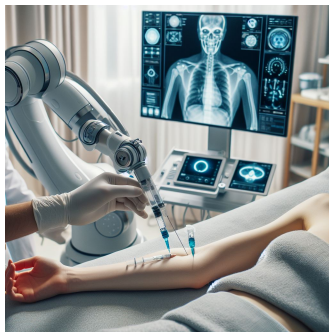


# U-Net

December 14, 2023

# The need for automation



# Segmentation techniques

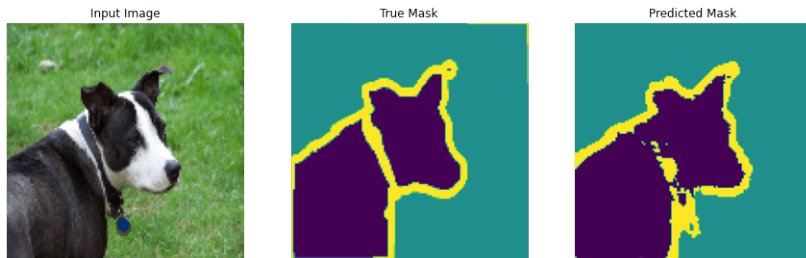


Figure: Segmentation example from Tensorflow

1. U-Net
2. YOLO
3. Deeplab

# U-net

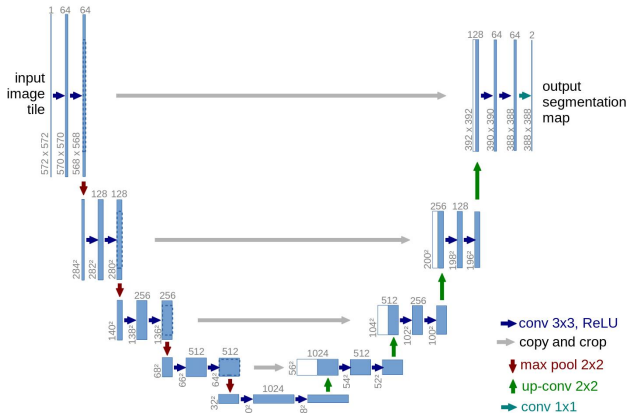


Figure: U-Net schematic

# 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:

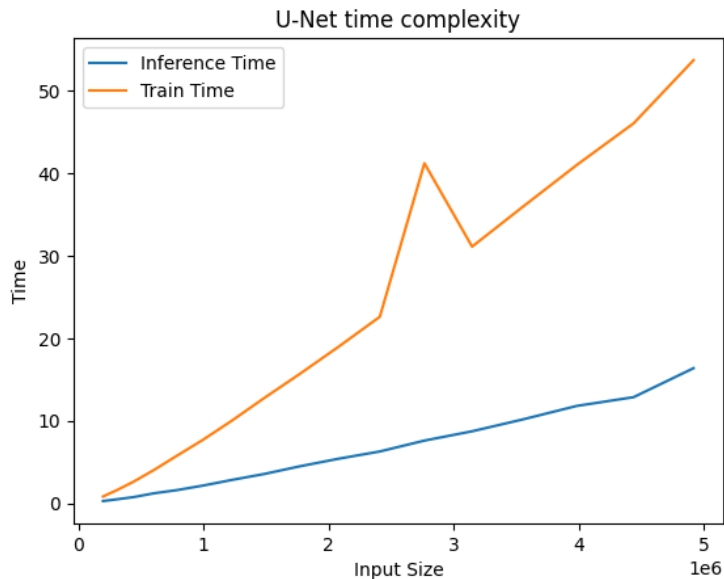
1. Inference memory (GPU)
2. Train memory (GPU)

## CPU time complexity

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

Table: CPU Complexity Table

# CPU time complexity continue



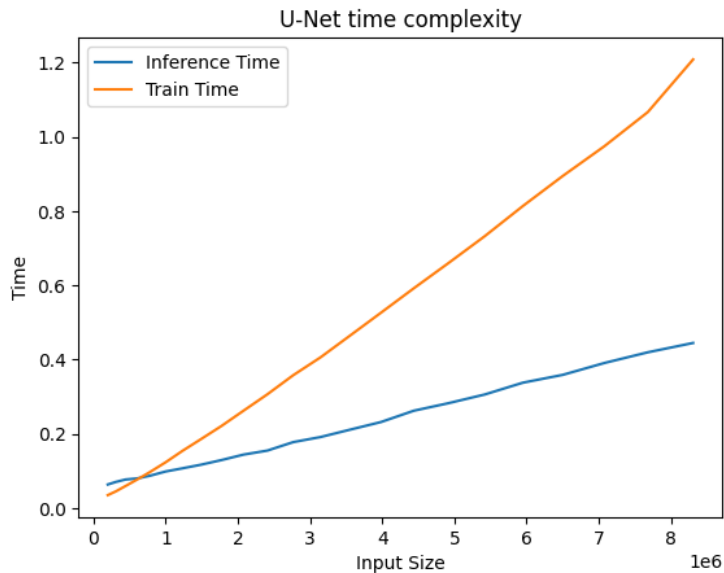


# GPU complexity

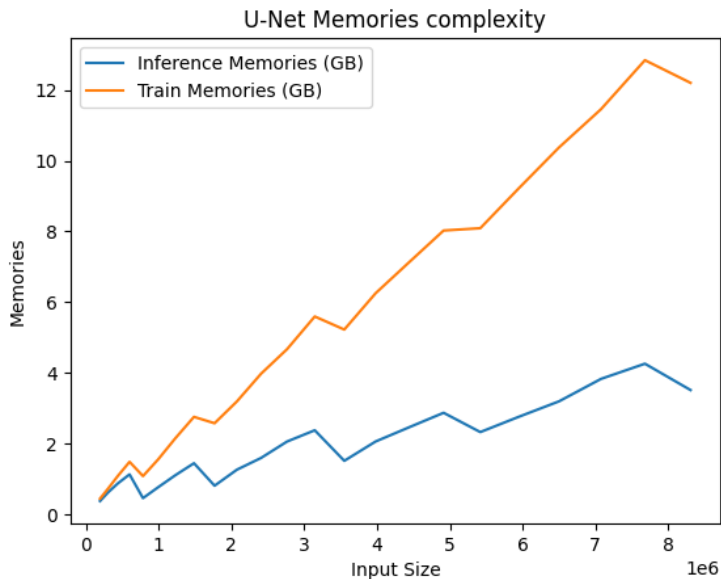
Image size	Infer time	Train time	Infer memory	Train memory
256x256	0.055 s	0.033 s	0.371 GB	0.439 GB
512x512	0.064 s	0.095 s	0.453 GB	1.077 GB
<b>576x576</b>	<b>0.087 s</b>	<b>0.121 s</b>	<b>0.763 GB</b>	<b>1.551 GB</b>
1024x1024	0.184 s	0.404 s	1.551 GB	5.594 GB
1472x1472	0.353 s	0.893 s	3.193 GB	10.379 GB
1664x1664	0.449 s	1.208 s	3.512 GB	12.206 GB

Table: GPU Complexity Table

# GPU time complexity



# GPU memory complexity



# Optimization

- ▶ Adjusting Network architecture: depth, ...
- ▶ Tuning hyperparameters: batch size, learning rate,
- ▶ Use existing model: use pretrained encoder
- ▶ ...

# Medical Application

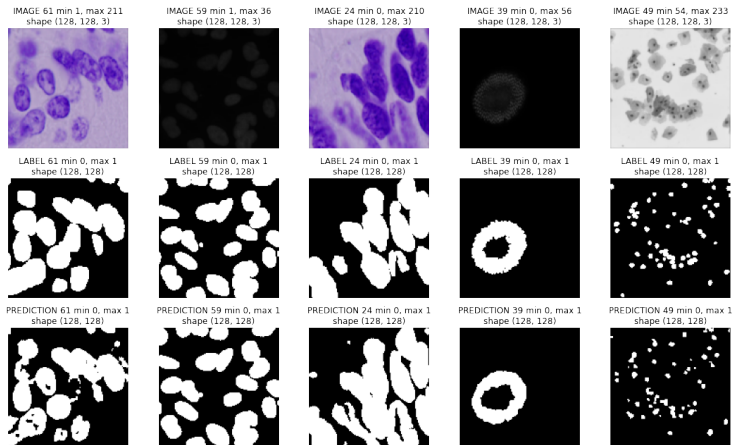


Figure: Kaggle: Automating nucleus detection

# Medical Application continue

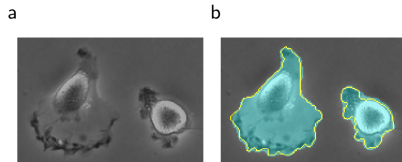


Figure: Glioblastoma-astrocytoma U373

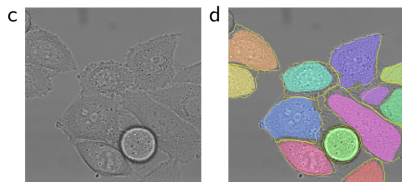
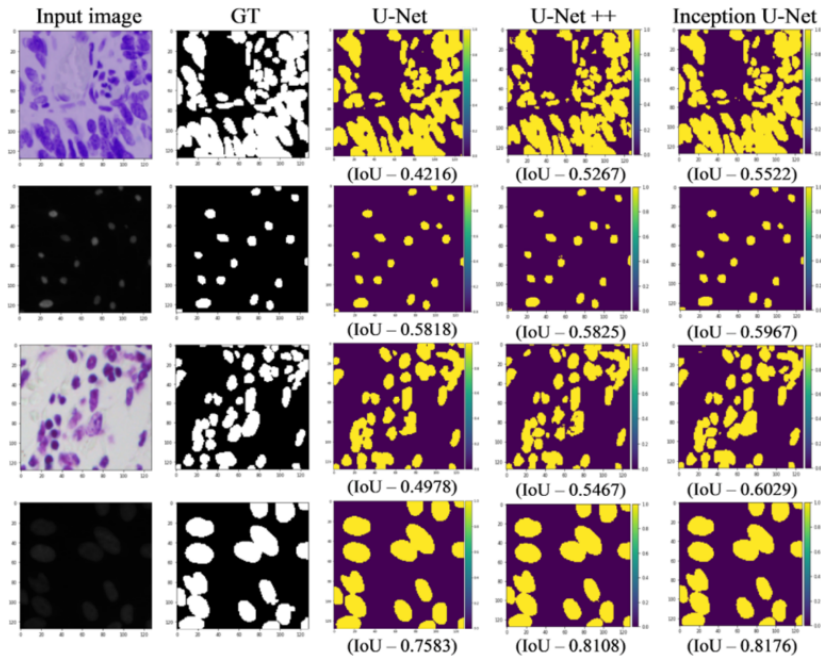


Figure: HeLa cells

# U-Net variants



# Other models

- ▶ DeepLab
- ▶ SegNet
- ▶ YoLo
- ▶ ...