MICROCARD - WP7
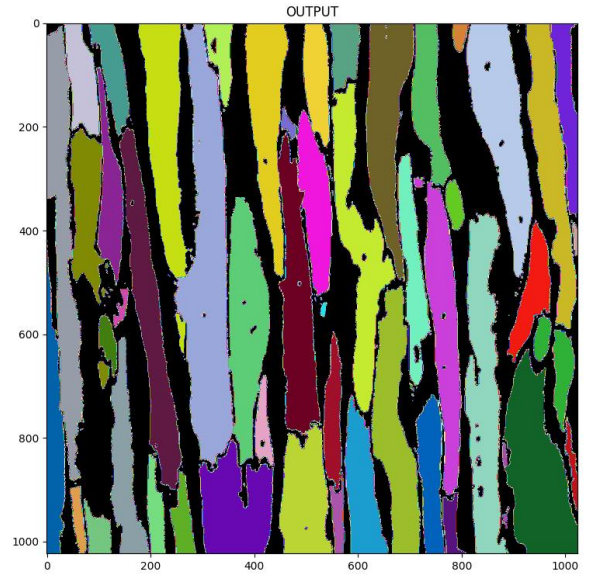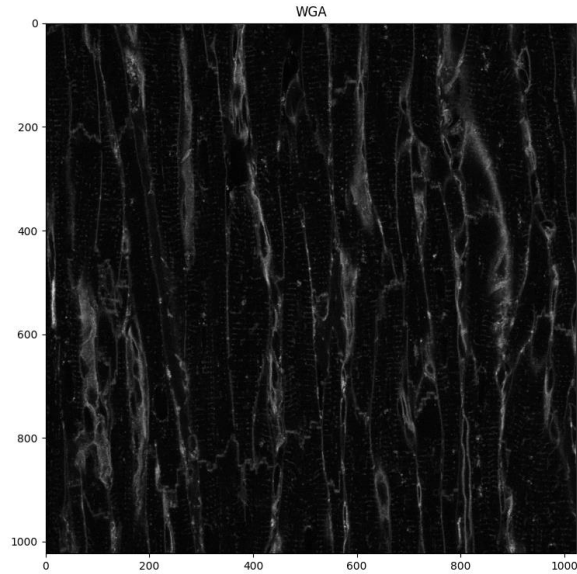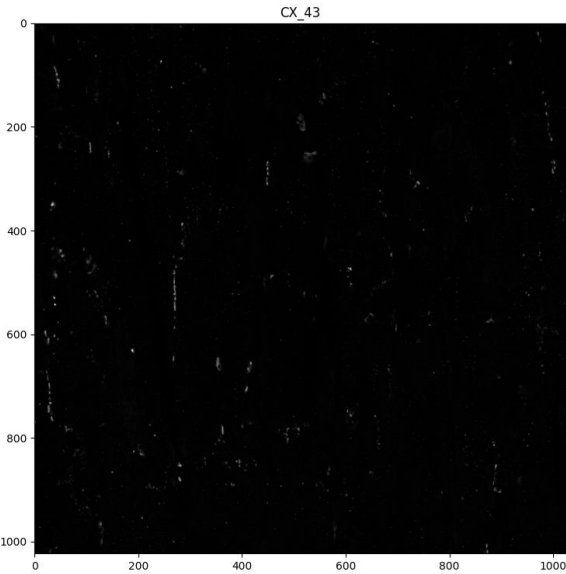## Deep learning technique for the instance segmentation of cardiomyocytes
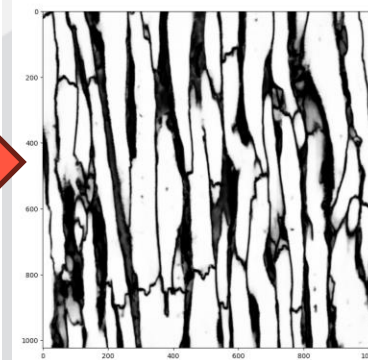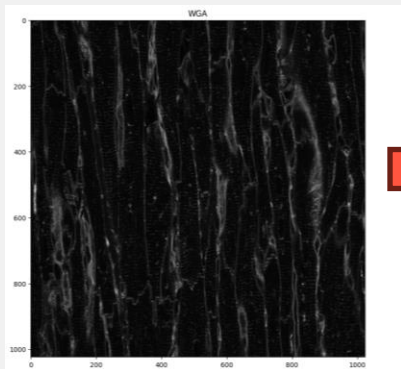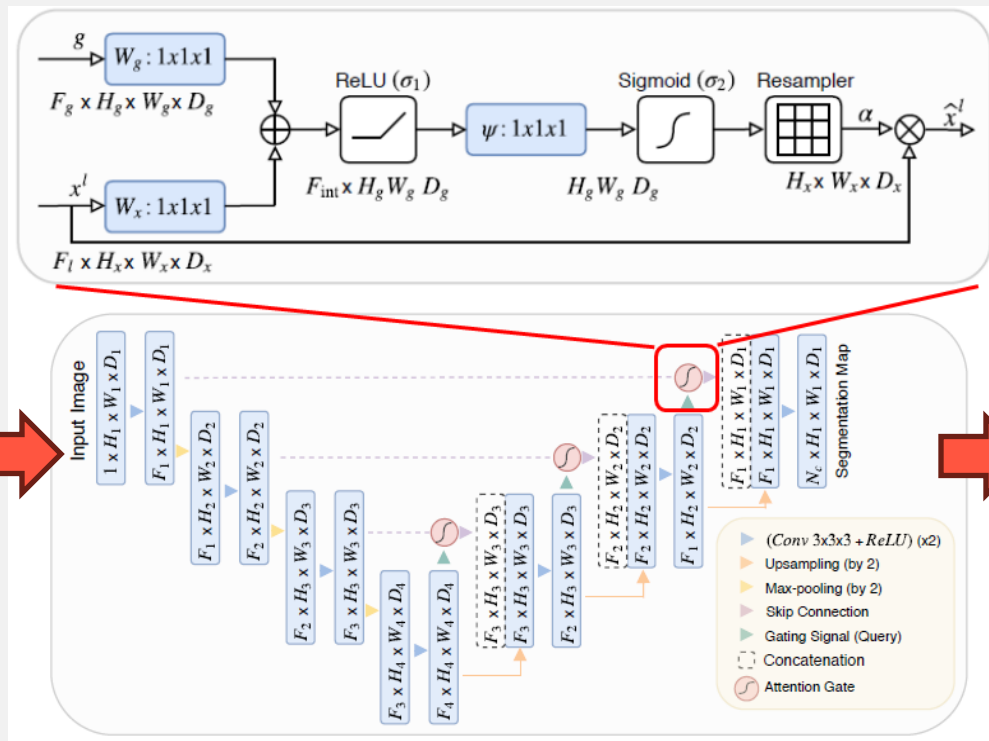
Dataset

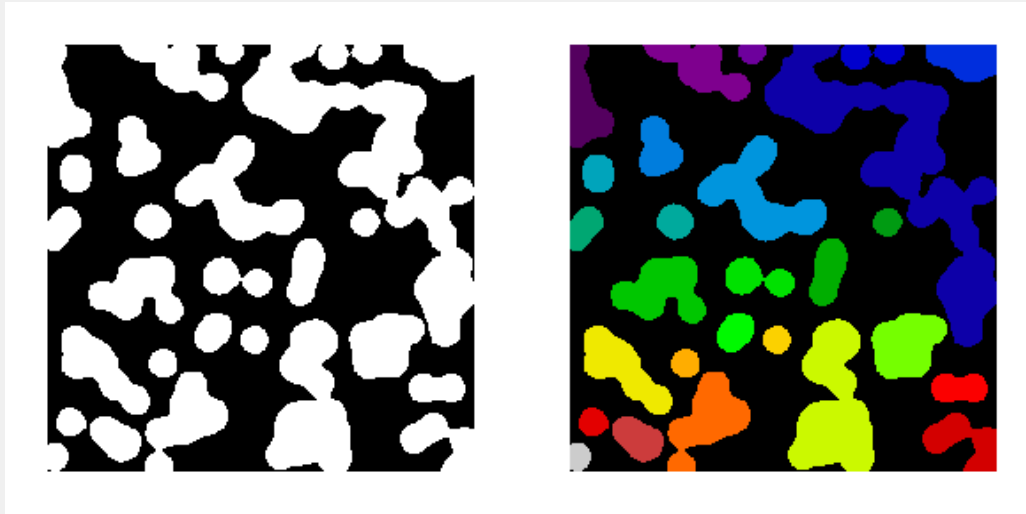- Two useful channels: CX43 (gap junction) and WGA (cell membrane)

Instance segmentation strategy

Attention UNET for semantic segmentation of cardiac cells

Instance segmentation strategy

- Analysis of connected component for instance segmentation.

- Focus on cells boundaries prediction and cells connectivity;

![ORÒBIX LIFE]

Loss function

Centerline dice (ClDice) loss

- Extract skeleton of the extracellular space from inverted mask and prediction;

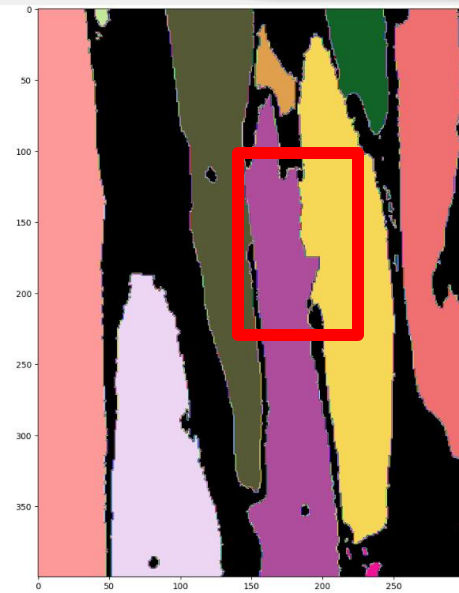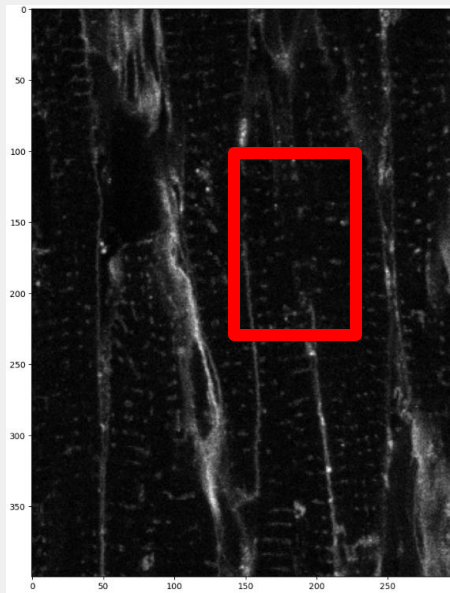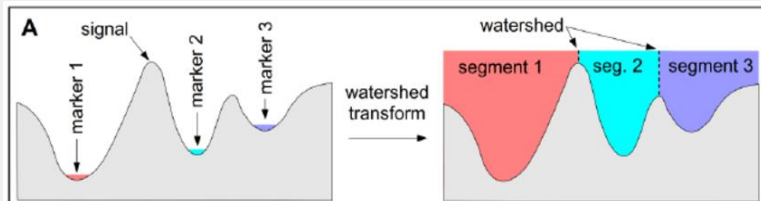- Intersection between skeleton of prediction and GT mask and vice versa

$$\text{Tprec}(S_P, V_L) = \frac{|S_P \cap V_L|}{|S_P|}; \quad \text{Tsens}(S_L, V_P) = \frac{|S_L \cap V_P|}{|S_L|}$$
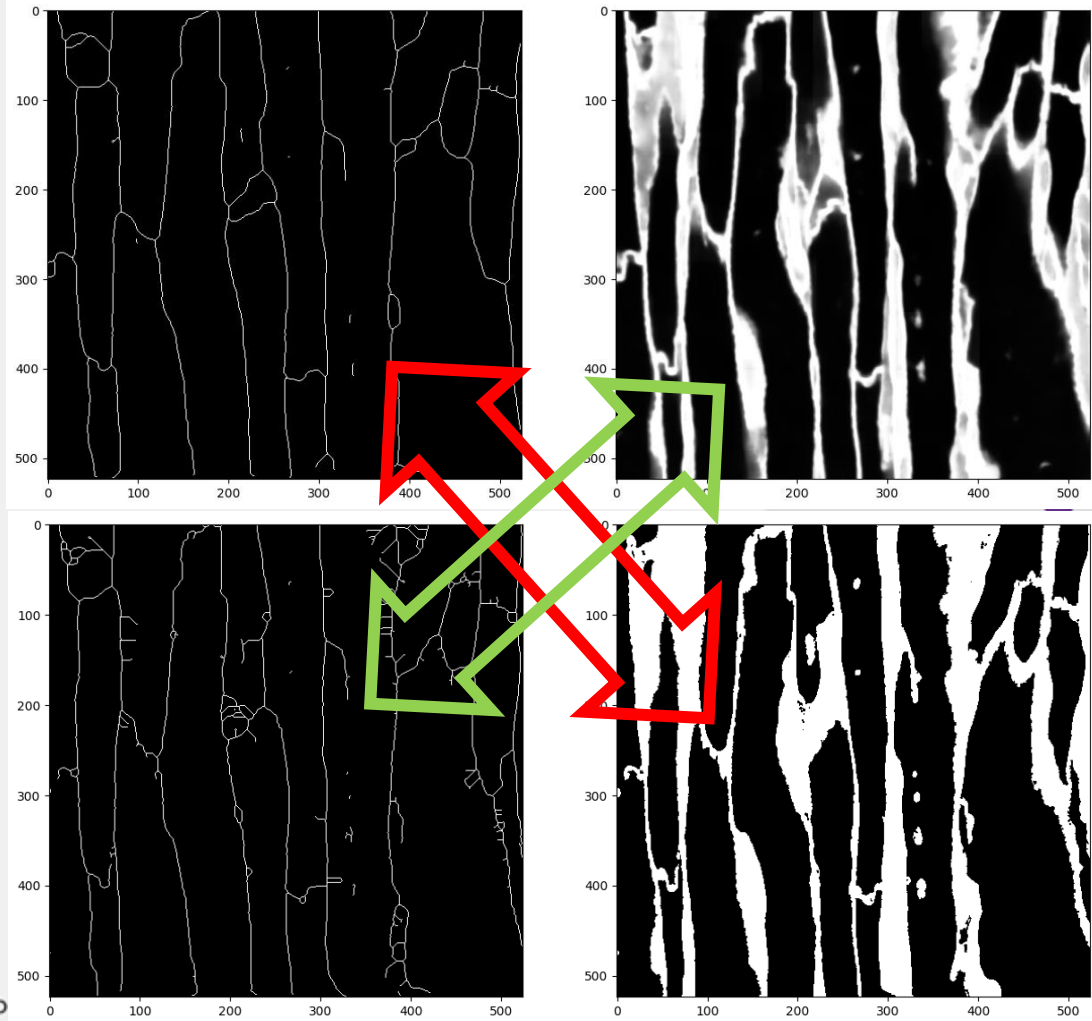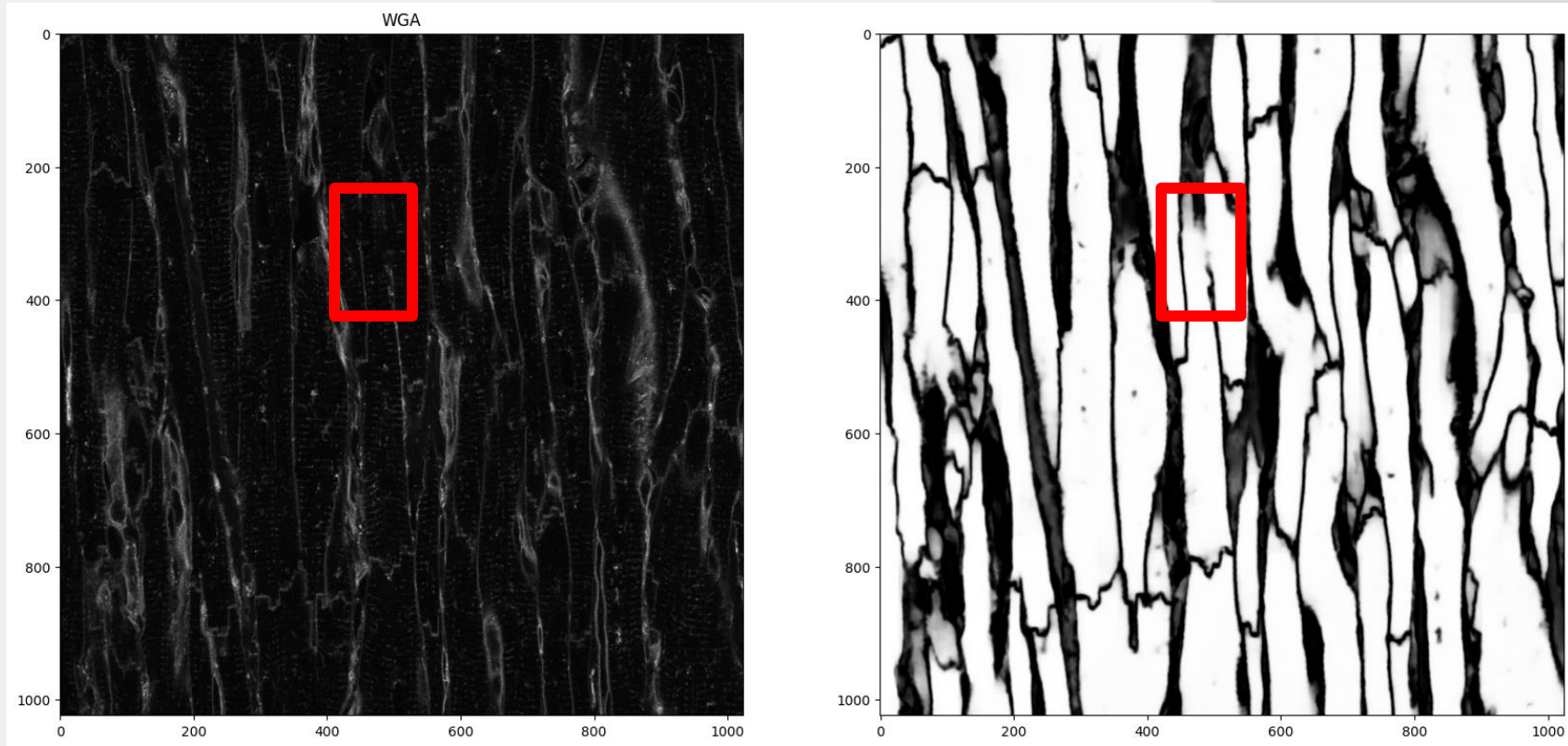
Instance segmentation strategy

Post processing

- Unclear border from WGA channel;

- Morphological operator for cell splitting;

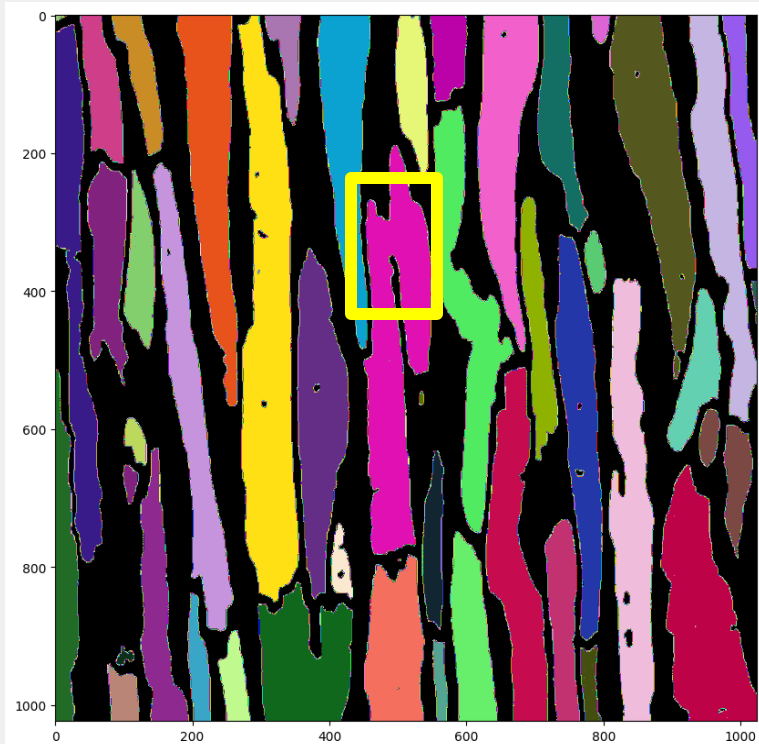- Watershed algorithm for retrieving the original segmentation.
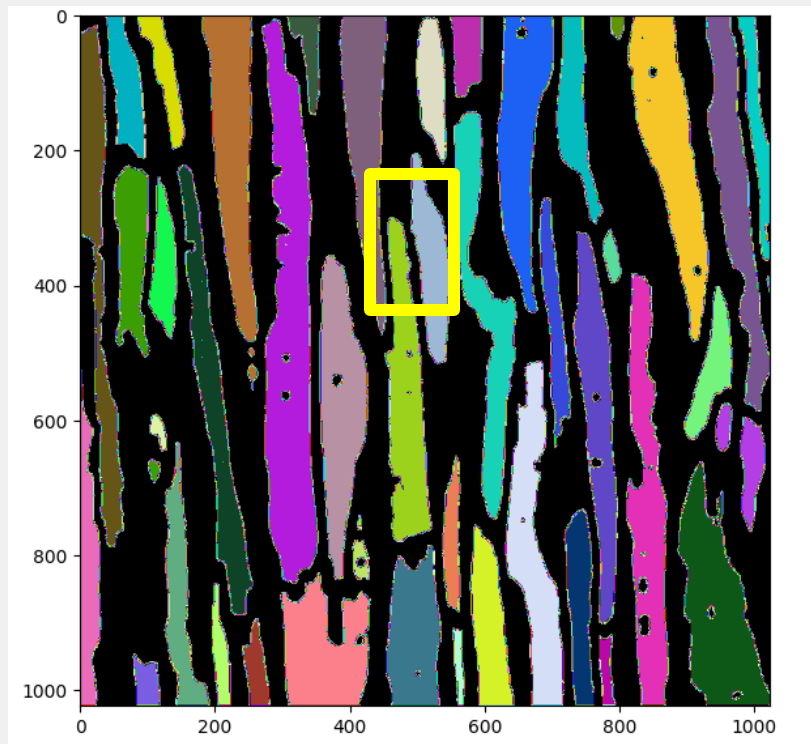
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Results – Segmentation prediction

WGA

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Results – Morphological filter

Connected components on binarized image

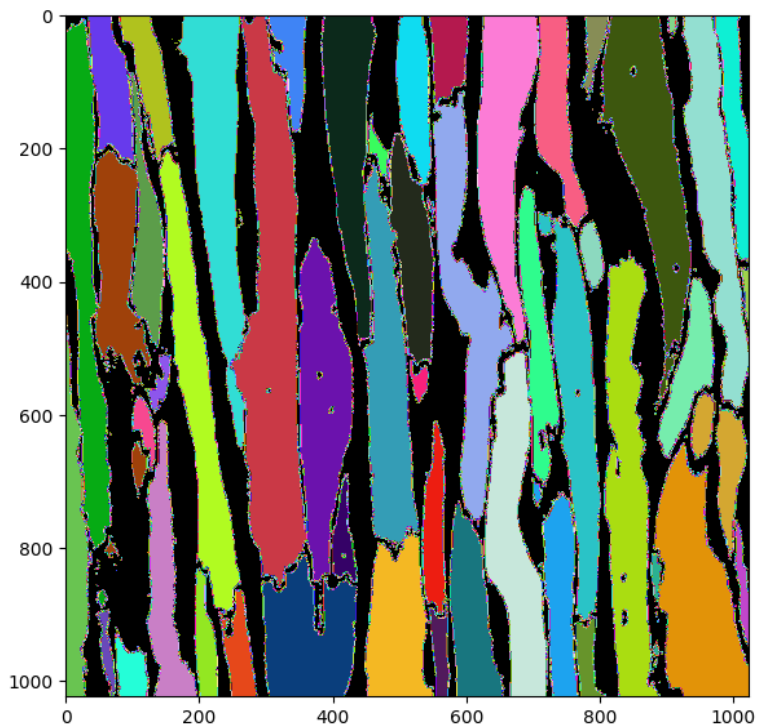After morphological operator

www.orobix.com
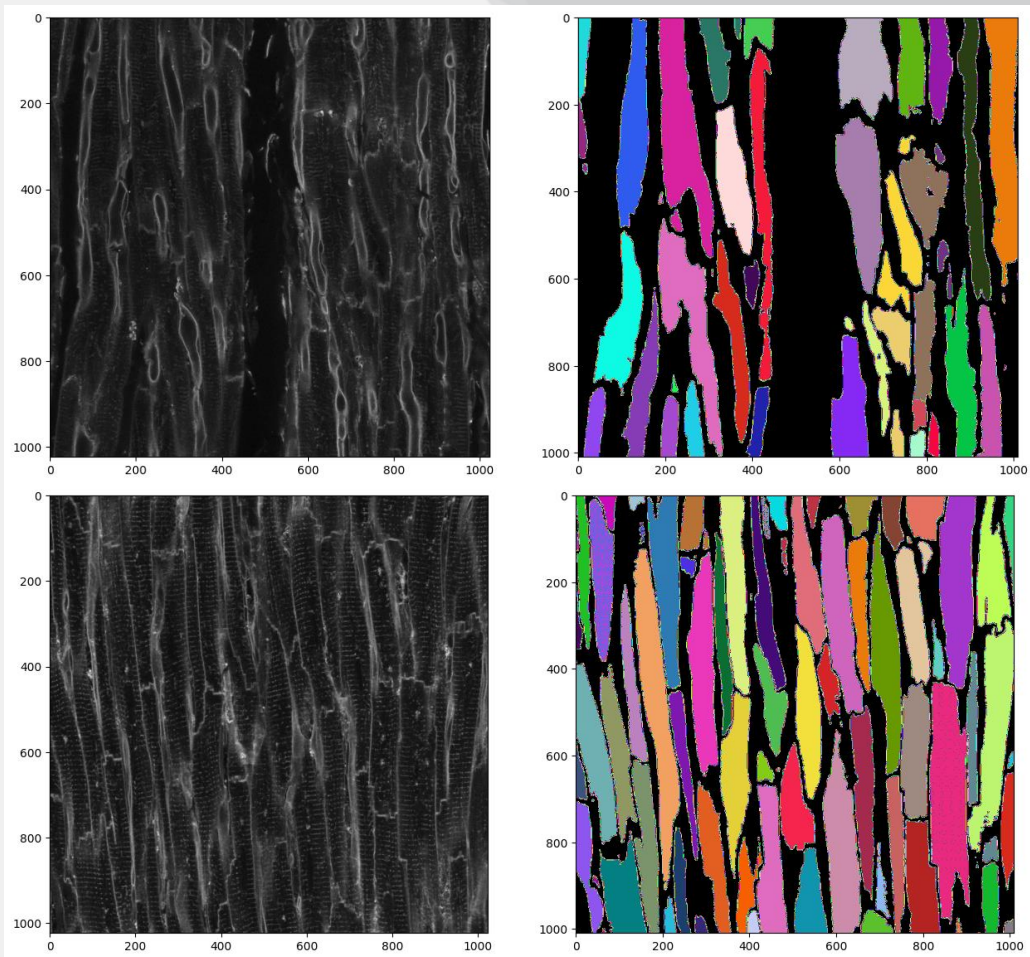
Results - Watershed

Prediction

GT

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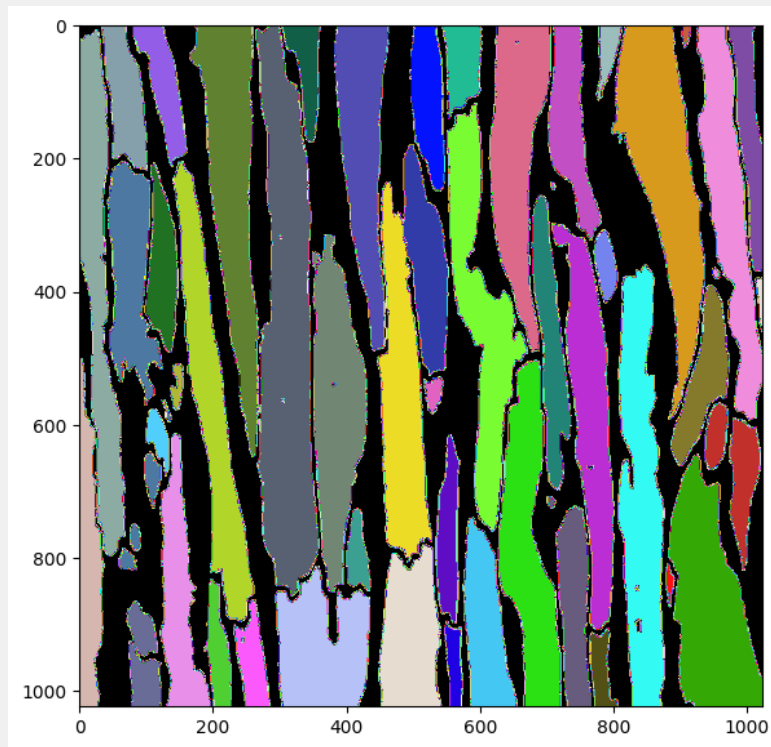
Results

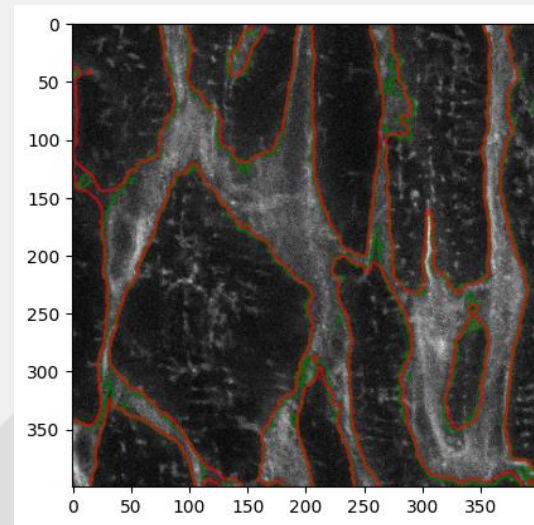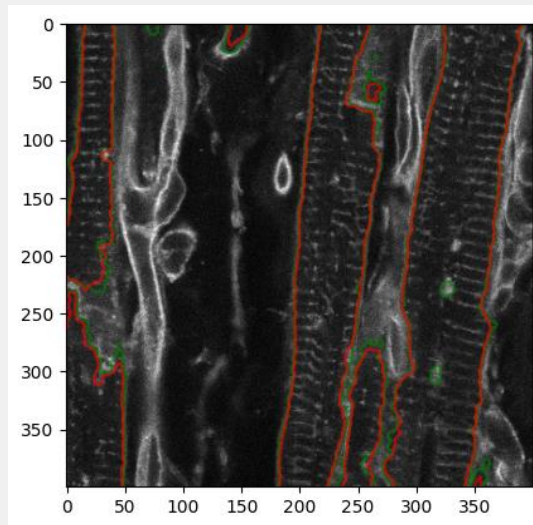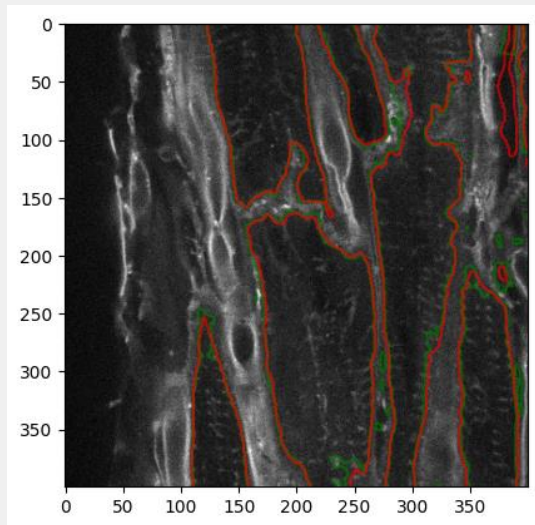- Good detection and segmentation for healthy (bottom) and unhealthy (top) samples;

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Results - metrics

ID	Val/test split	Total cells volume (%)	TP	Recall	Precision	Dice score
171101_1_s3	Val	44.77%	71	94.67%	94.67%	93.14%
170817_1_s3	Val	52.15%	85	93.41%	92.40%	95.81%
170811_1_s3	Val	68.92%	86	92.47%	93.47%	96.14%
170626_1	Val	68.87%	216	97.29%	95.15%	96.29%
170104_1	Test	70.31 %	150	97.40%	95.54%	91.41%
170105_1	Test	66.46 %	110	98.21%	94.83%	95.03%

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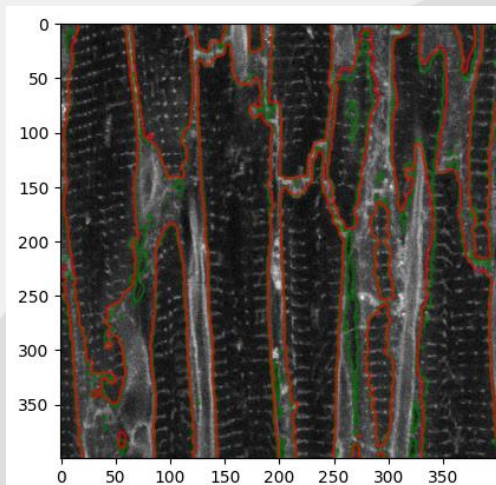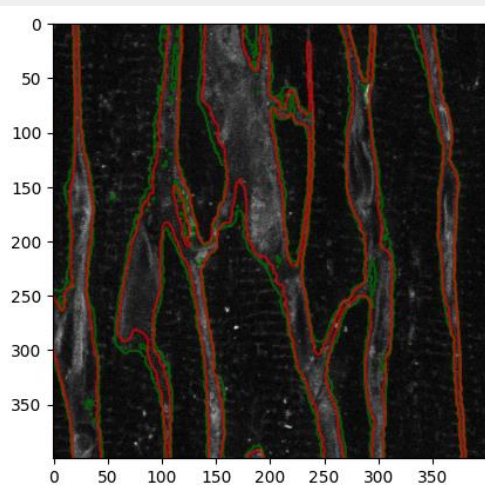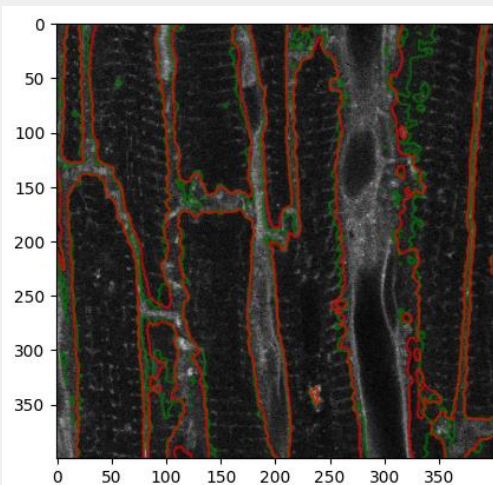
Results - semantic segmentation

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Detection problems

Prediction

GT

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Detection problems

Prediction

GT

14

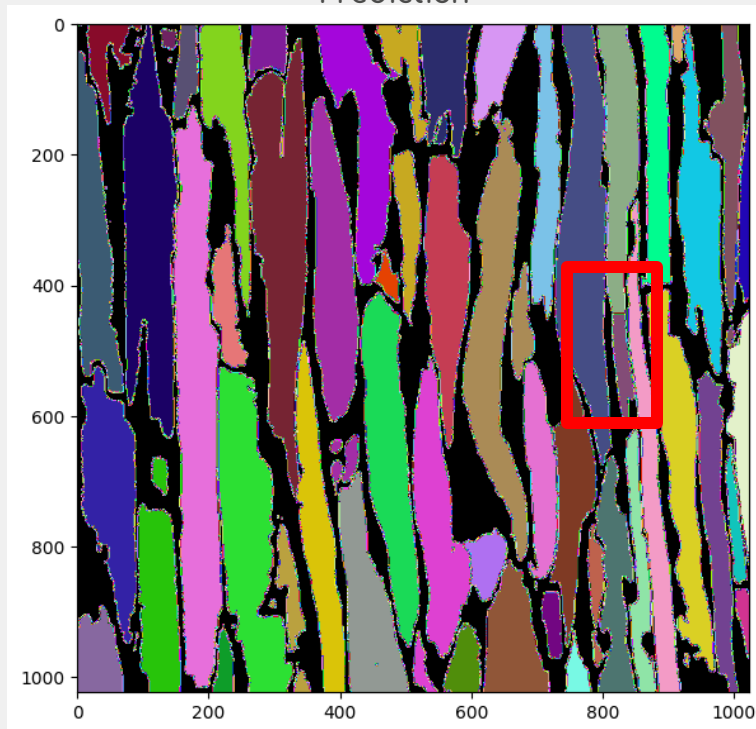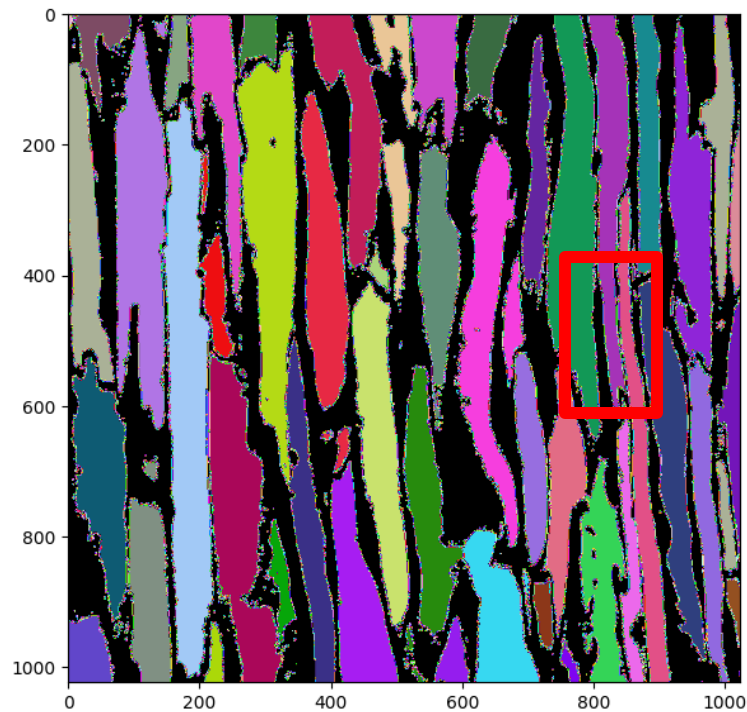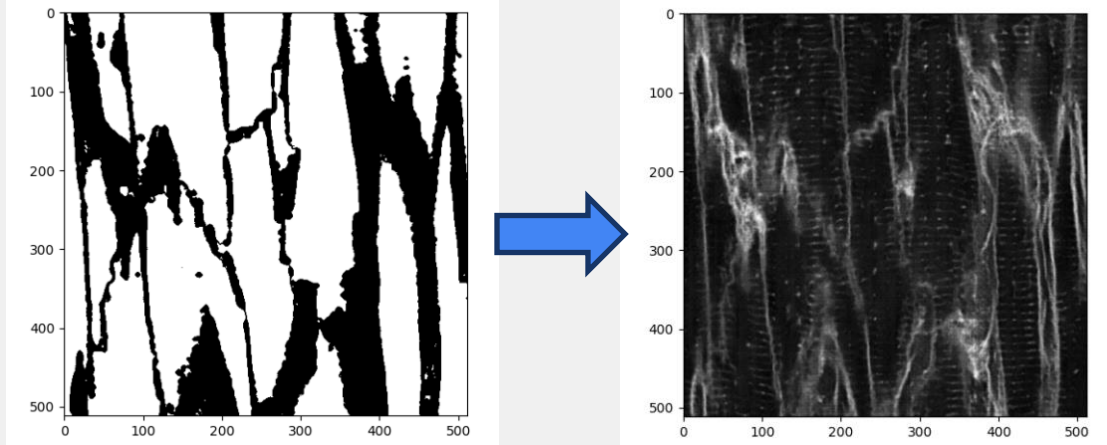www.orobix.com
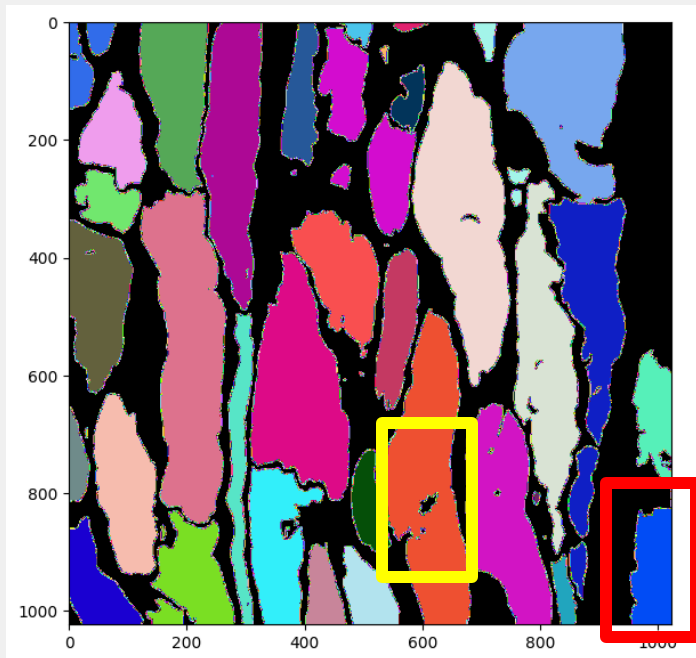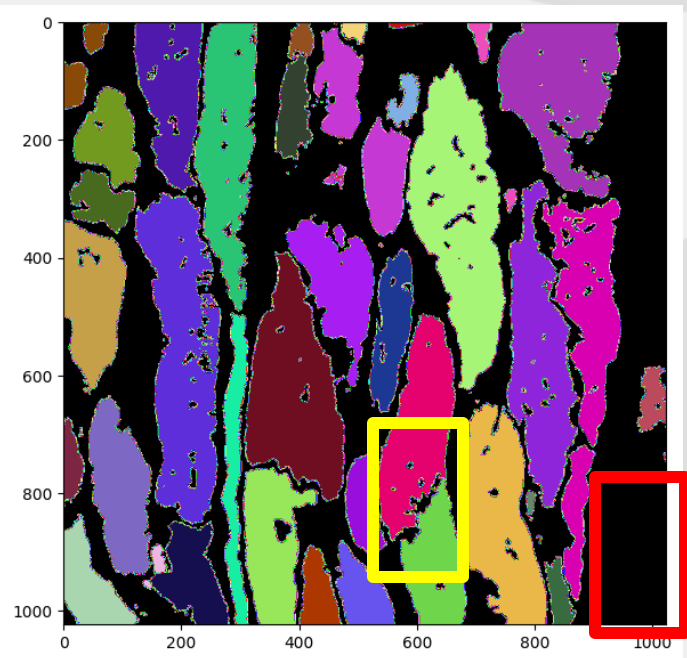
Next step

- Different Neural Network for semantic segmentation;

- Generate synthetic data to improve results in more complex samples.

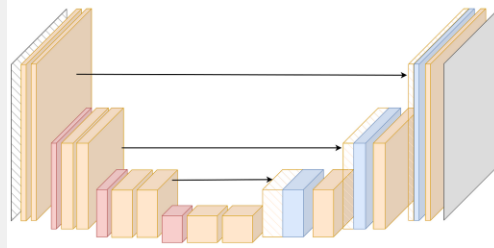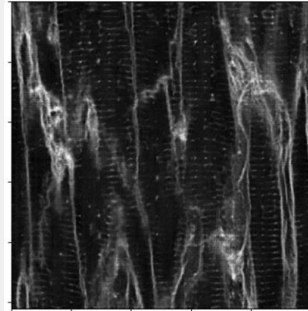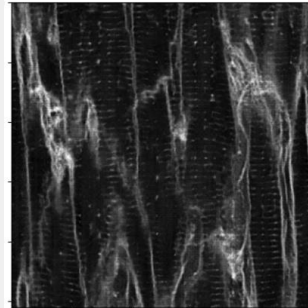www.orobix.com

Pix2Pix – Image to image translation
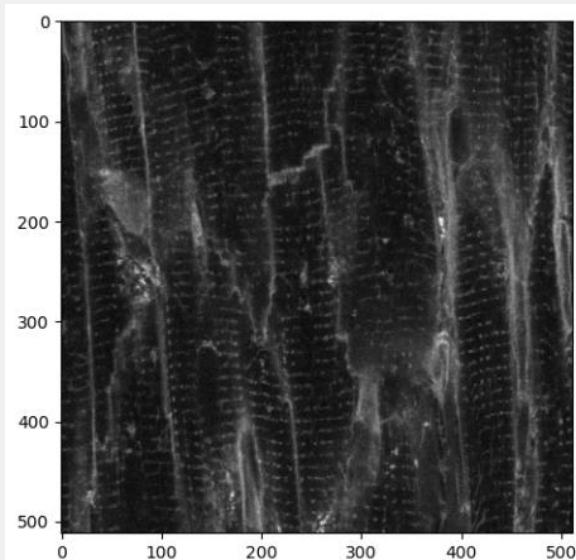

Binary mask

Generator

Fake generated image

Discriminator
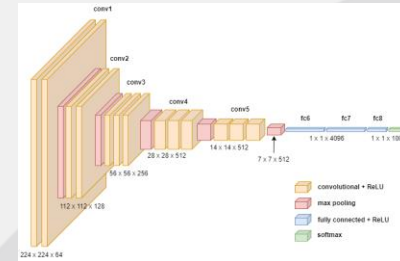
Real image
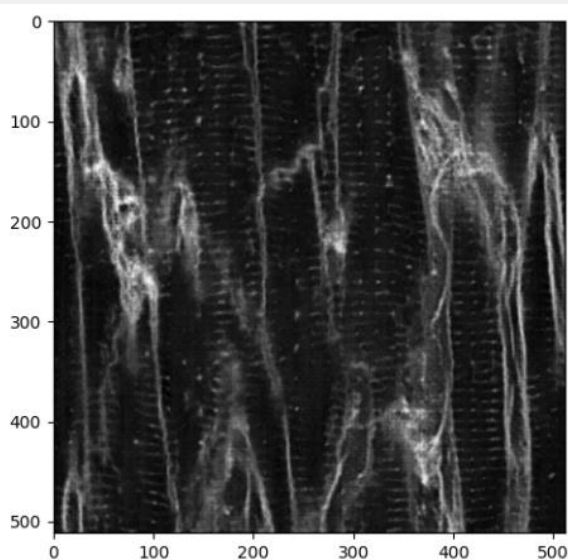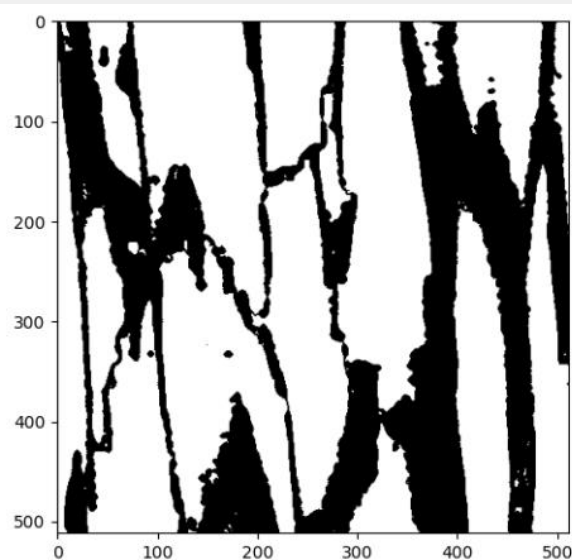
Real or fake?

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Pix2Pix – Image to Image translation

Real   Generated   GT mask

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Pix2Pix – Image to Image translation

Real
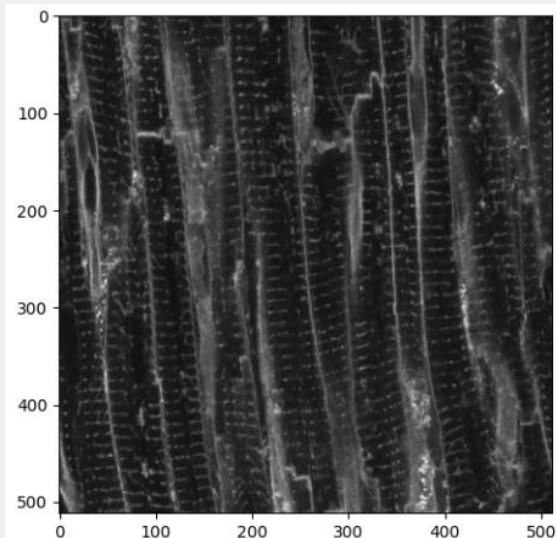
Generated

GT mask

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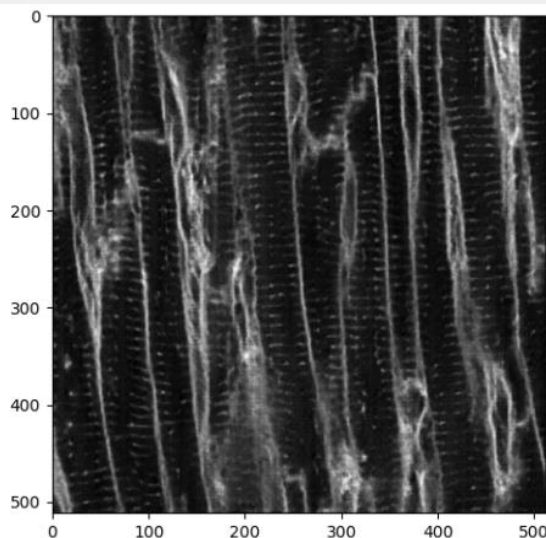# Pix2Pix – Image to Image translation

Real   Generated   GT mask
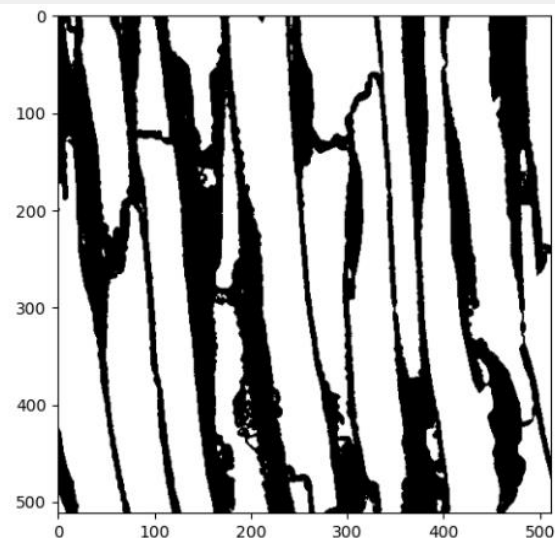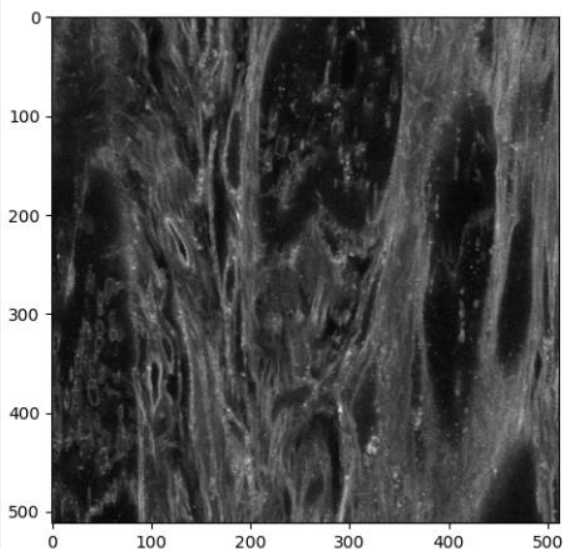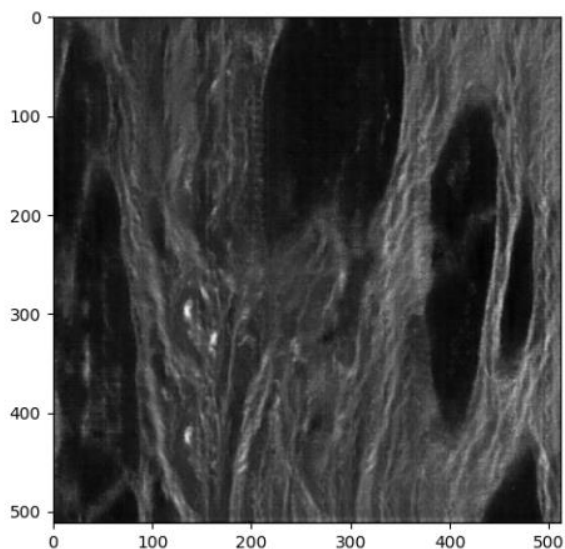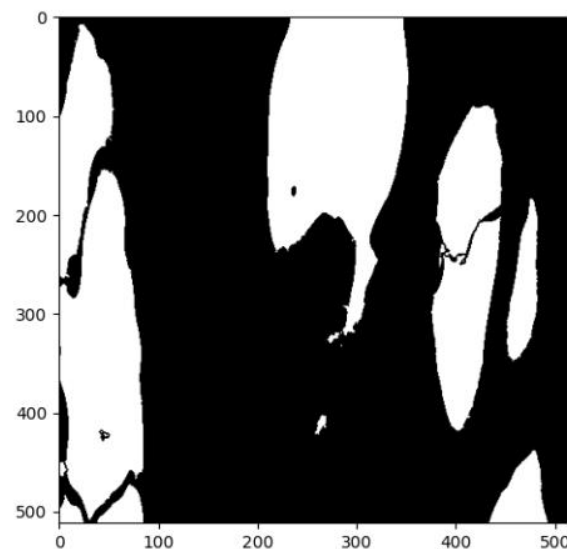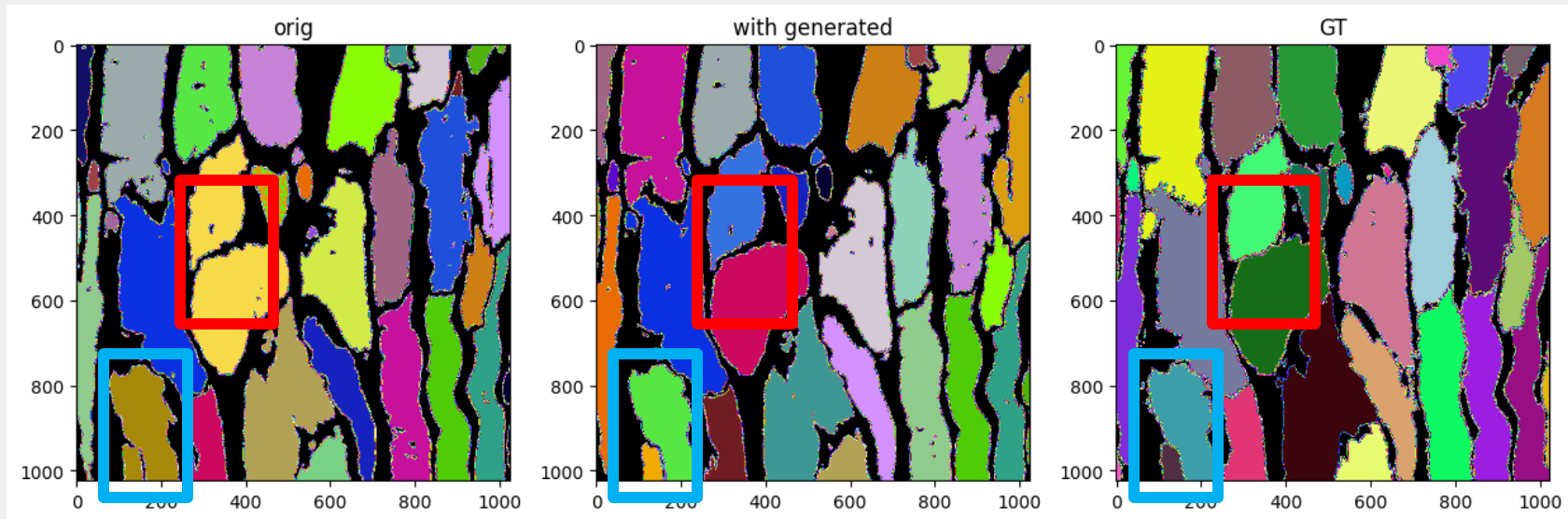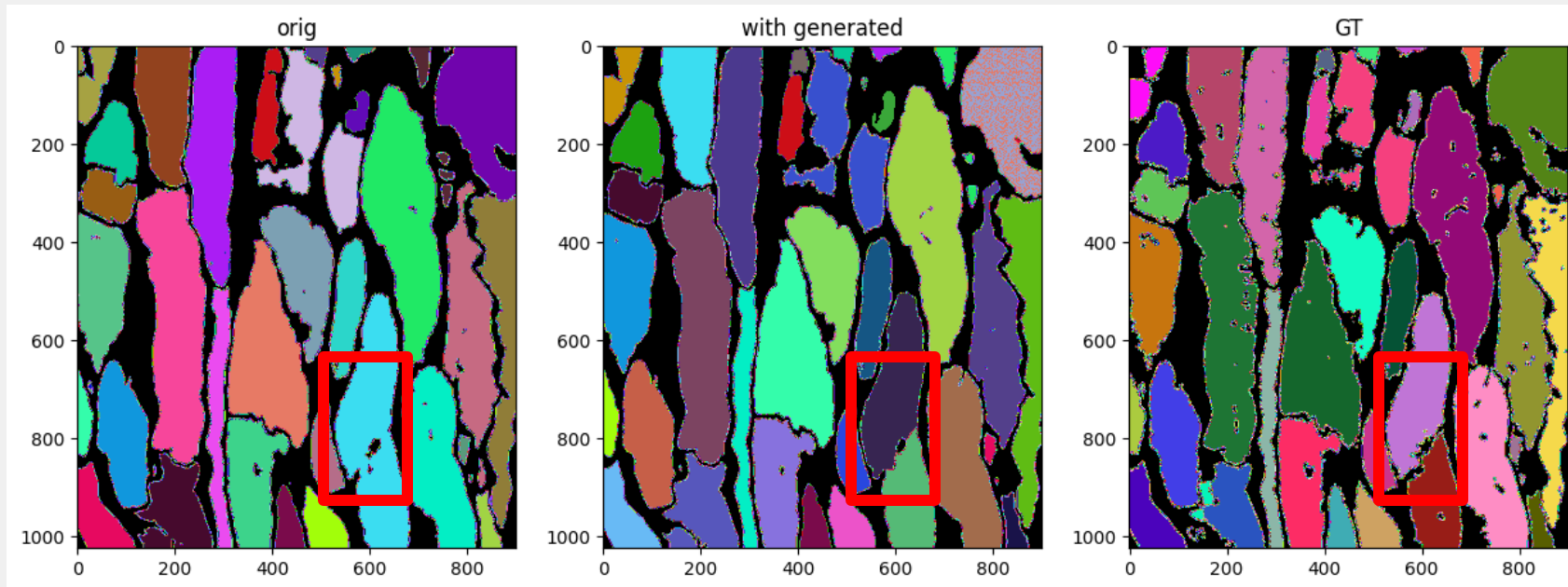
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Pix2Pix – Image to Image translation

ID	Recall with generated data	Precision with generated data	Recall	Precision	Delta recall	Delta precision
170626_1	98.67%	97.80%	95.15%	97.29%	3.52%	0.51%
170811_1_s3	93.55%	96.67%	93.47%	92.47%	0.08%	4.20%
170105_1	94.21%	97.44%	95.54%	97.40%	-1.33%	0.04%
171101_1_s3	94.59%	94.59%	94.67%	94.67%	-0.08%	-0.08%
170817_1_s3	94.57%	94.57%	92.40%	93.41%	2.17%	1.16%
170104_1	95.36%	96.64%	95.54%	97.40%	-0.18%	-0.76%

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Results with generated data

orig | with generated | GT

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Results with generated data
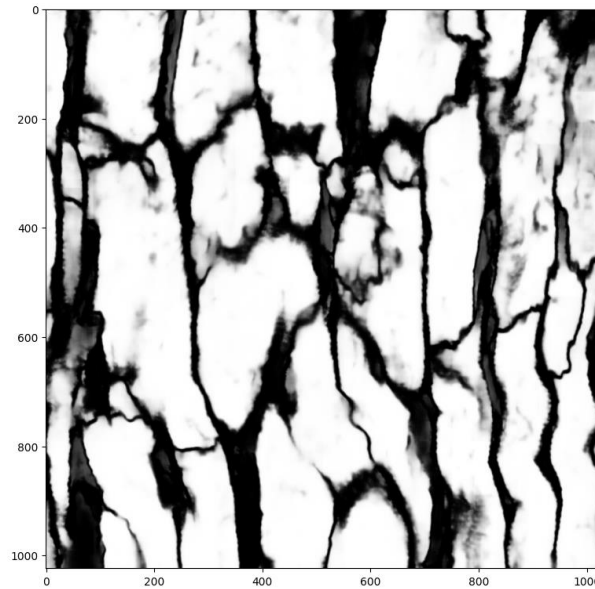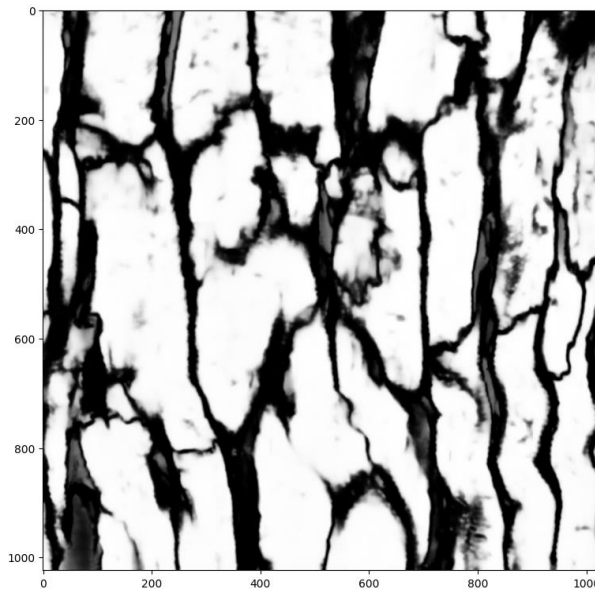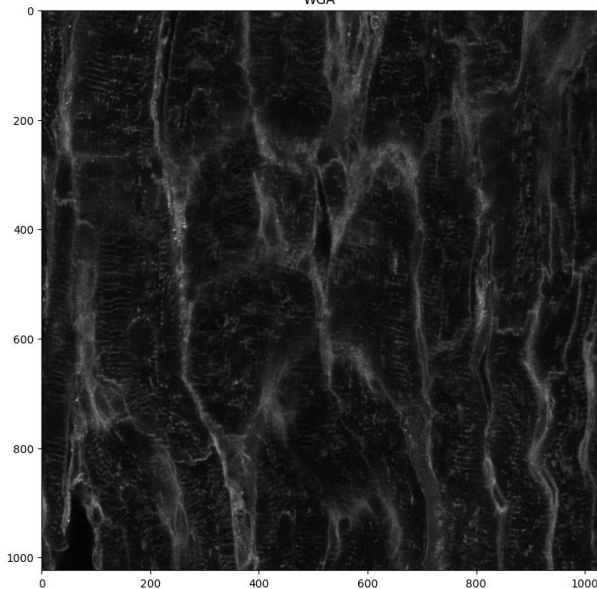

orig   with generated   GT

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Results with generated data

Output with real data

Output with synthetic

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THANK YOU

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