Segmentation of cells using Mask-RCNN and U-Net

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Introduction

Clinicians and researchers spend an enormous amount of time and resources on repetitive, manual tasks, such as identifying and counting objects in images. The process of identifying objects can be highly subjective, which induces reproducibility issues. Segmentation of gland is challenging due to the great variation of glandular morphology.
By using deep learning to aid clinicians and researchers in identifying objects in images, the repetitive and complex tasks can be reduced, while minimizing scientific reproducibility issues.

Model specifications:

Model:
ResNet-50 Convolutional Neural Network
Optimizer:

Stochastic Gradient Descent (SGD)
Hyperparameters:
- *Initial learning rate*: 0.005
- *Momentum*: 0.9
- *Weight decay*: 0.0005
- *Learning rate decay*: Staircase, 10x every 3 epochs
- *Batch size:* 2
- *Epochs*: 200

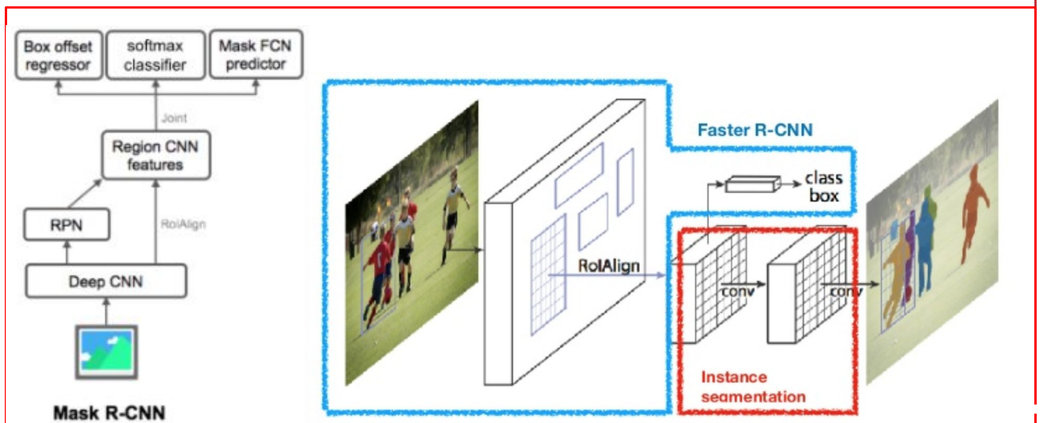
Loss function of Mask R-CNN

$$\mathcal{L} = \mathcal{L}_{\text{cls}} + \mathcal{L}_{\text{box}} + \mathcal{L}_{\text{mask}}$$

The GLAND (Warwick-QU) Dataset

The dataset was used in a competition in 2015 about gland segmentation on images of Hematoxylin and Eosin (H&E) stained slides, together with ground truth annotations by expert pathologists

Architecture of Mask R-CNN



Mask R-CNN Results

(Object detection and semantic segmentation)

Image 80

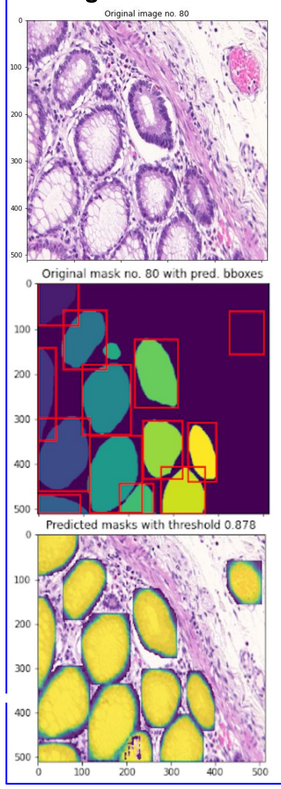
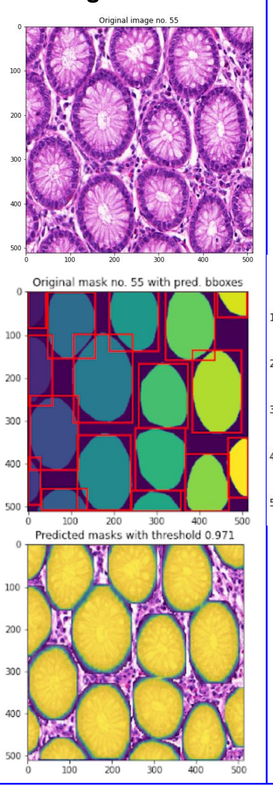


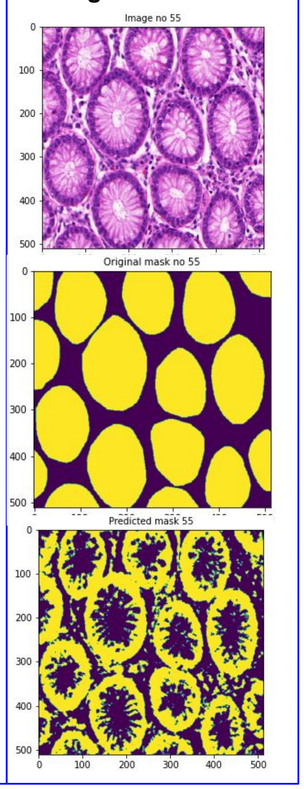
Image 55



U-Net Results

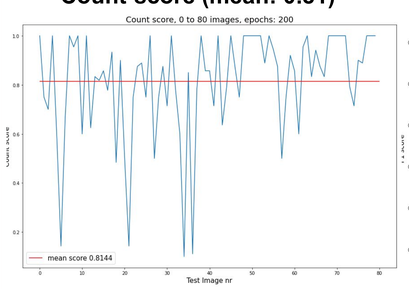
(Semantic segmentation)

Image 55

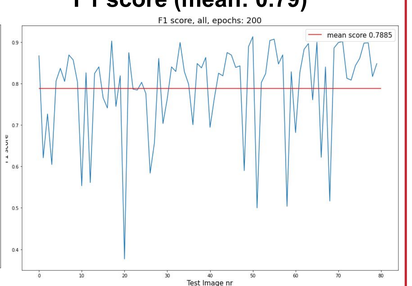


Mask R-CNN metrics (all images)

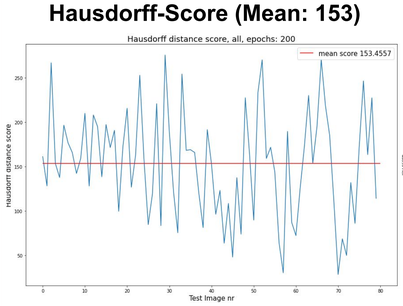
Count-score (mean: 0.81)



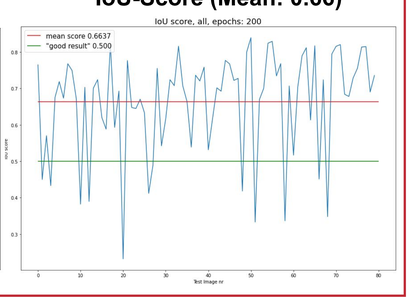
F1 score (mean: 0.79)



Hausdorff-Score (Mean: 153)

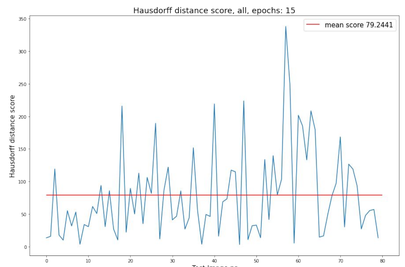


IoU-Score (Mean: 0.66)

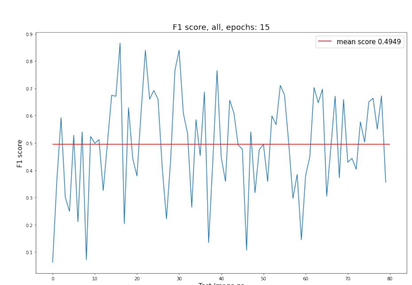


U-Net Metrics (15 epochs)

Hausdorff-Score (mean: 79)



F1 score (mean: 0.49)



Algorithm	F1 Score	Hausdorff Distance
U-Net	0.49	79
Mask R-CNN	0.79	153

Future work

- More data augmentation
- Look more into alt. optimizers (such as AdamW)
- Use a deeper architecture, such as ResNet-101
- Improve metrics
- Different batch sizes

References

[1] *HE, Kaiming, et al. Mask r-cnn. In: Proceedings of the IEEE international conference on computer vision. 2017. p. 2961-2969.*

[2] *REN, Shaoqing, et al. Faster r-cnn: Towards real-time object detection with region proposal networks. In: Advances in neural information processing systems. 2015. p. 91-99.*

[3]*Torchvision Object Detection Finetuning Tutorial, [URL: https://pytorch.org/tutorials/intermediate/torchvision_tutorial.html]*