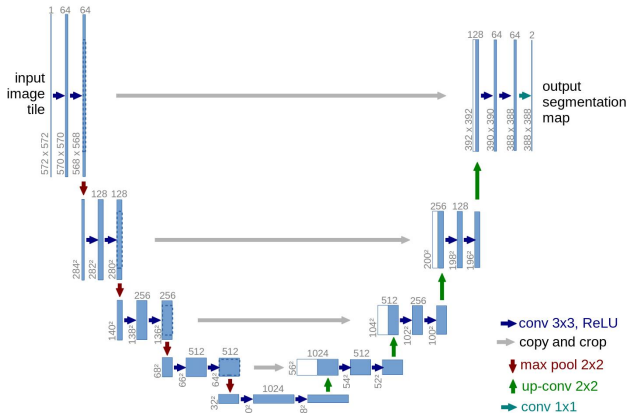
1. U-Net
2. YOLO
3. Deeplab

U-net

Figure: U-Net schematic

U-net implementation

Github

Complexity

FCNN Model size is constant: 118 MG

Time complexity:

1. Inference time (CPU)
2. Train time (CPU)
3. Inference time (GPU)
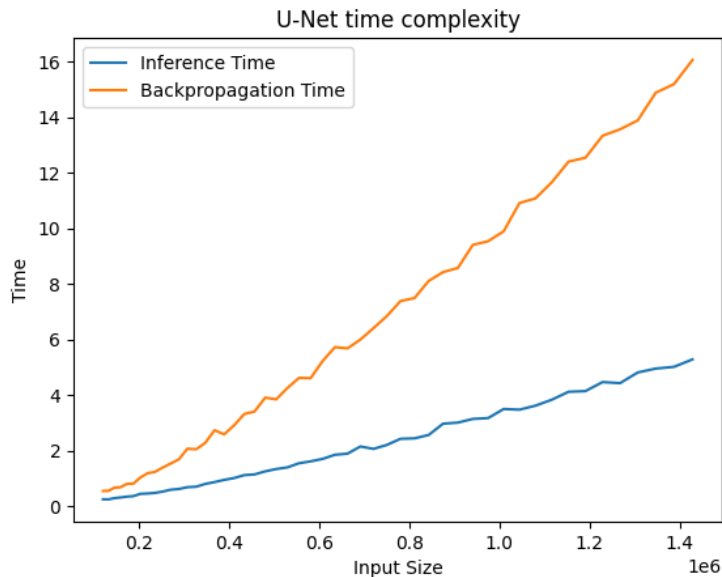4. Train time (GPU)

Memory complexity:

1. Inference memory (GPU)
2. Train memory (GPU)

CPU time complexity

Image Size	Inference Time	Train Time
256x256	0.369 s	1.320 s
512x512	2.429 s	9.094 s
576x576	**3.408 s**	**12.201 s**
1024x1024	13.780 s	50.855 s
1280x1280	23.943 s	93.930 s

Table: CPU Complexity Table

CPU time complexity continue

U-Net time complexity

GPU complexity

Image size	Infer time	Train time	Infer memory	Train memory
256x256	0.055 s	0.033 s	0.371 GB	0.439 GB
512x512	0.064 s	0.095 s	0.453 GB	1.077 GB
576x576	**0.087 s**	**0.121 s**	**0.763 GB**	**1.551 GB**
1024x1024	0.184 s	0.404 s	1.551 GB	5.594 GB
1472x1472	0.353 s	0.893 s	3.193 GB	10.379 GB
1664x1664	0.449 s	0.449 s	3.512 GB	12.206 GB

Table: GPU Complexity Table

GPU time complexity

GPU memory complexity
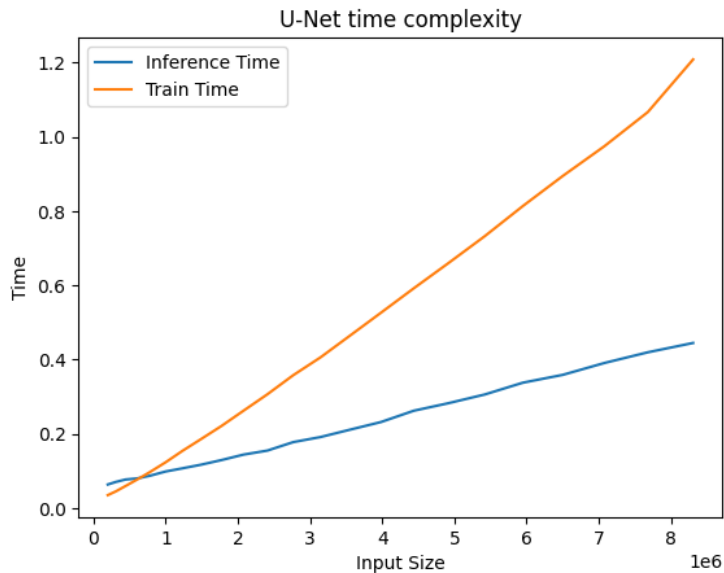
U-Net Memories complexity
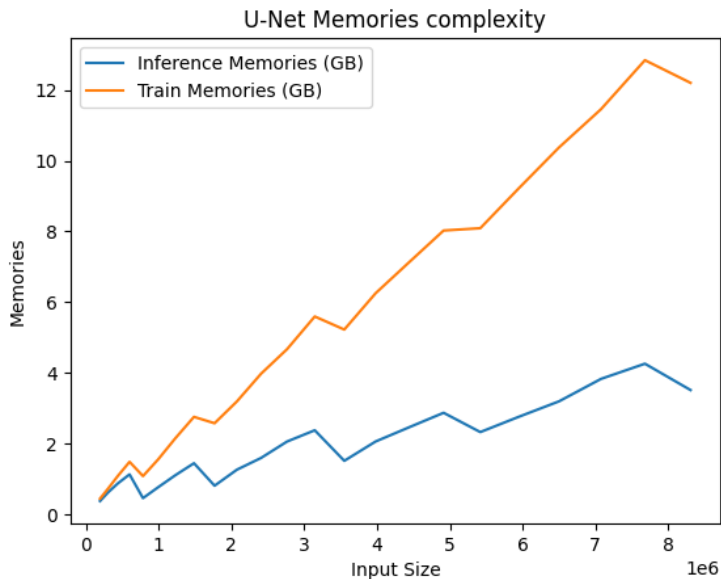
Optimization

- Adjusting Network architucture: deepth, ...
- Tuning hyperarameters: batch size, learing rate,
- Use existing model: use pretrained encoder
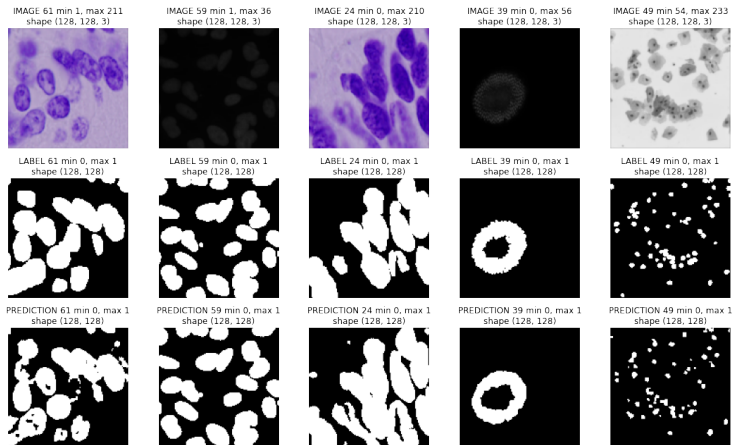- ...

Medical Application

Figure: Kaggle: Automating nucleus detection
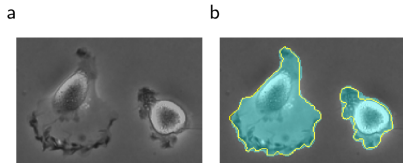
Medical Application continue
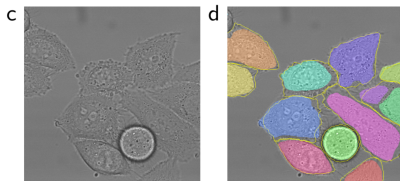

Figure: Glioblastoma-astrocytoma U373

Figure: HeLa cells

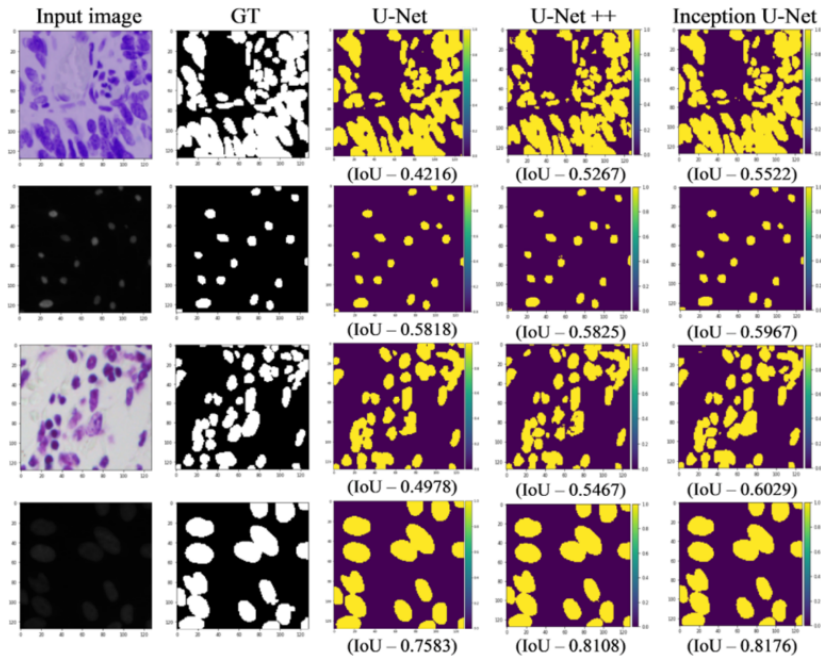# U-Net variants

Input image	GT	U-Net	U-Net ++	Inception U-Net
		(IoU − 0.4216)	(IoU − 0.5267)	(IoU − 0.5522)
		(IoU − 0.5818)	(IoU − 0.5825)	(IoU − 0.5967)
		(IoU − 0.4978)	(IoU − 0.5467)	(IoU − 0.6029)
		(IoU − 0.7583)	(IoU − 0.8108)	(IoU − 0.8176)

Other models

- DeepLab
- SegNet
- YoLo
- ...