

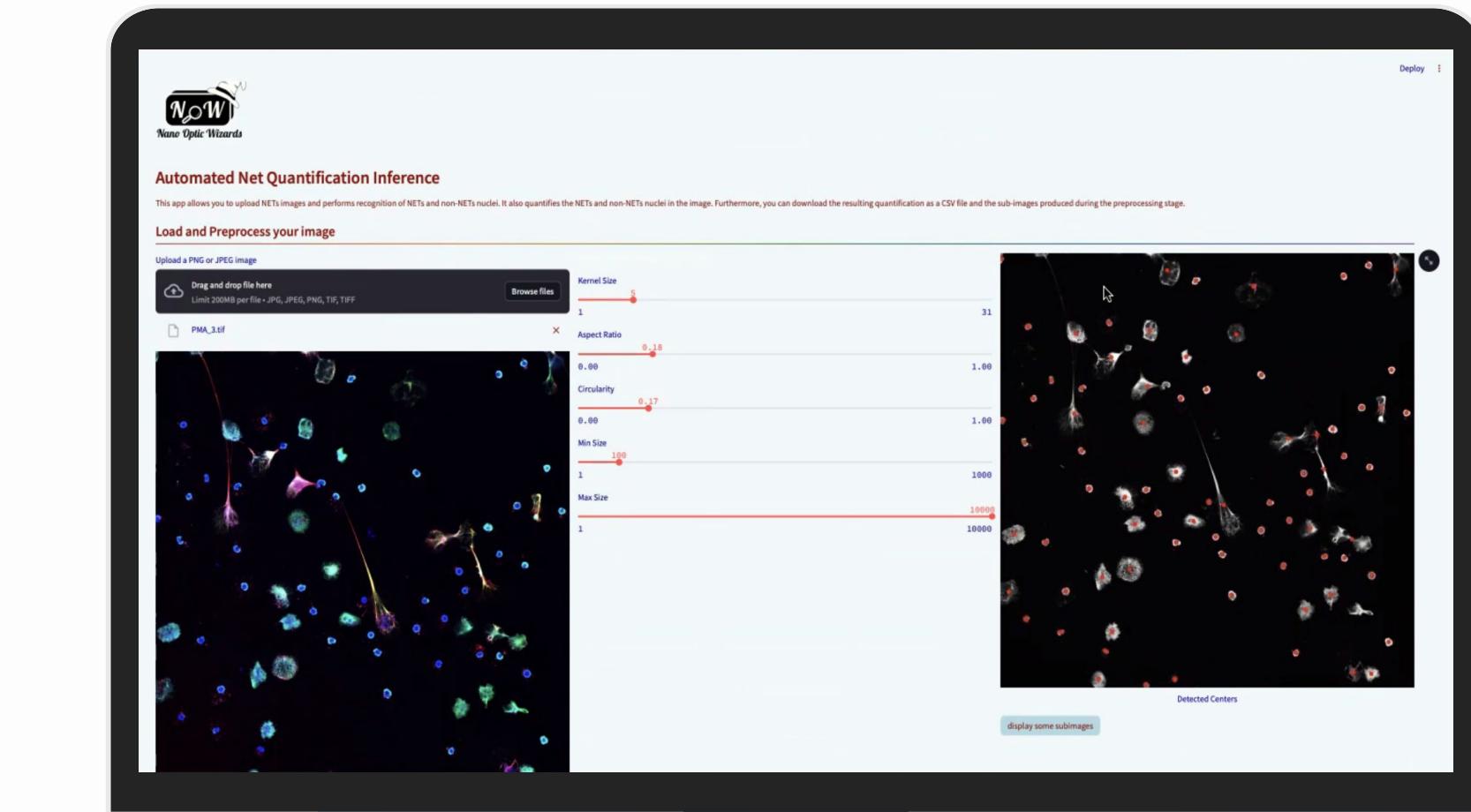


Nano Optic Wizards

Automated NET Recognition & Quantification

Date: 20/06/2024

 neue fische
School and Pool for Digital Talent



Overview

- Our Team
- Introduction
- Project Goal and Objectives
- Our Strategy
- Results and Discussion
- Meet our App
- Outlook





Nano Optic Wizards



Dipali Kale

Ph.D Chemistry



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Energy Engineer and
Data Scientist



Niharika Garg

Ph.D
Natural Sciences



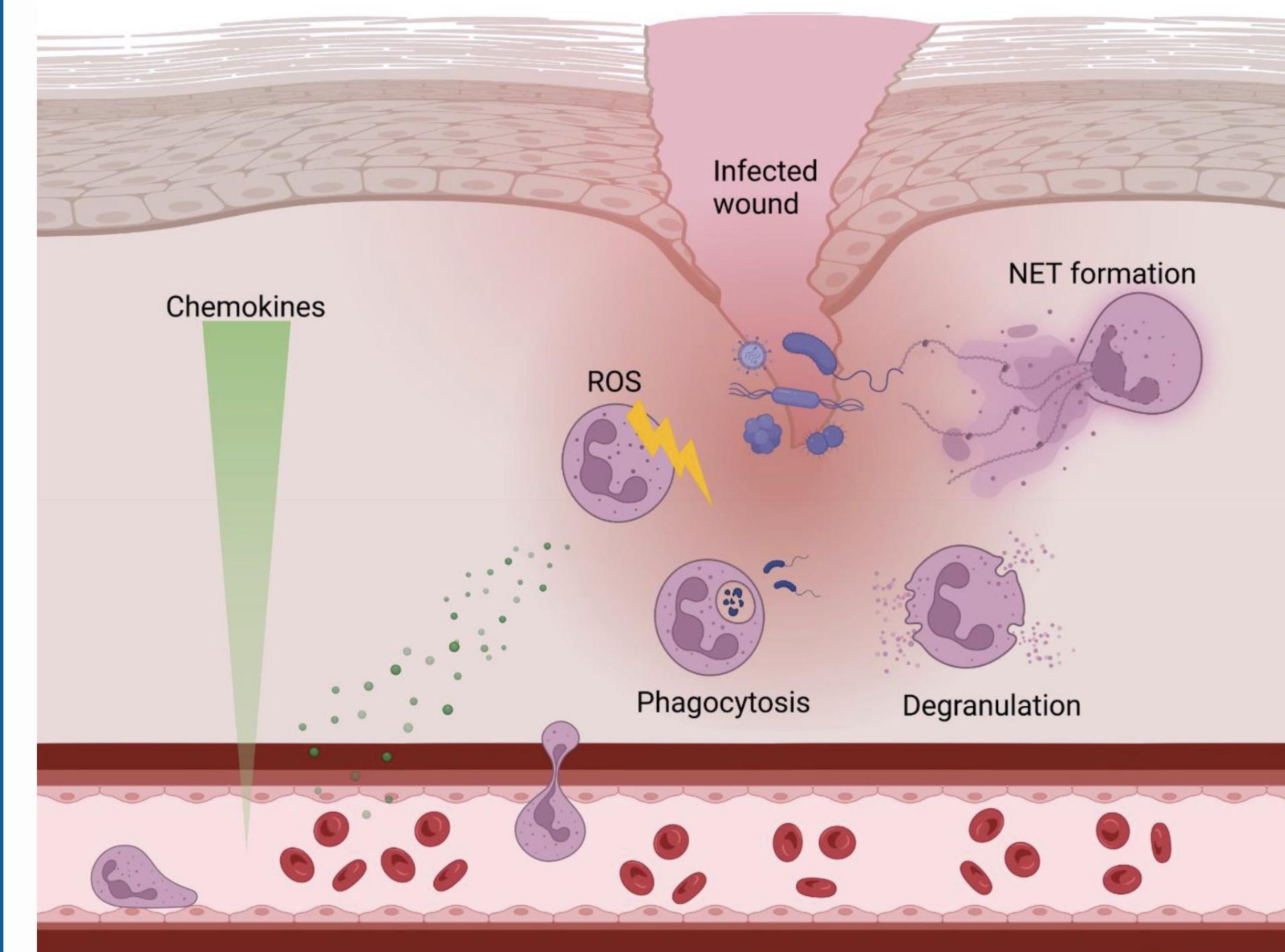
Dominik van Bodegraven

Ph.D
Biology/ Virology

Introduction

Neutrophil Extracellular Traps (NETs)

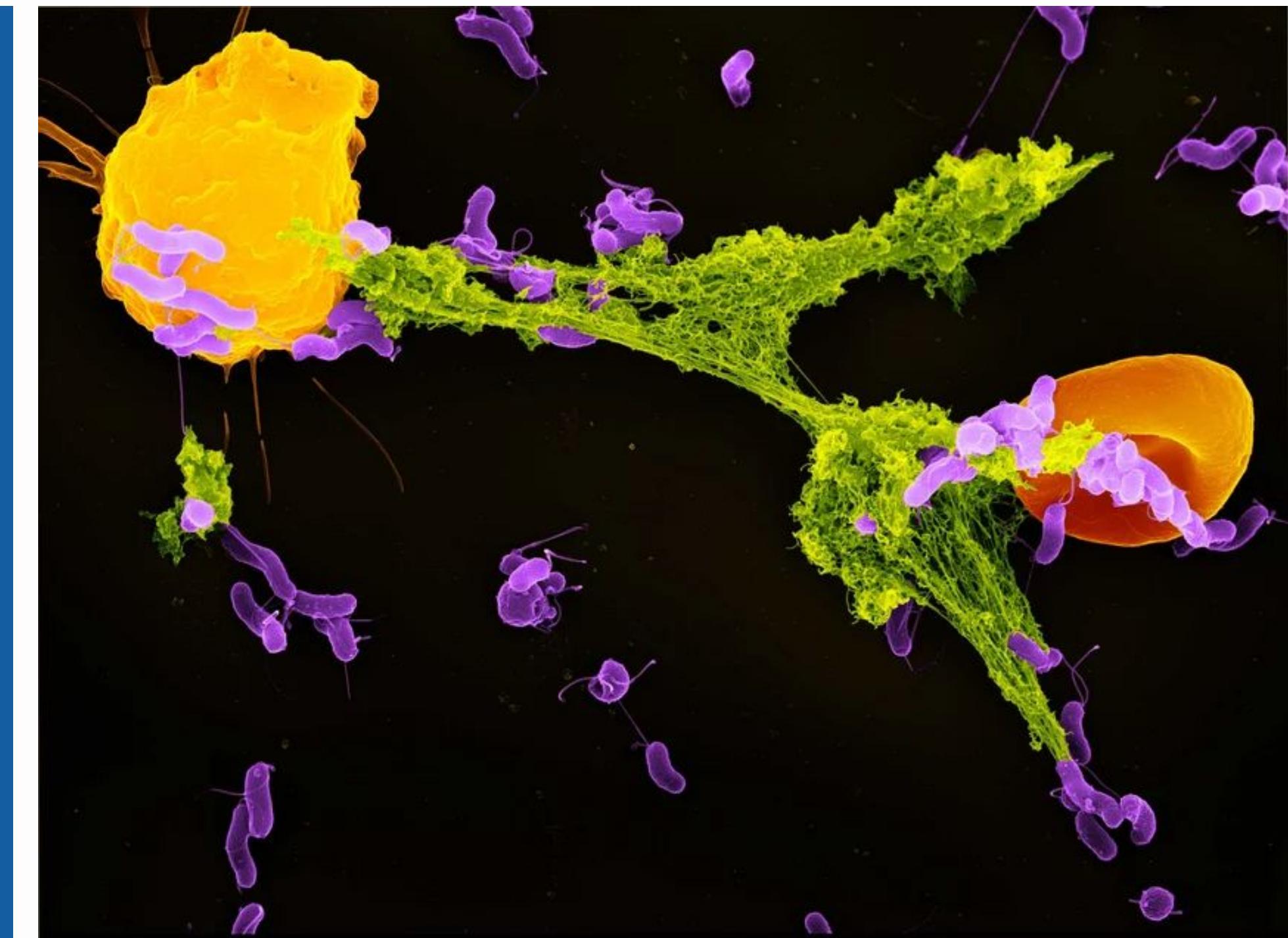
- Part of the innate immune response
- Neutrophils perform programmed cell death (NETosis)
- NET: DNA backbone + (antimicrobial) proteins



Introduction

Neutrophil Extracellular Traps (NETs)

- Part of the innate immune response
- Neutrophils perform programmed cell death (NETosis)
- NET: DNA backbone + (antimicrobial) proteins

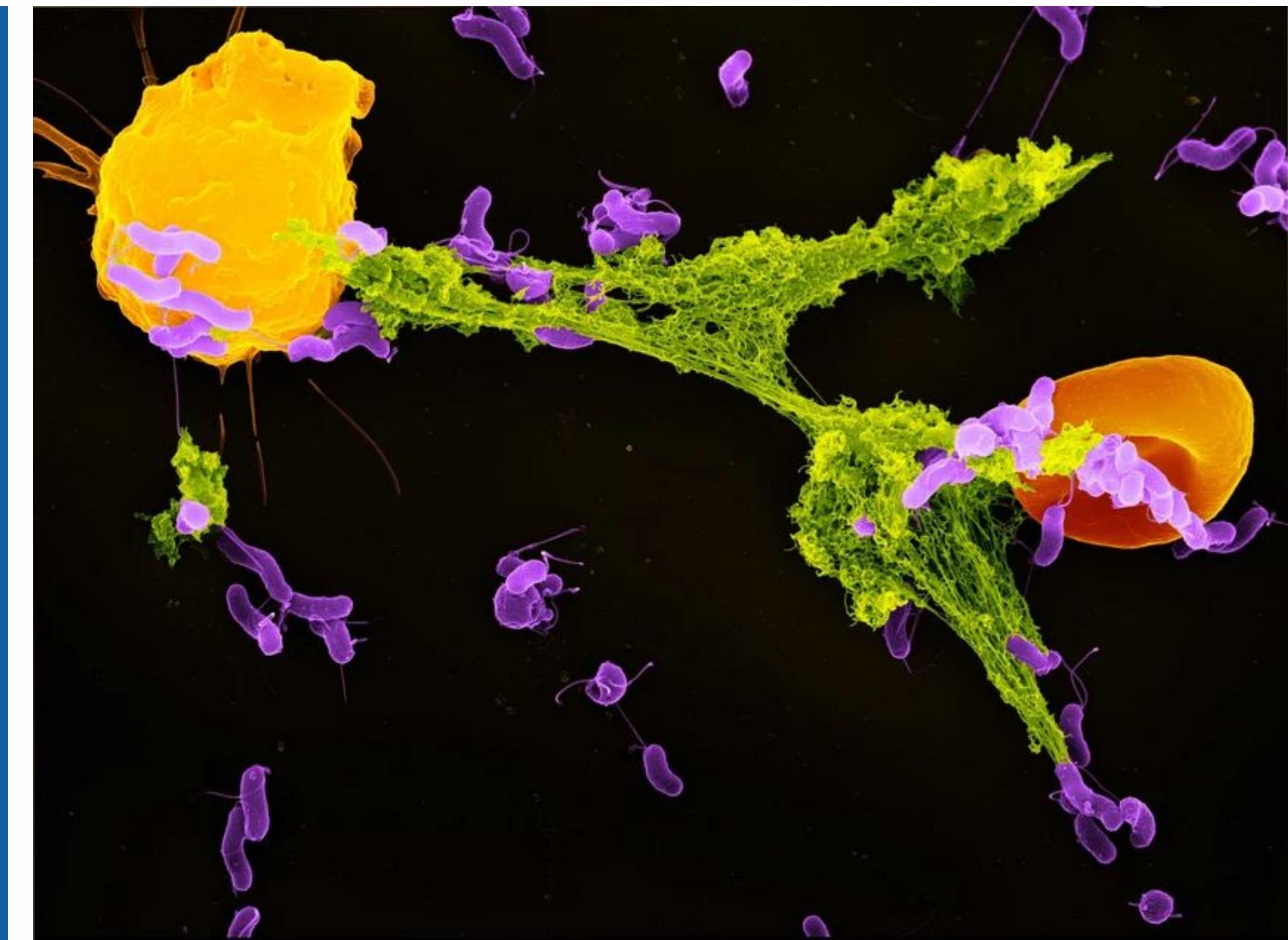


Introduction

Neutrophil Extracellular Traps (NETs)

- Part of the innate immune response
- Neutrophils perform programmed cell death (NETosis)
- NET: DNA backbone + (antimicrobial) proteins

- Important research target
- Provide tool for quantification



NETs in microscopic images

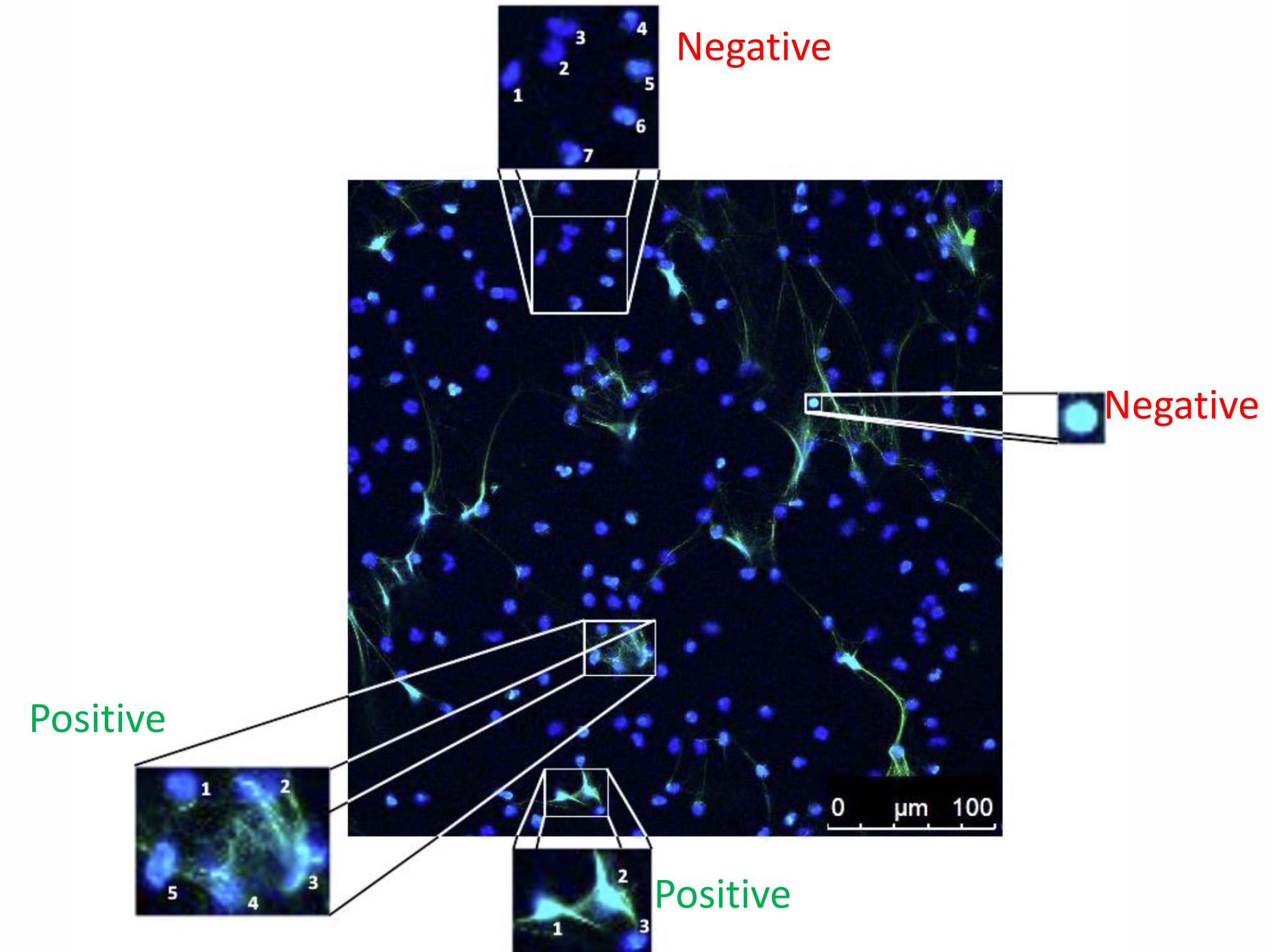
Criteria to define NETs

NET positive cell

- Off-shoot
- Enlarged, decondensed nucleus

NET negative cell

- Small blue or (green) dots



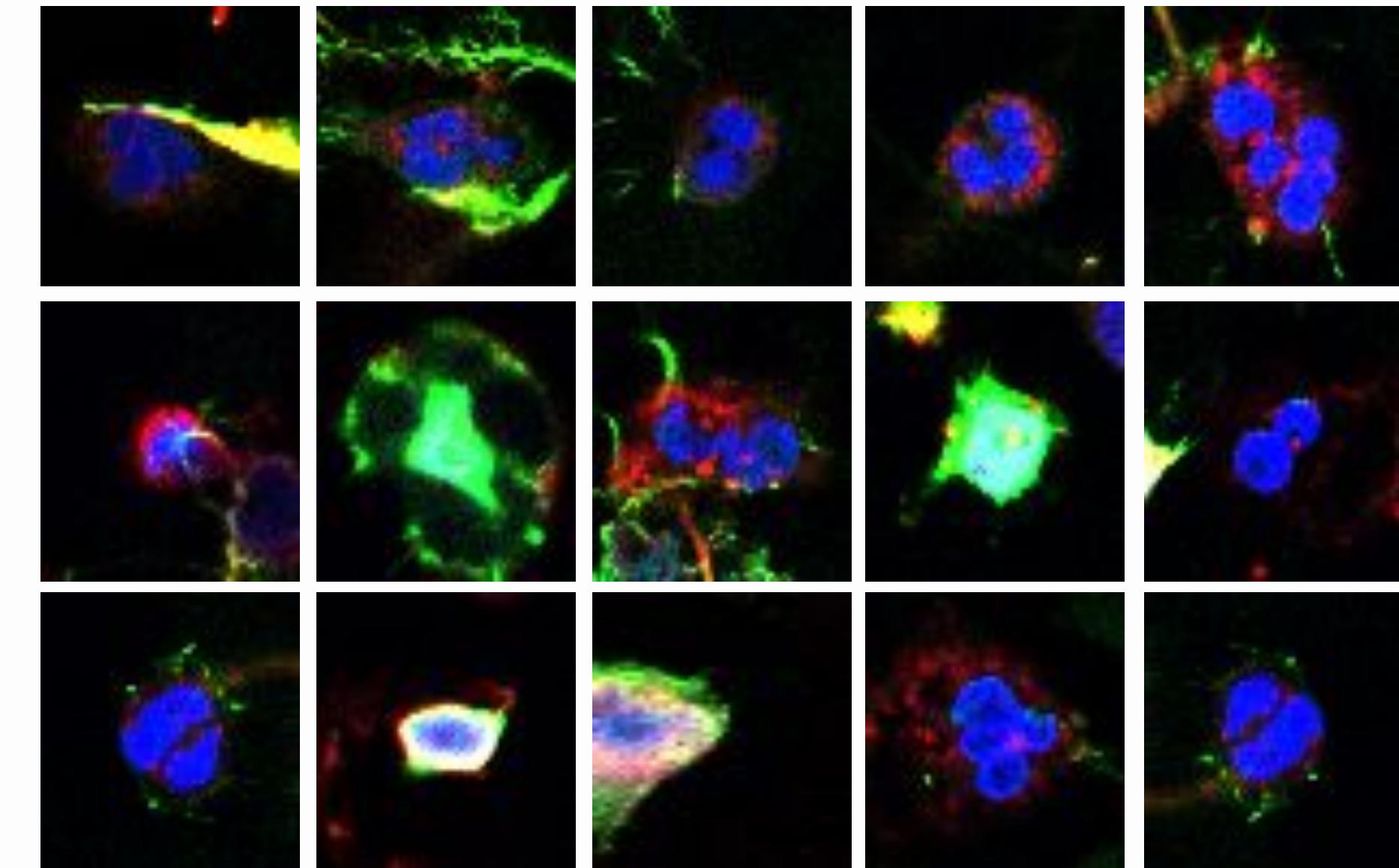
Immunofluorescence microscopy images of isolated Neutrophils stained with DAPI (blue), NET marker- DNA histones-1-complexes(green).

About the Data

Challenges with the NET detection

- Heterogeneity of the different shapes

Variety of NET positive cells

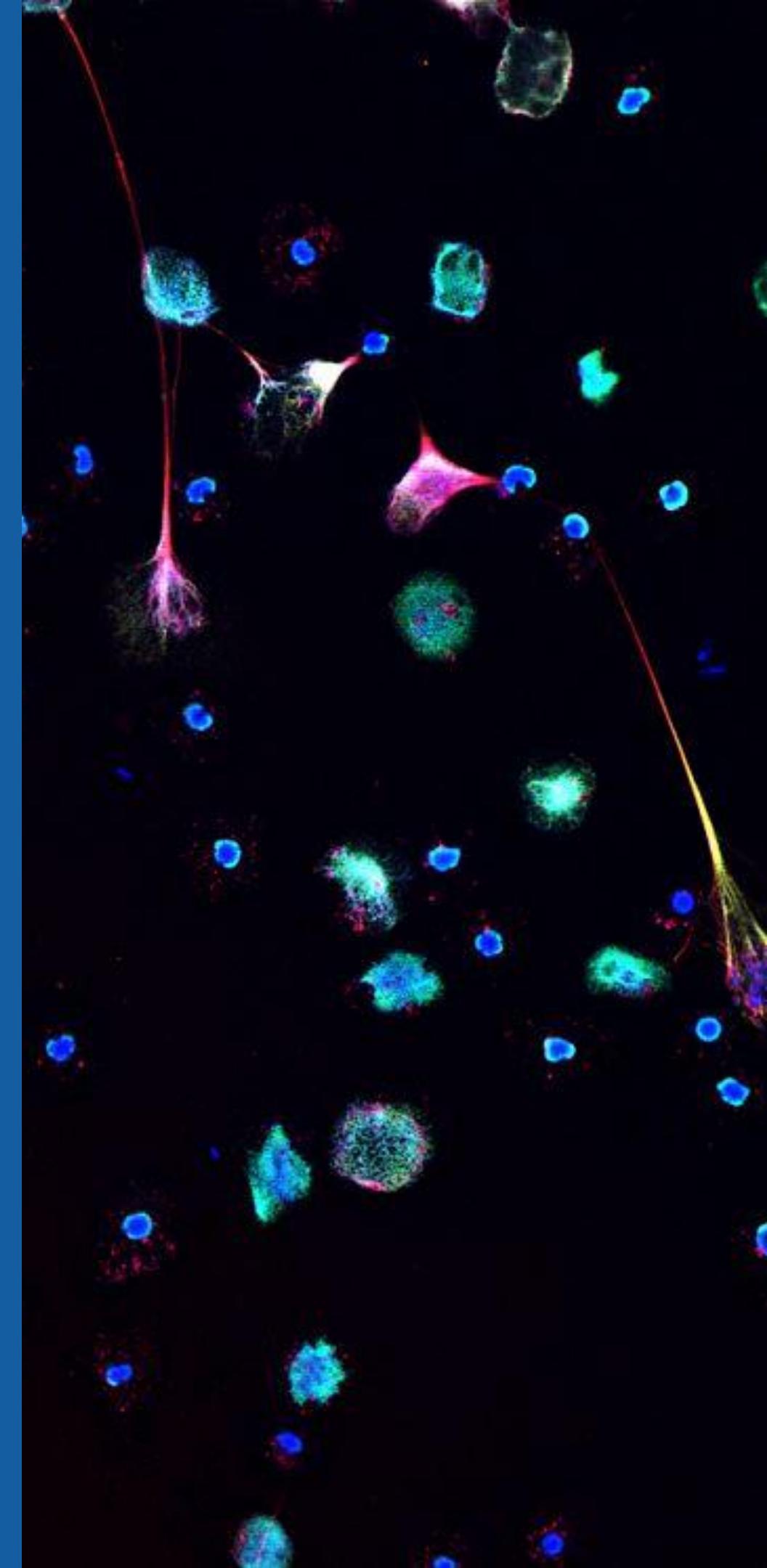


Immunofluorescence microscopy images of isolated Neutrophils stained with DAPI (blue), NET marker- DNA histones-1-complexes(green) and Myeloperoxidase (red)

Project Goal and Objective

Goal

To build machine learning tool for automated Nets segmentation and quantification

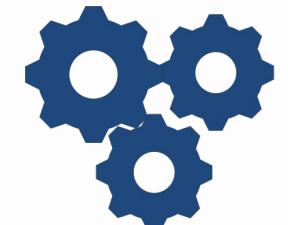


Project Goal and Objective

Goal

To build machine learning tool for automated Nets segmentation and quantification

Objective



Data Preprocessing

- Establish preprocessing pipeline for microscopy images



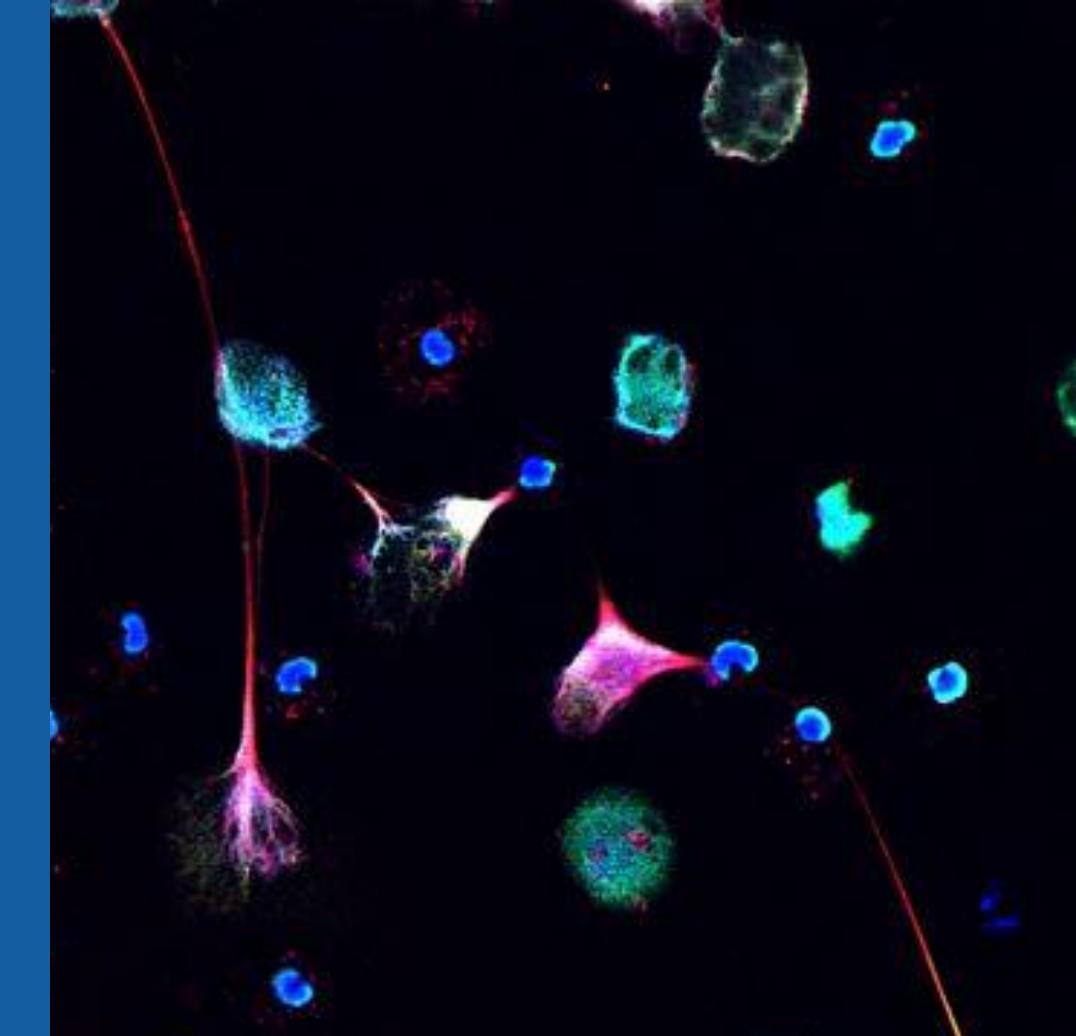
Modelling

- Train different machine learning models
- Identify the best model



Web App

- Construct an easy-to-use application for microscopical images
- Provide Counts of NETs



Trained models

→ CNN Model

Logistic Regression
Model

01

VGG16 Object Detection model

02

Detectron image segmentation
model

03

Trained models

CNN Model

→ Logistic Regression
Model

01

VGG16 Object Detection model

02

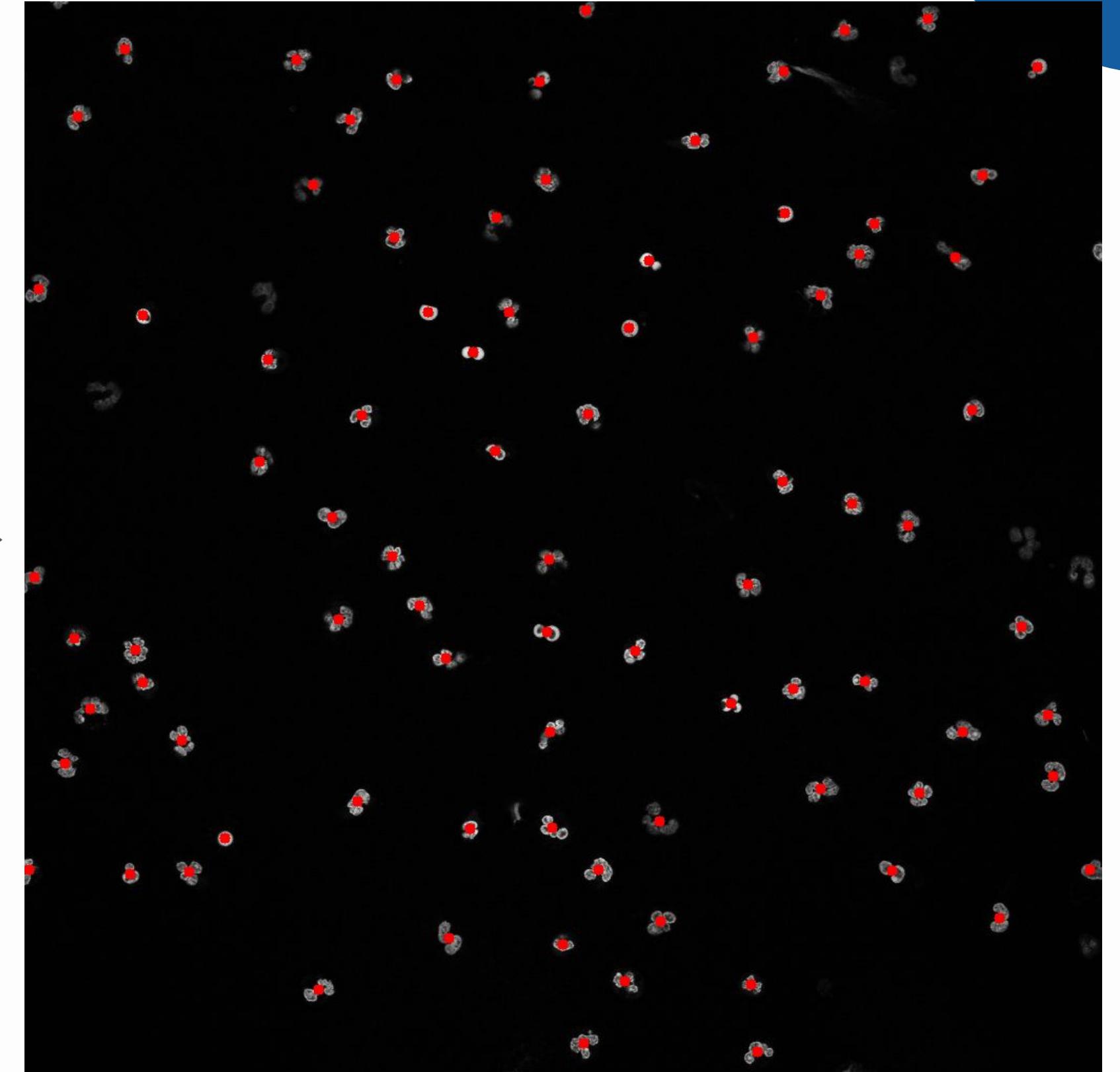
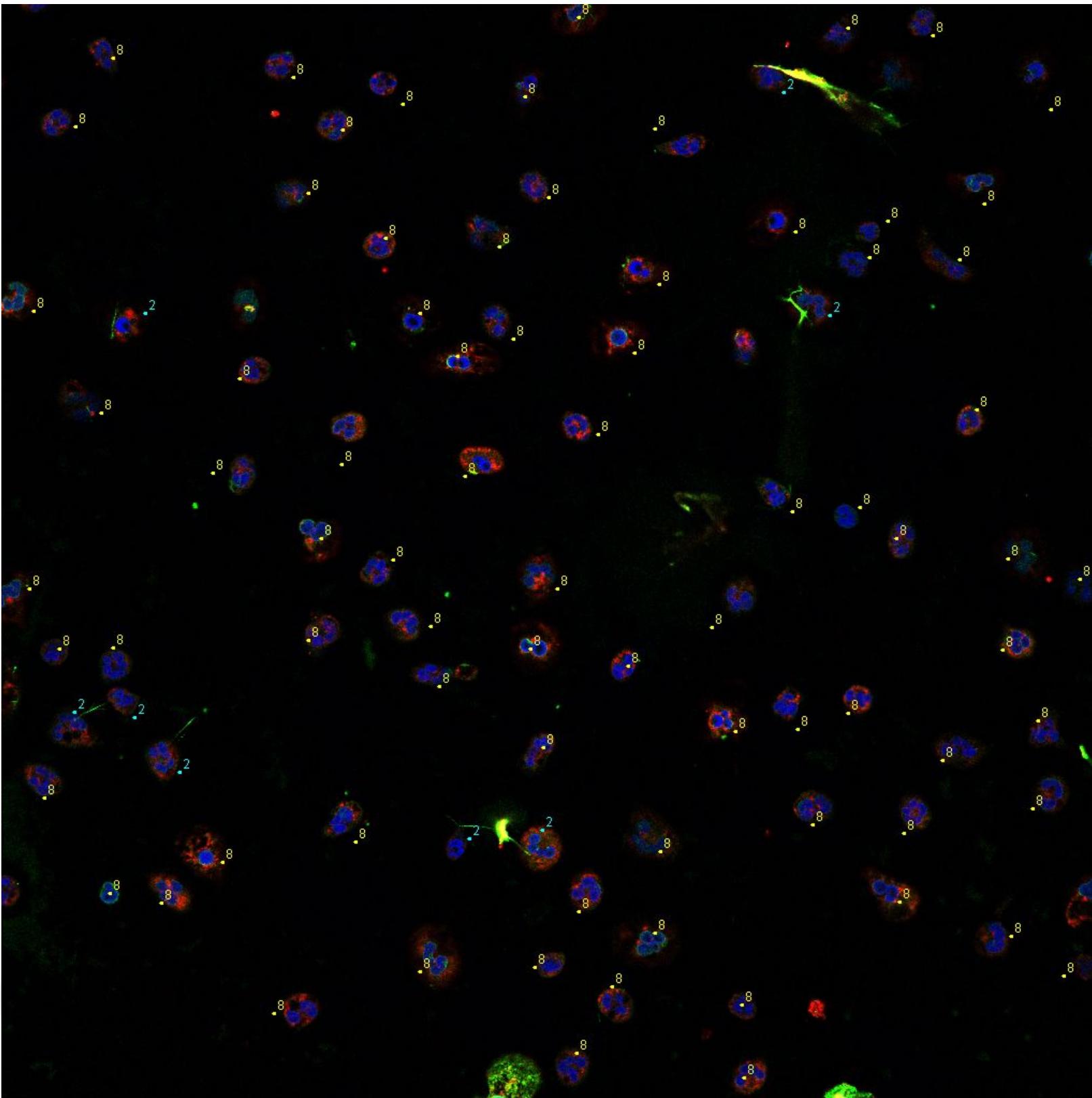
Detectron image segmentation
model

03

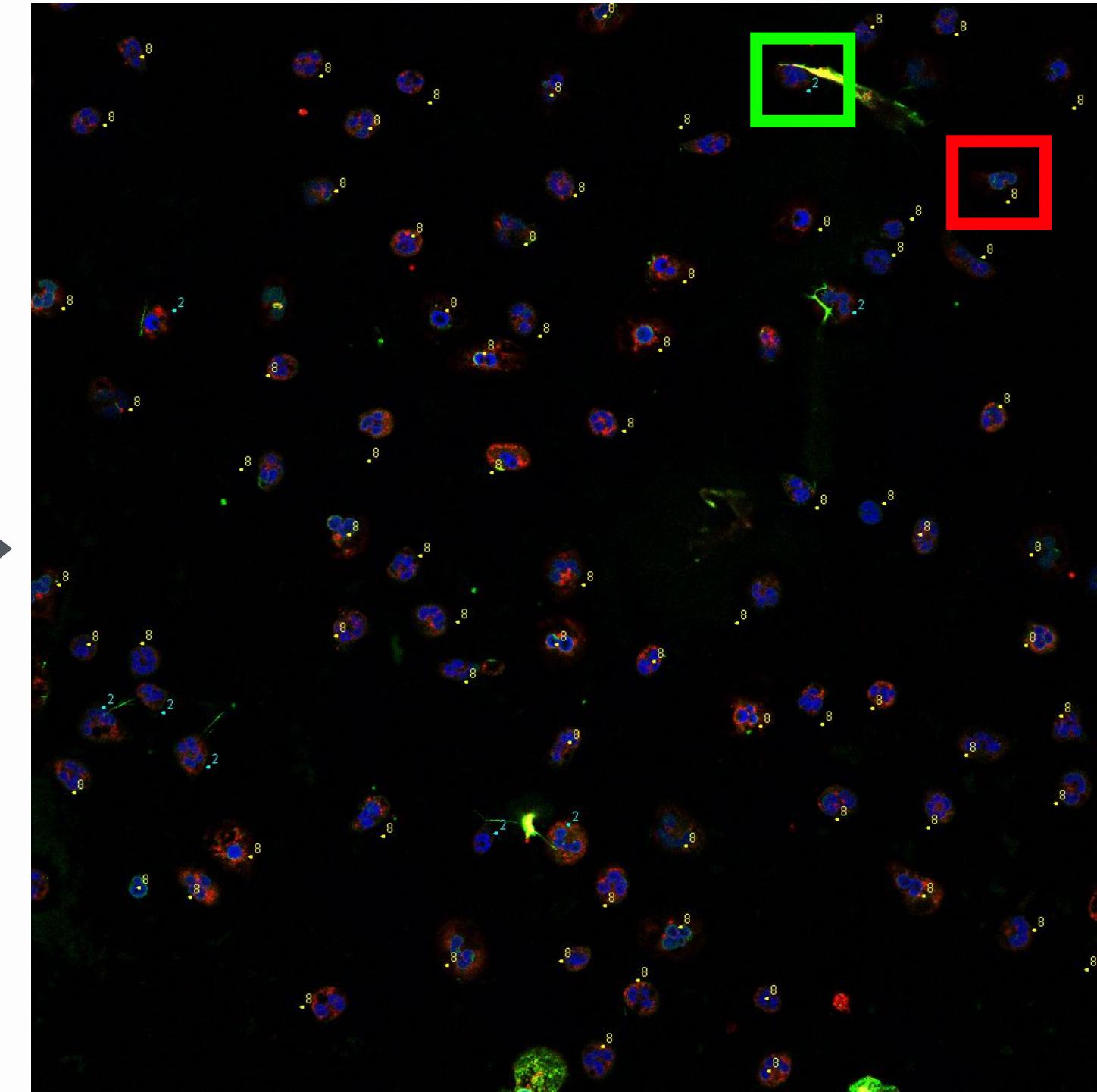
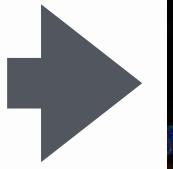
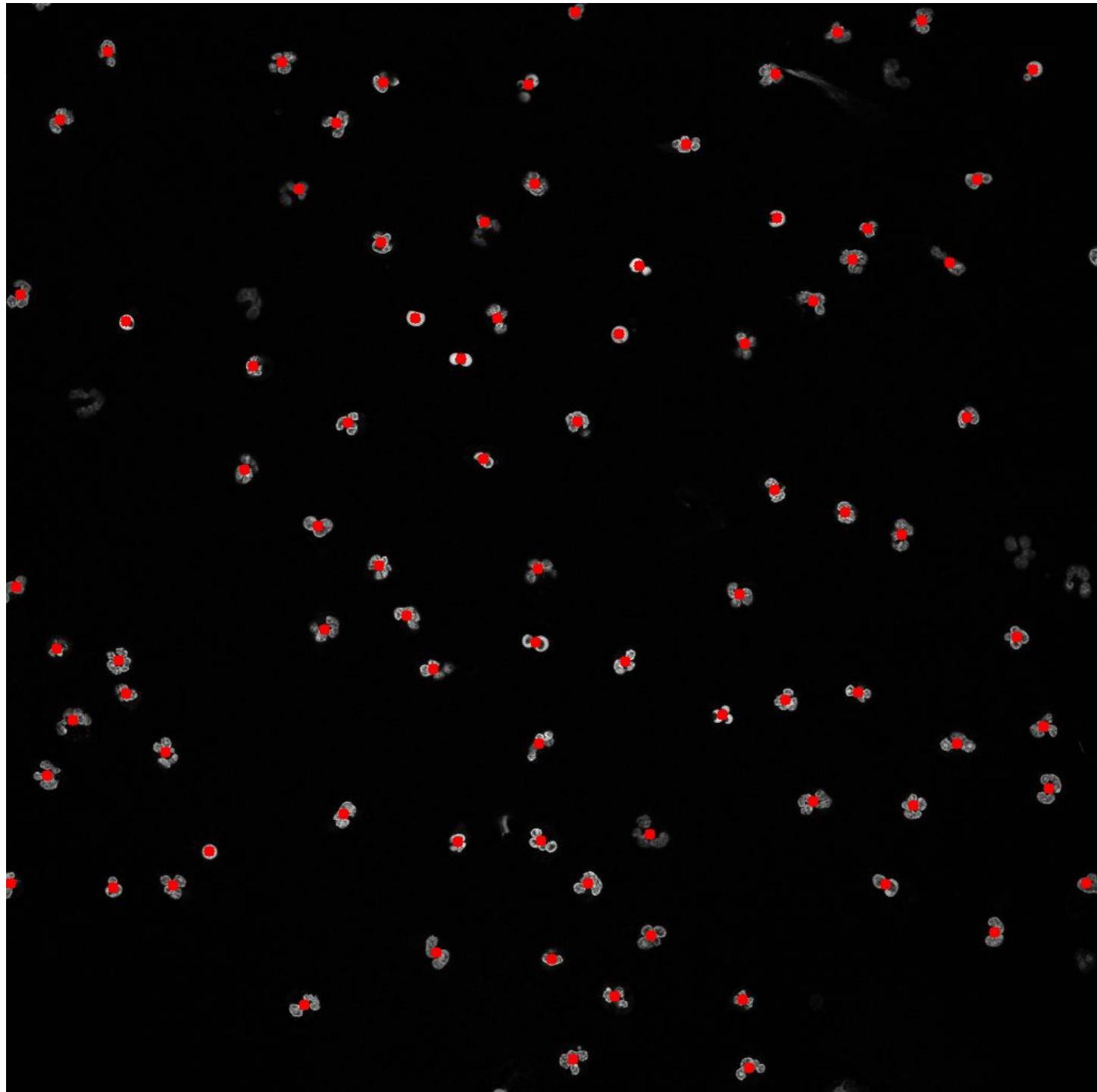
Sub-Imaging based Logistic
Regression model



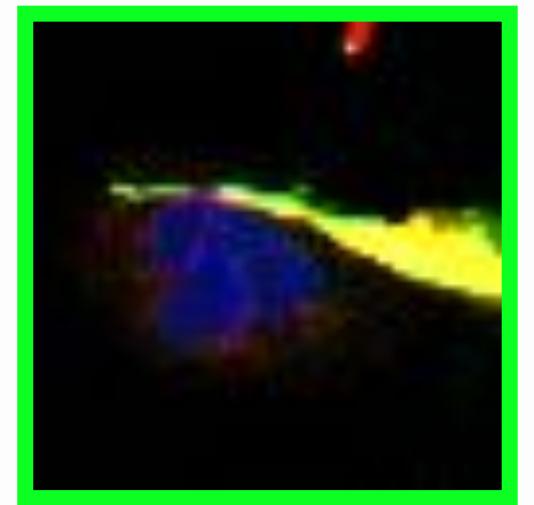
Sub-Imaging Pipeline



Use coordinates to make subimages of three color image



NET positive

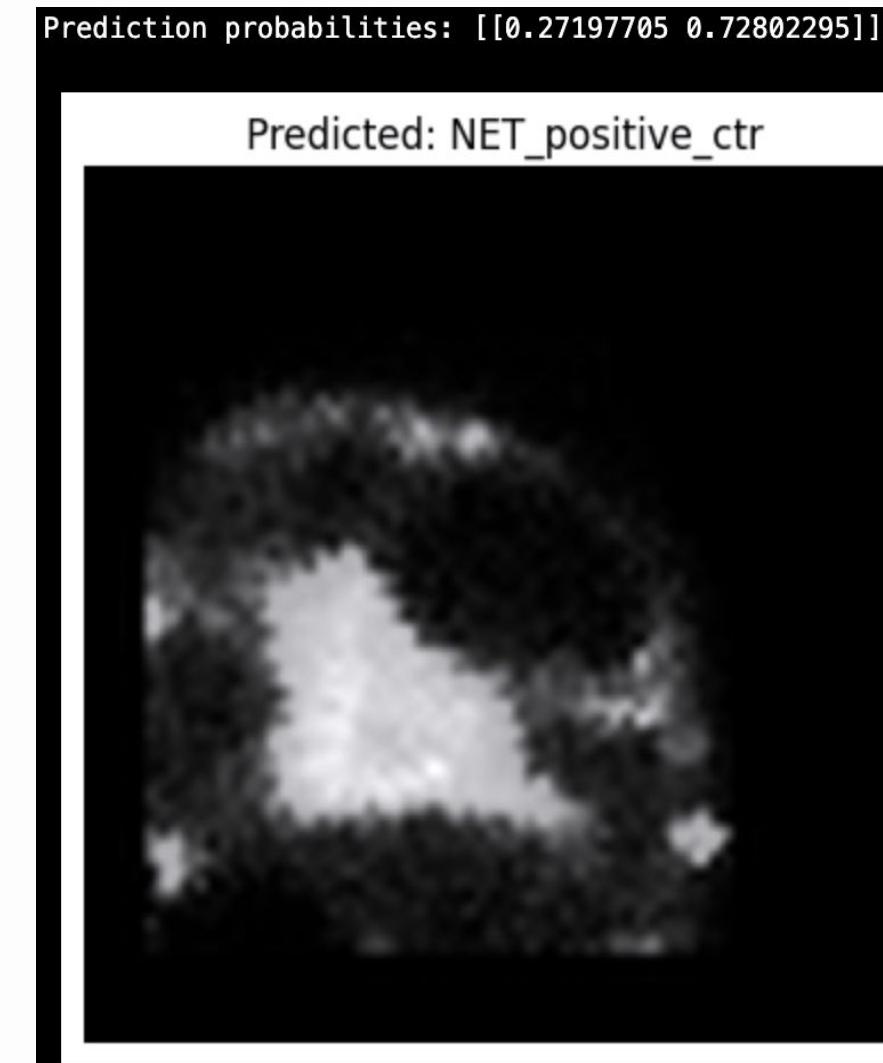
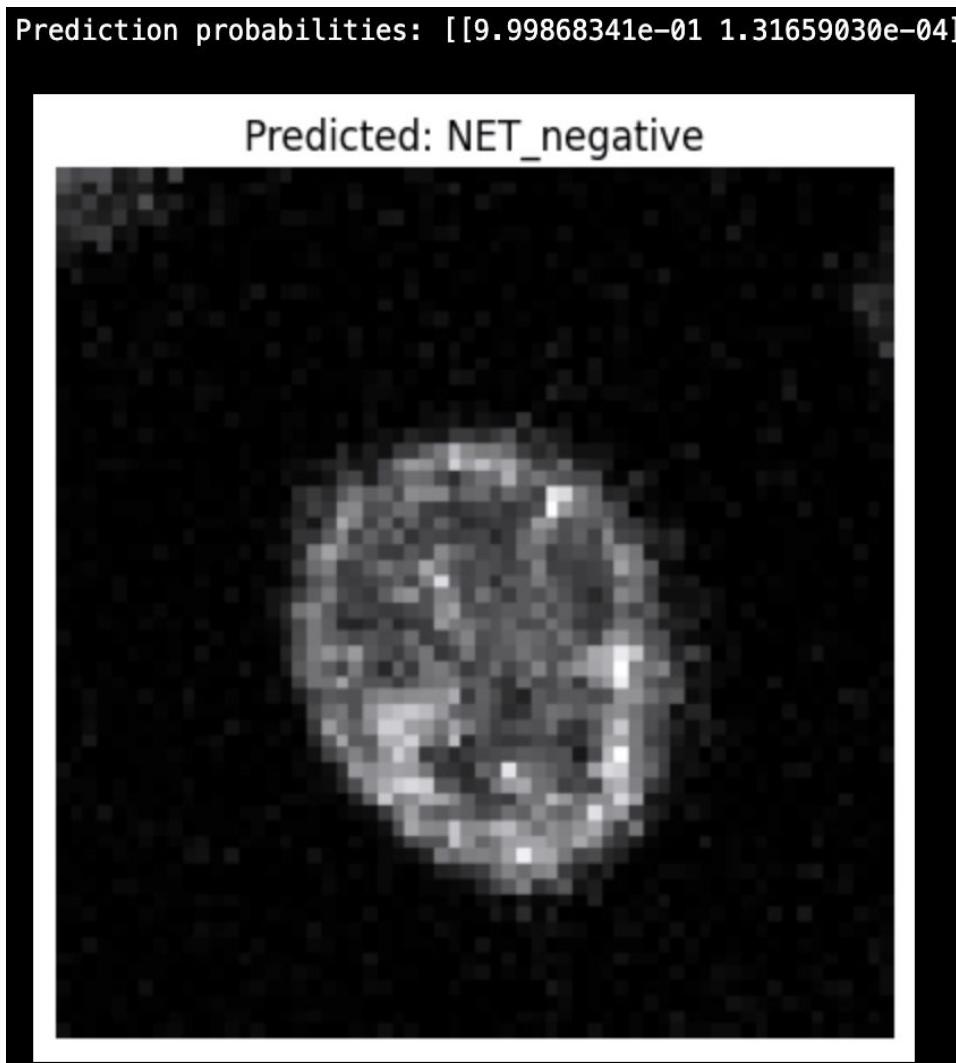


NET negative

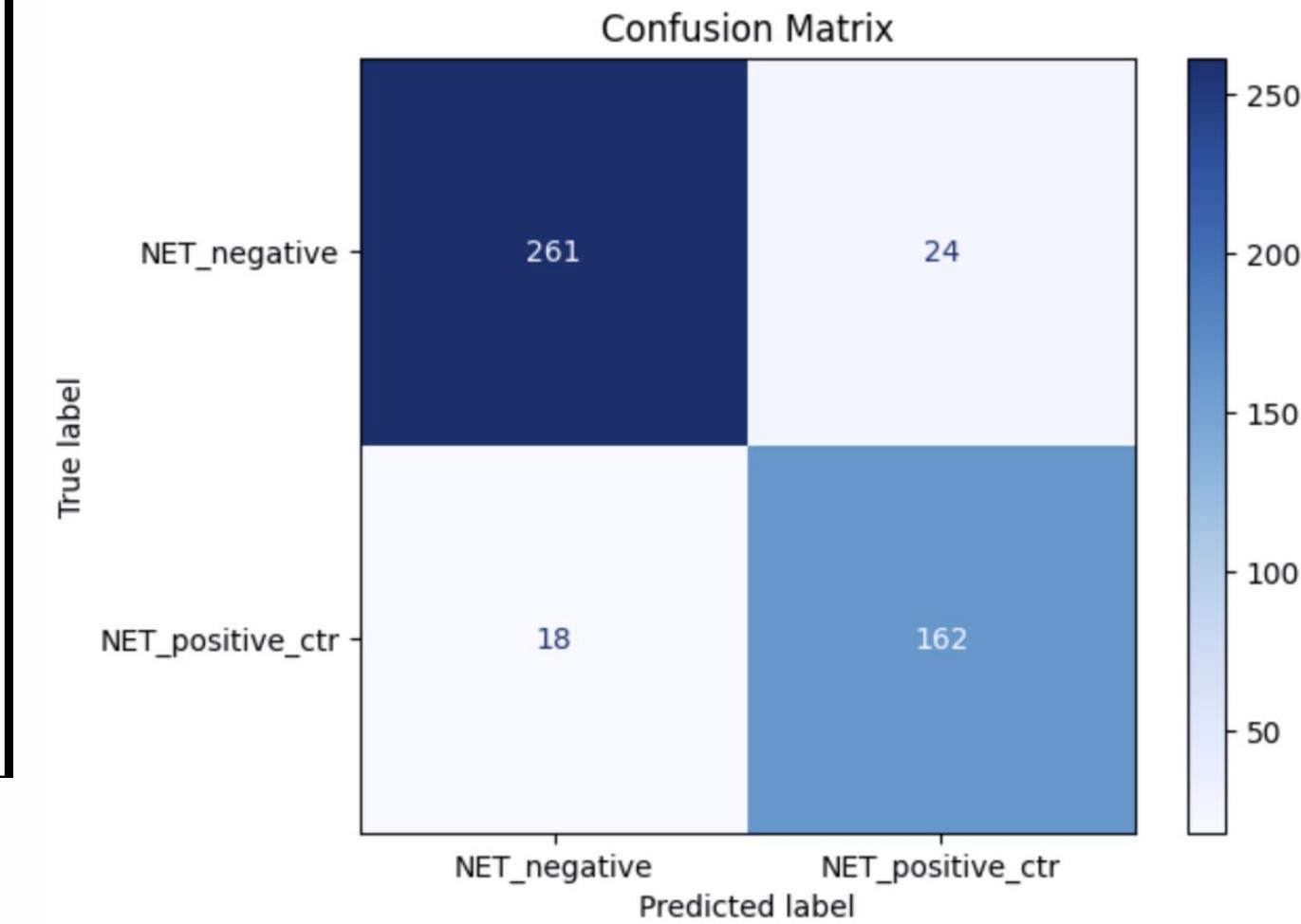


Results and Discussion

Classification model- Logistic regression



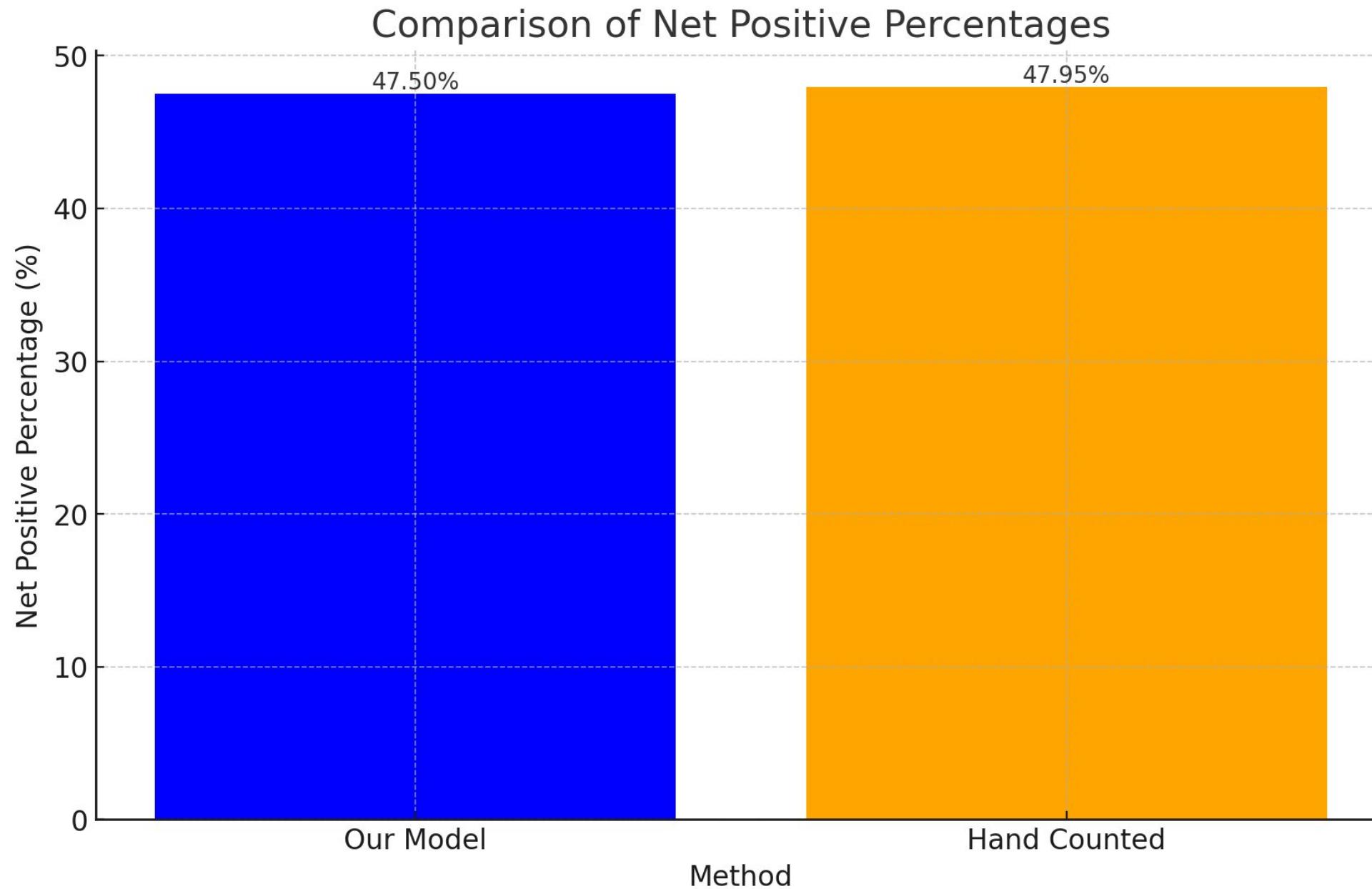
Classification Report:					
	precision	recall	f1-score	support	
NET_negative	0.94	0.92	0.93	285	
NET_positive_ctr	0.87	0.90	0.89	180	
accuracy			0.91	465	



Meet Our App

LINK

Comparison of hand counting, and automated quantification



Outlook

- Robust model to deal with heterogeneity of the data.
- Improve model with more images
- Implement
 - option to brighten images
 - batch processing
 - downloading intermediate images

Acknowledgements



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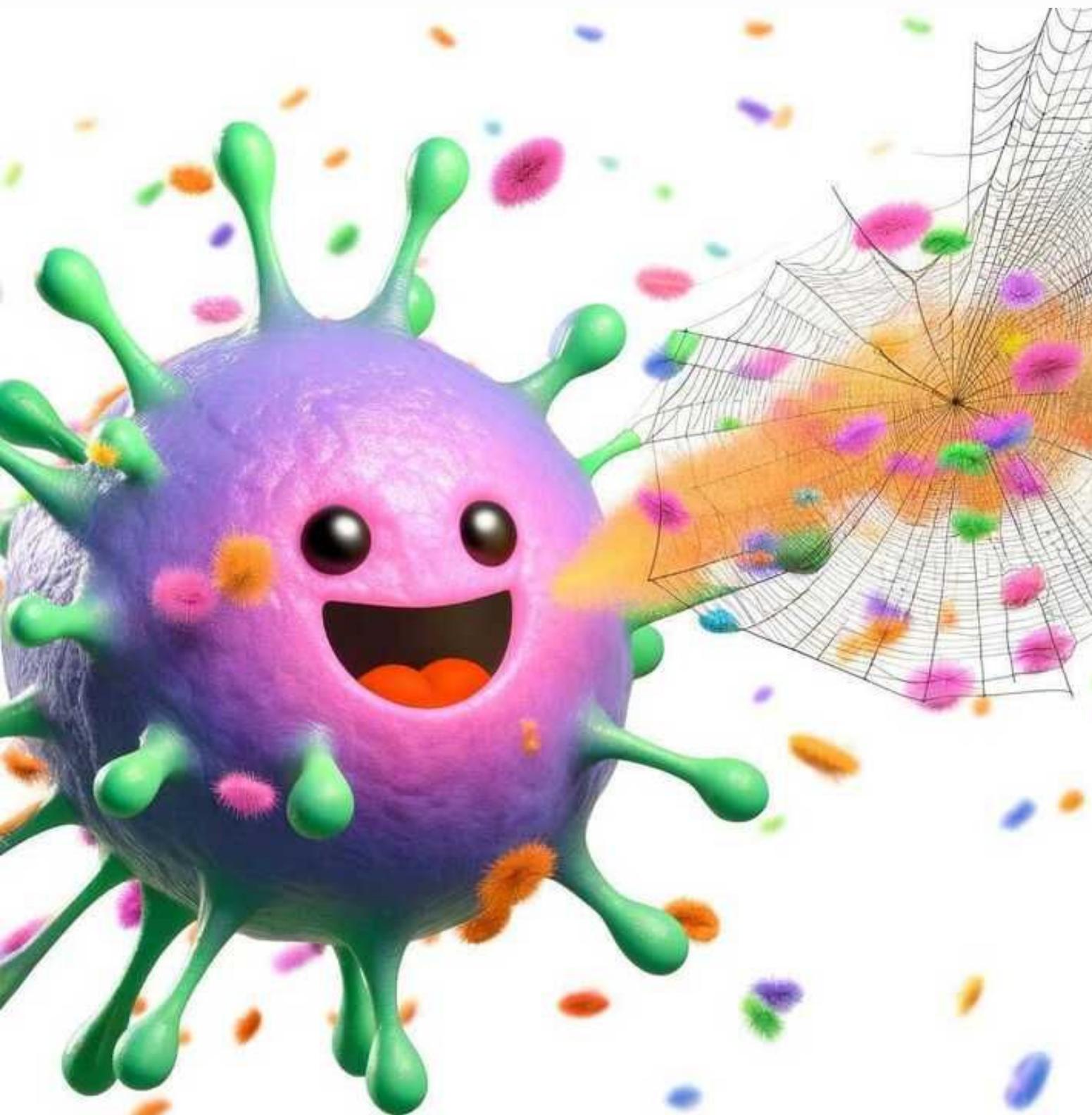
cgn-ds-24-2 cohort

Institute of Biochemistry - TiHo, Hannover



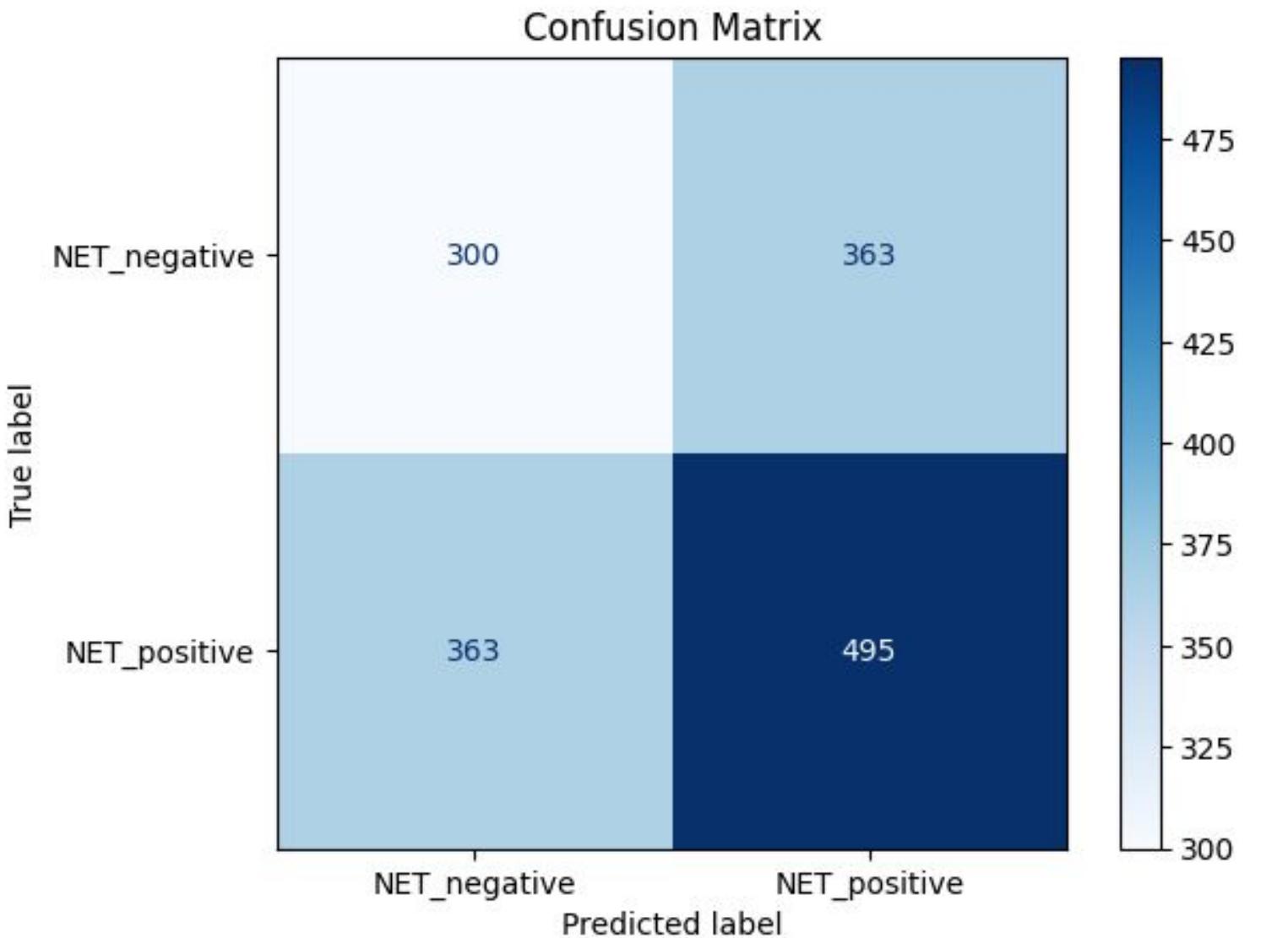


THANK YOU!

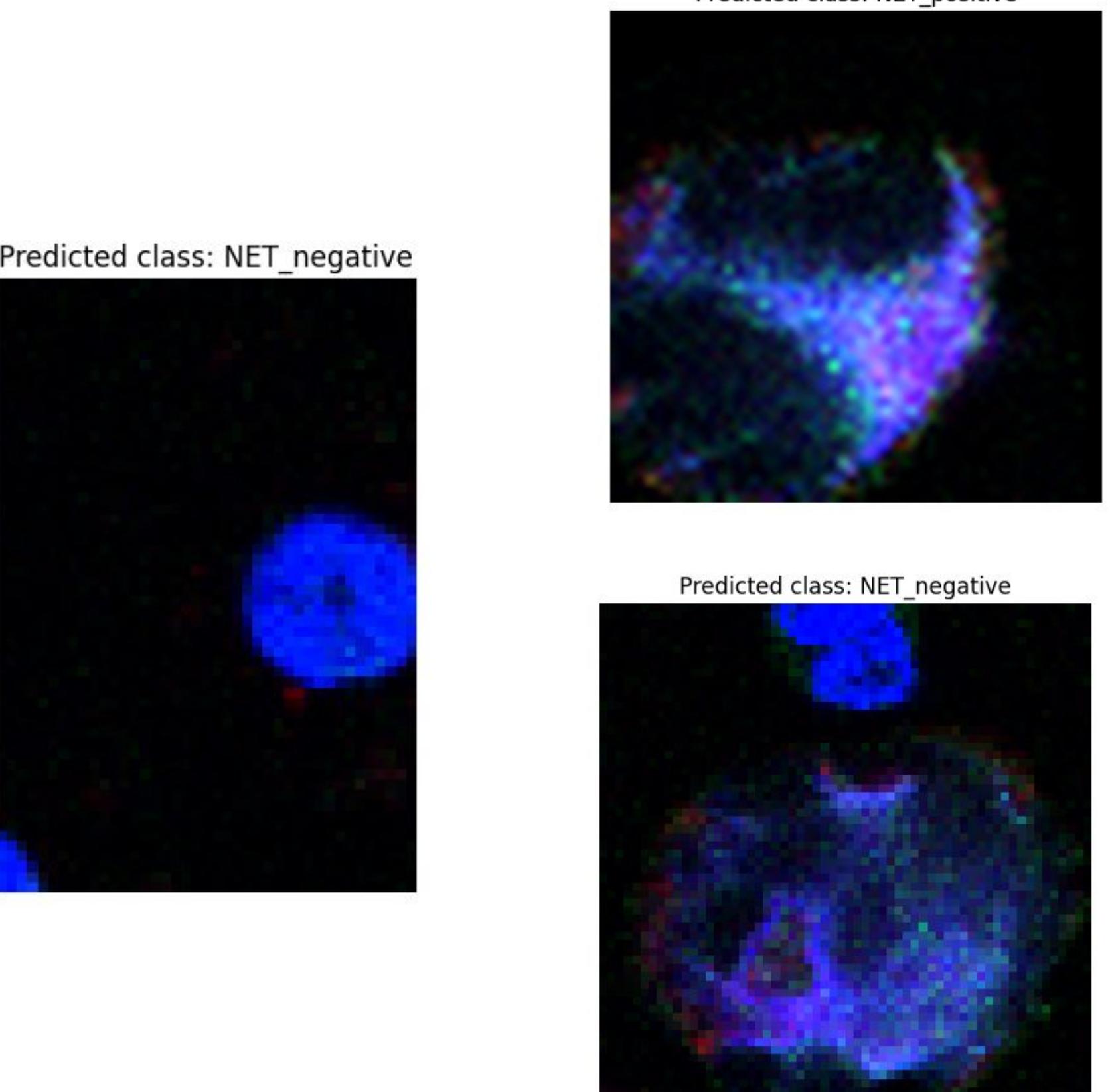


Supplementary Slides

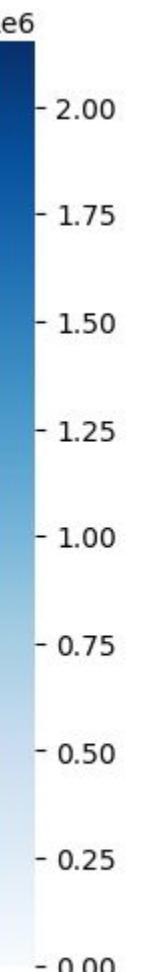
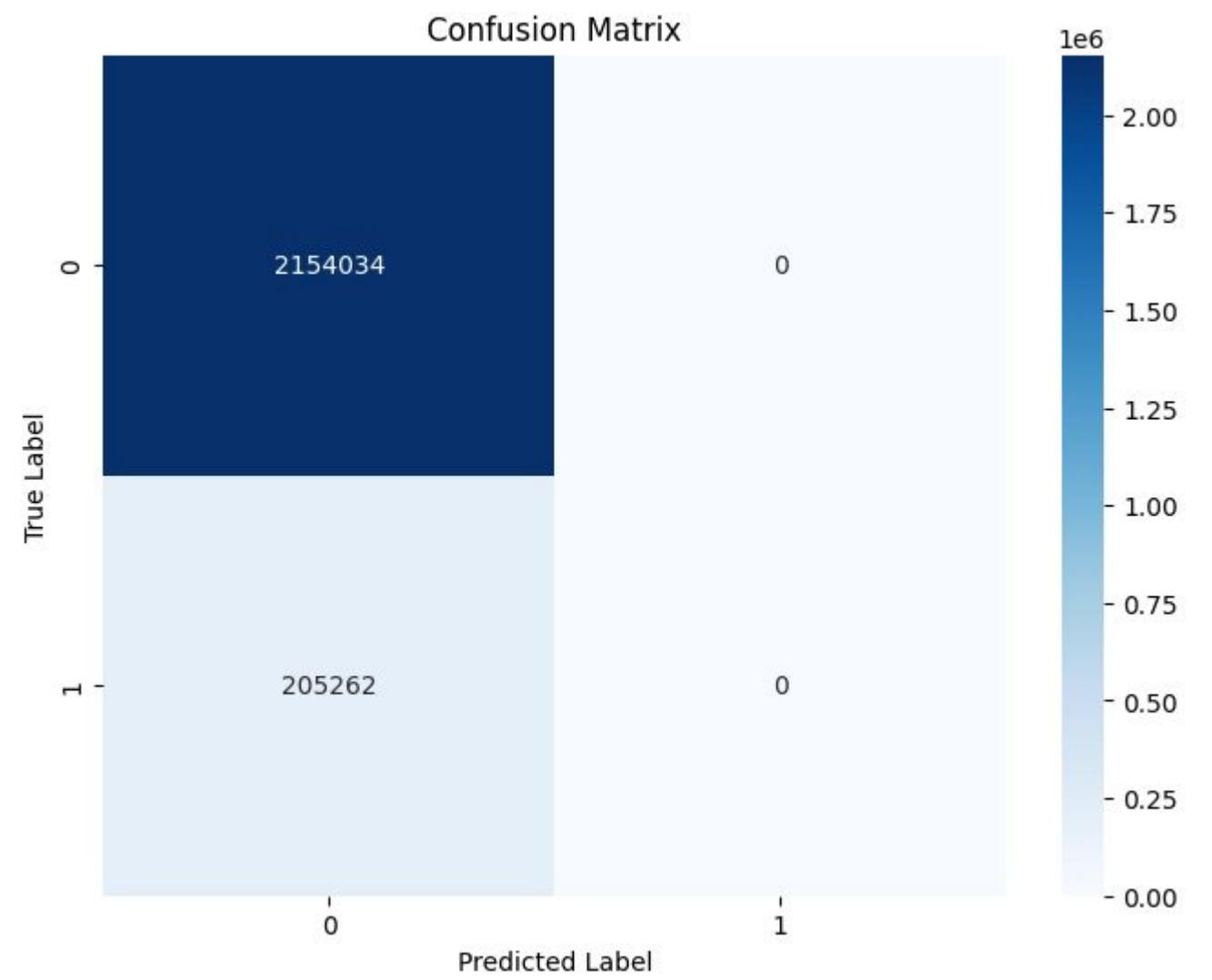
Results: VGG16, F1 Metrics



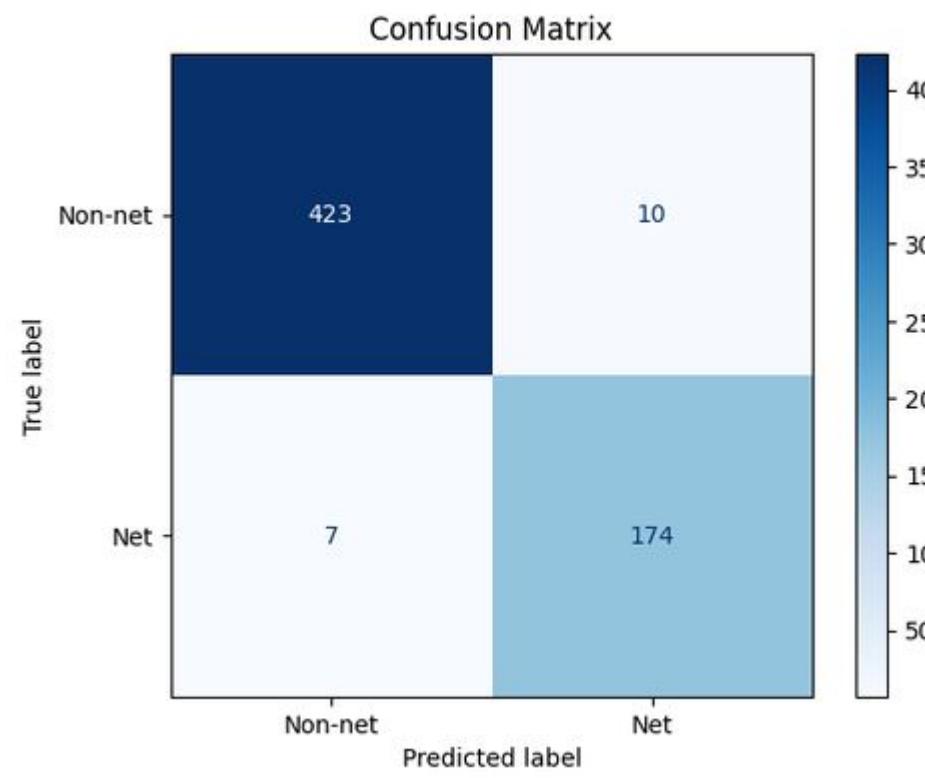
Classification Report:				
	precision	recall	f1-score	support
NET_negative	0.45	0.45	0.45	663
NET_positive	0.58	0.58	0.58	858
accuracy			0.52	1521
macro avg	0.51	0.51	0.51	1521
weighted avg	0.52	0.52	0.52	1521



Results: U-net

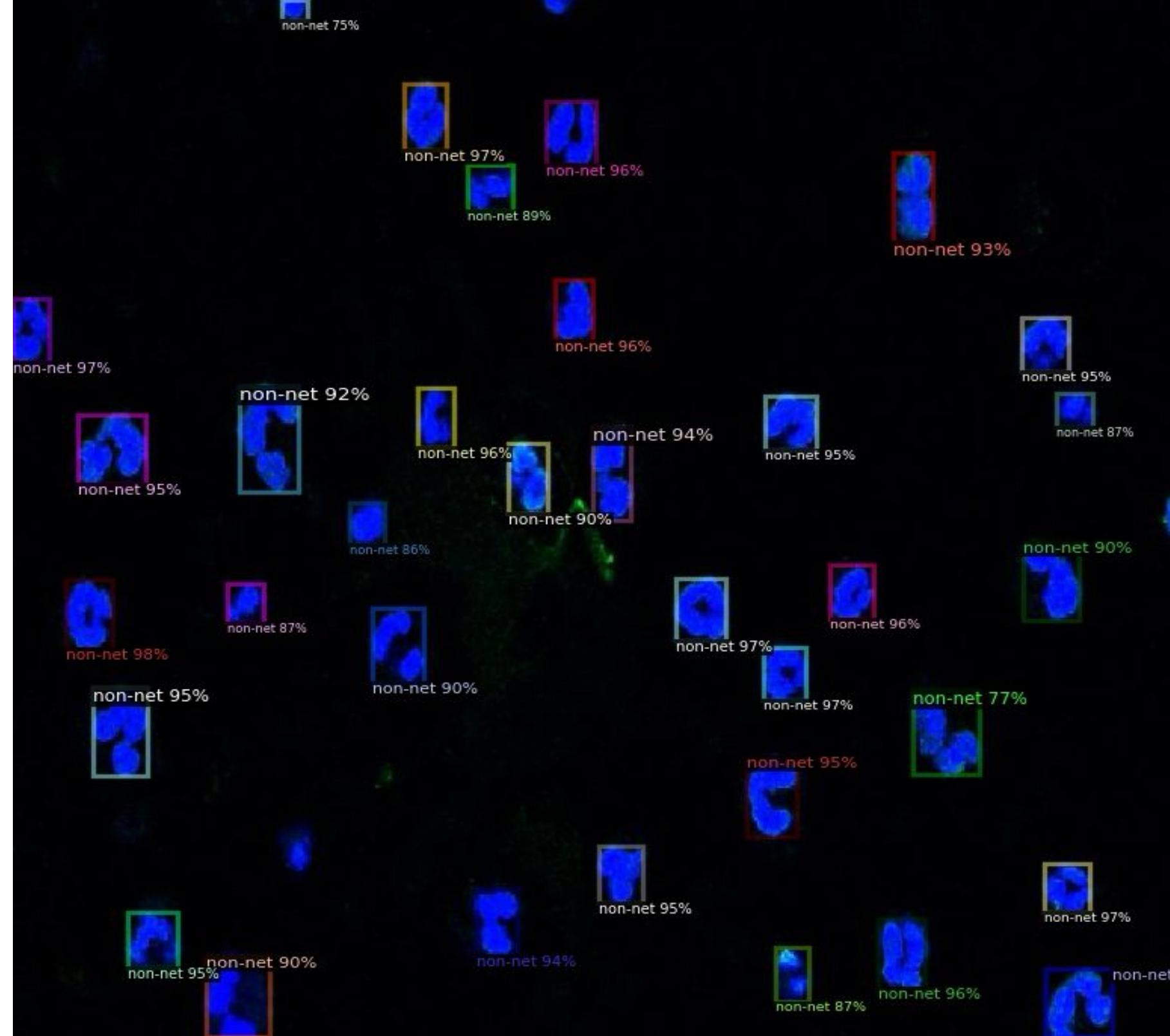


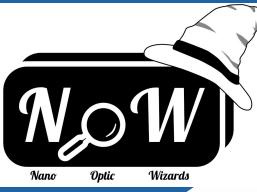
Results Detectron -maskRCNN model



Classification Report:

	precision	recall	f1-score	support
Non-net	0.98	0.98	0.98	433
Net	0.95	0.96	0.95	181
accuracy		0.97	0.97	614
macro avg	0.96	0.97	0.97	614
weighted avg	0.97	0.97	0.97	614

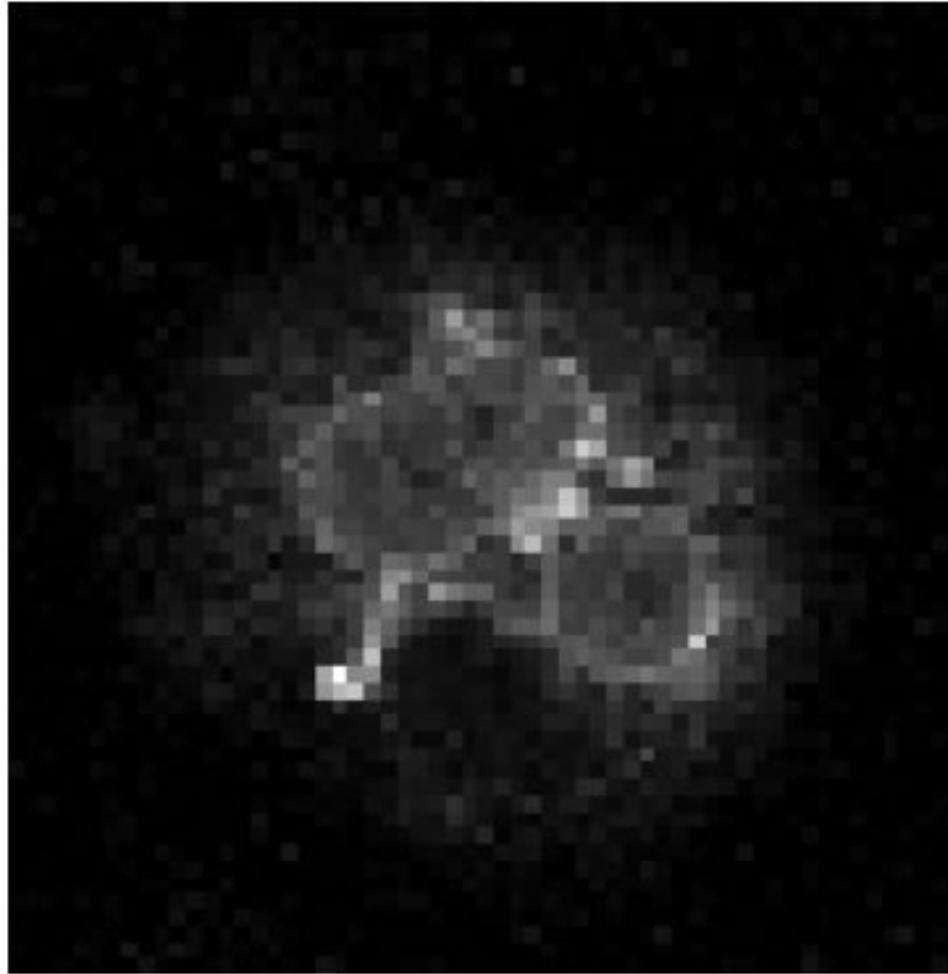




Nano-optic wizard

```
Predicted class: NET_negative
Prediction probabilities: [[0.87796915 0.1220308]]
```

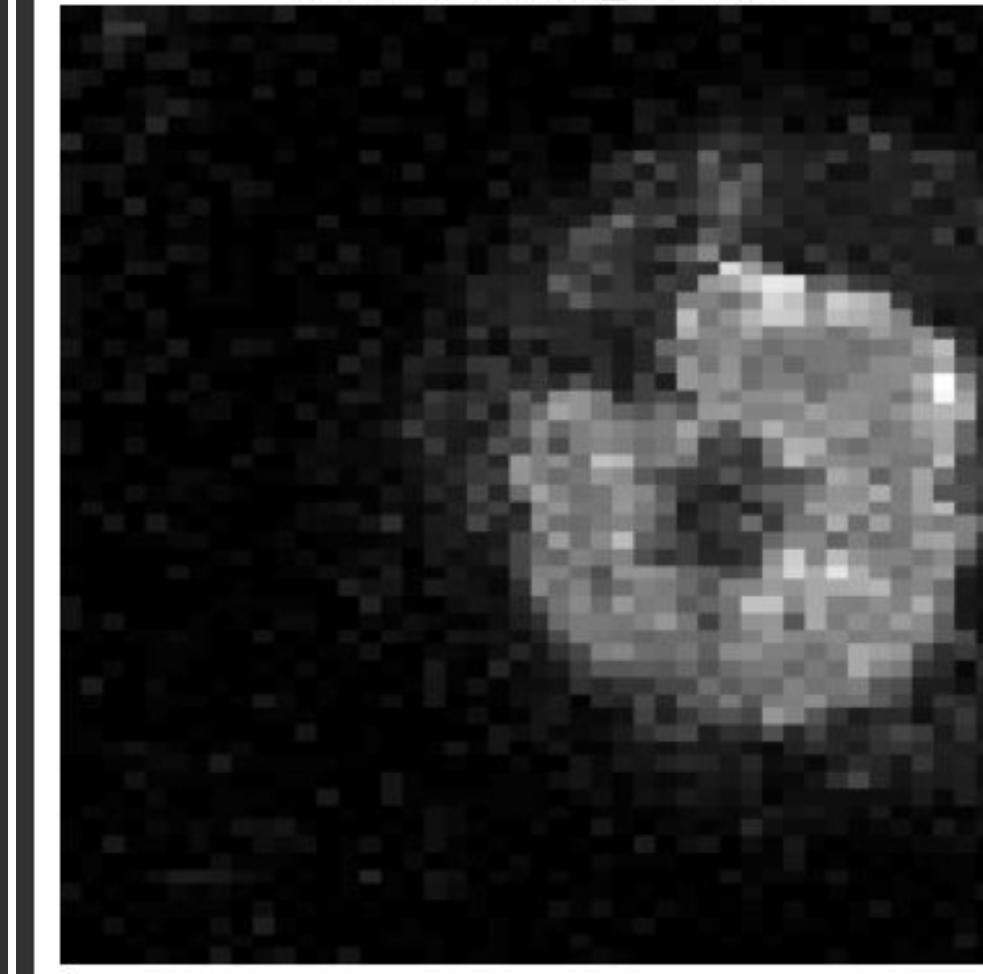
Predicted: NET_negative



```
(0, array([[0.87796915, 0.12203085]]))
```

```
Predicted class: NET_positive
Prediction probabilities: [[0.14160624 0.8583937]]
```

Predicted: NET_positive



```
(1, array([[0.14160624, 0.85839376]]))
```