Midterm presentation

Automated recognition of NETs

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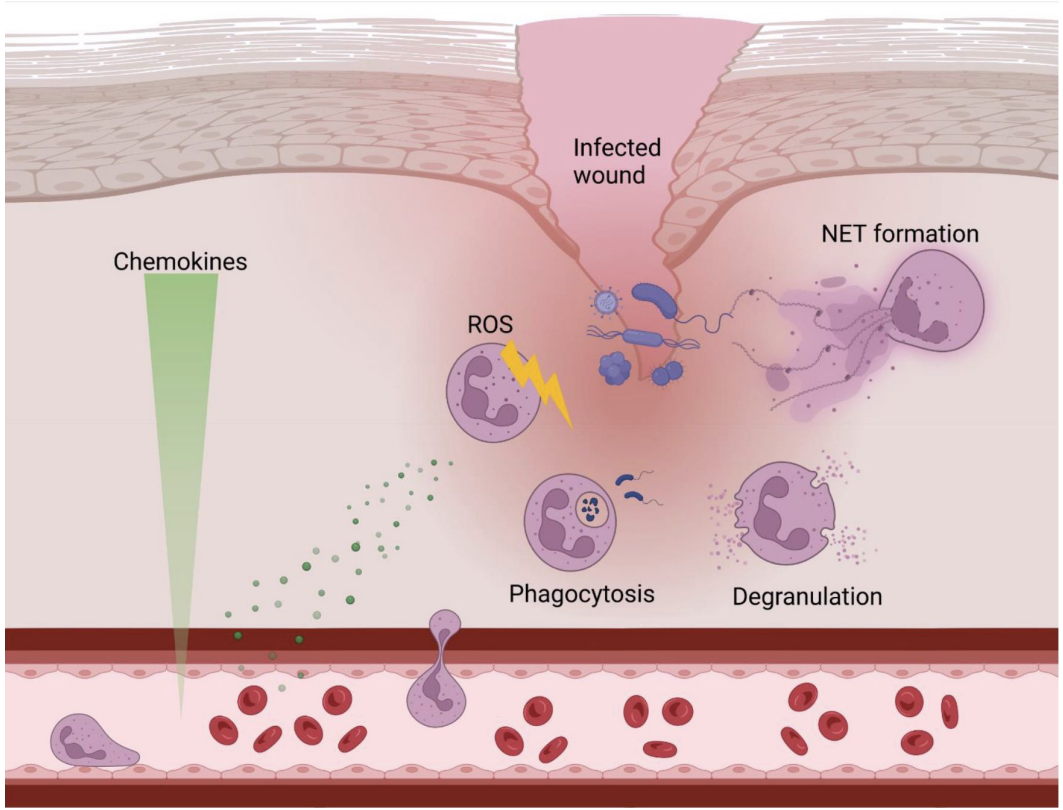
Stakeholder

Interesting for anyone working in the NET field

Neutrophil Extracellular Traps

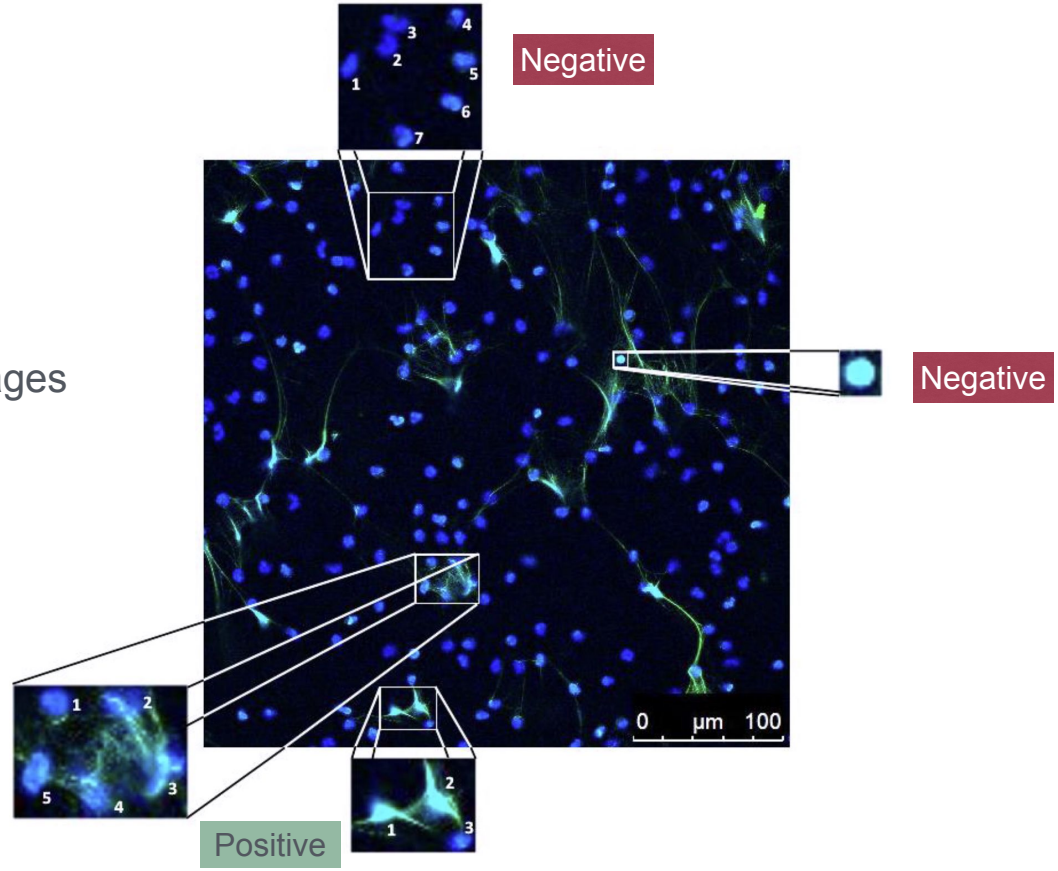
NETs

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



How does our data look like?

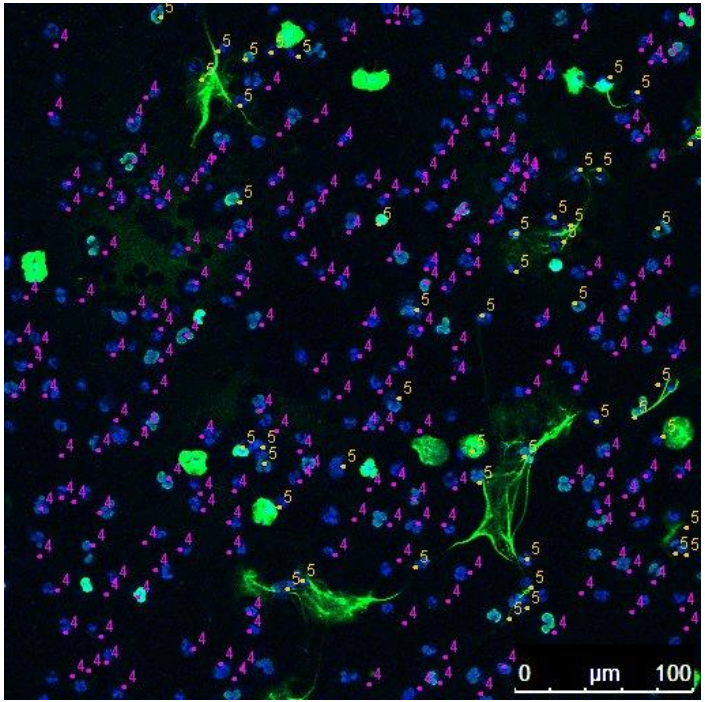
38 manually annotated images



Baseline models

Earlier attempts to automatise the NET counting

- Goal to reach: precision of hand counting



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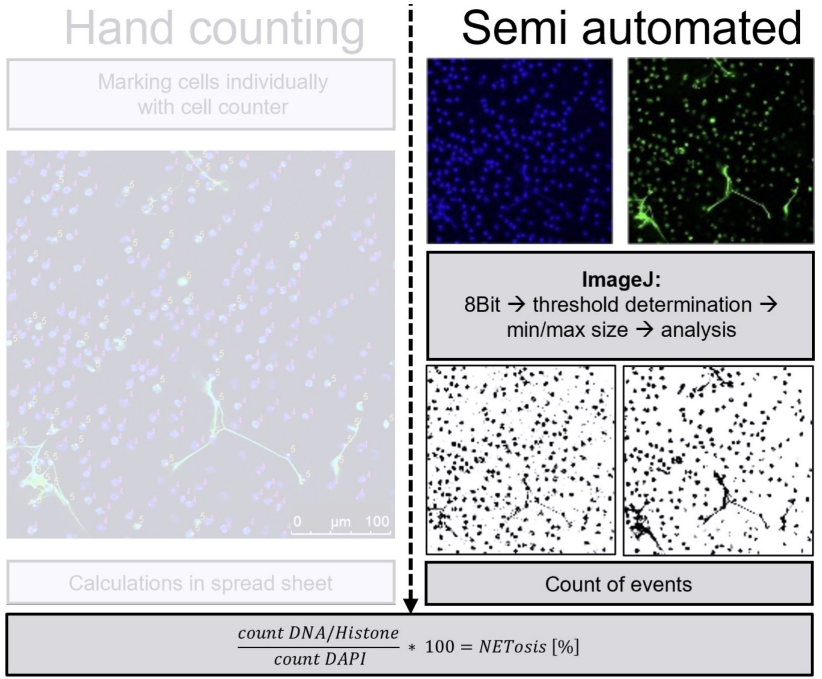
- Goal to reach: precision of hand counting
- Baseline models:
  - Semi automated with ImageJ



Brinkmann et al., 2013

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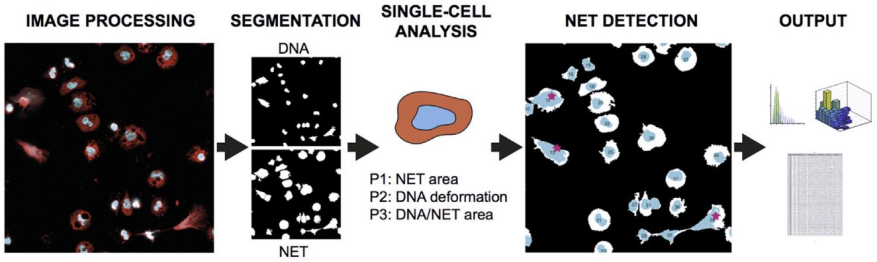
  - Semi automated with ImageJ
  - Fully automated with NETQUANT (MATLAB)

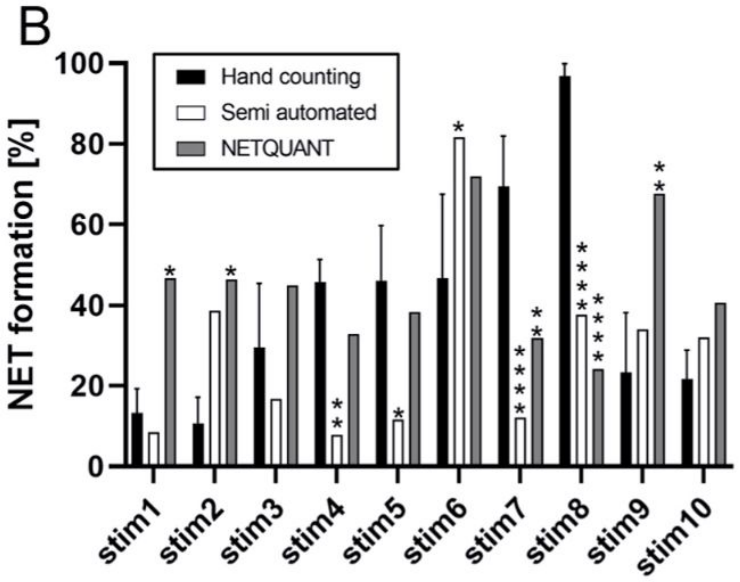


Mohanty et al., 2018

Baseline models

Earlier attempts to automatise the NET counting

- Goal to reach: precision of hand counting
- Baseline models:
  - Semi automated with ImageJ
  - Fully automated with NETQUANT (MATLAB)
- Overall poor performance of both models



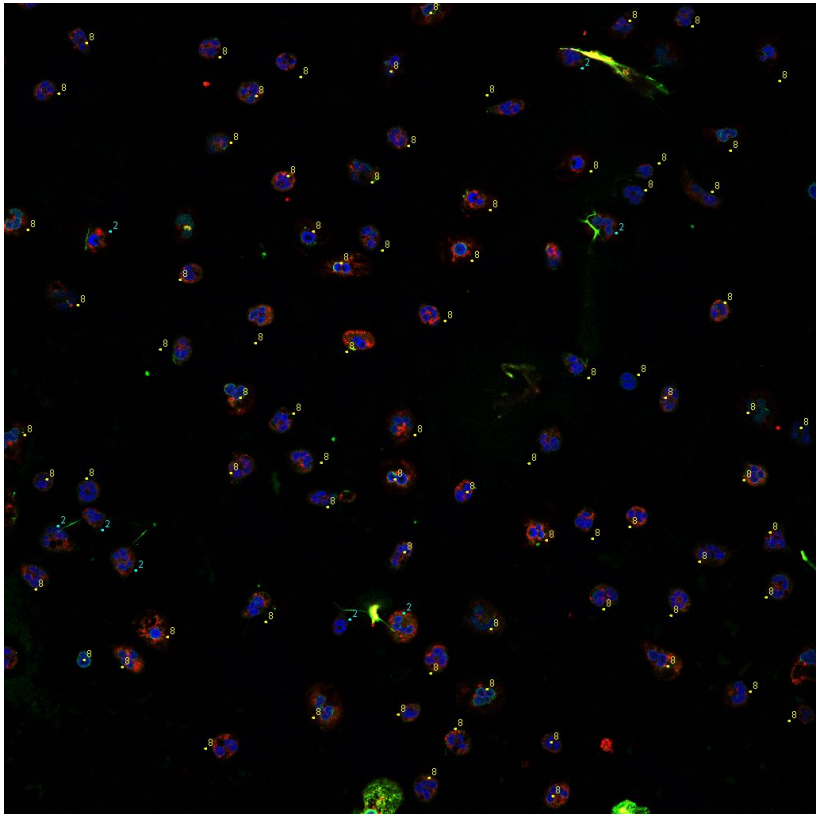
Henneck et al., 2023

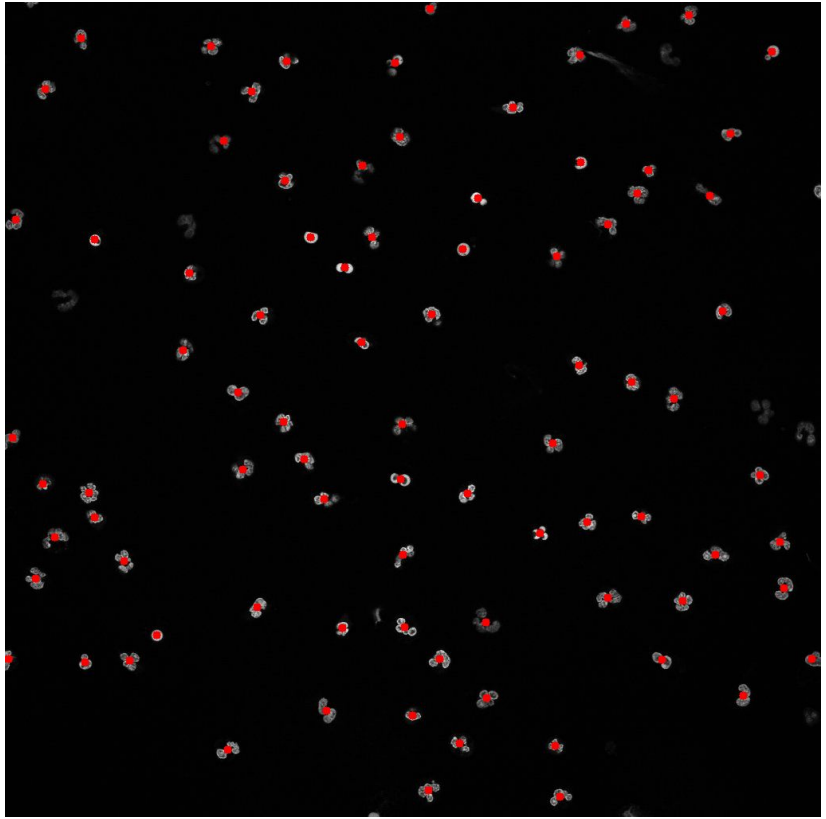
Two modelling approaches

- Use recall or F1 score as main metrics to capture maximum positives (recall) and also taking false negatives and false positives into account (F1).
- Continue with two different approaches:
  - Subimaging
  - Segmentation

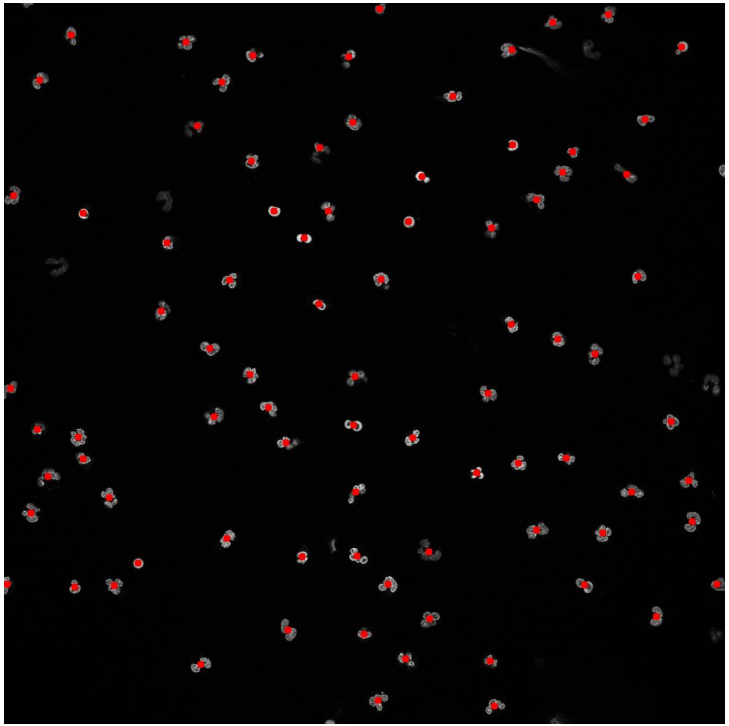
Model 1: Subimaging

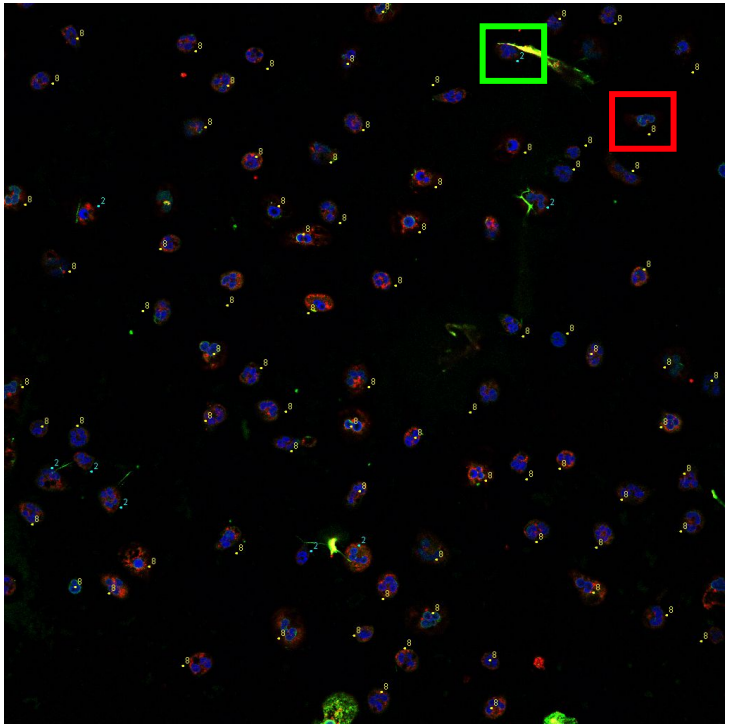
Get coordinates of nucleus centres in blue channel



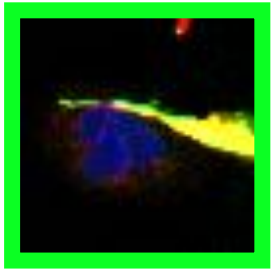


Use coordinates to make subimages of three color image





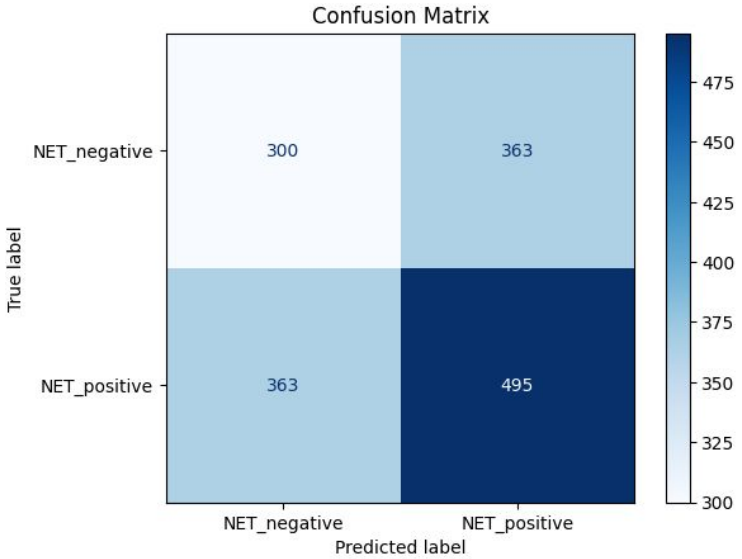
NET positive



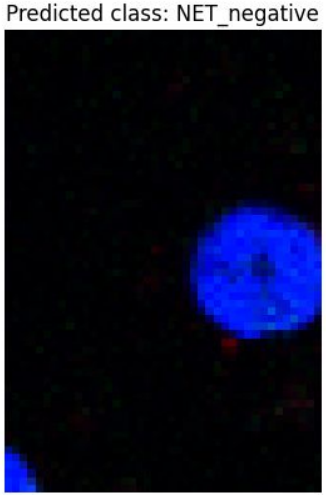
NET negative

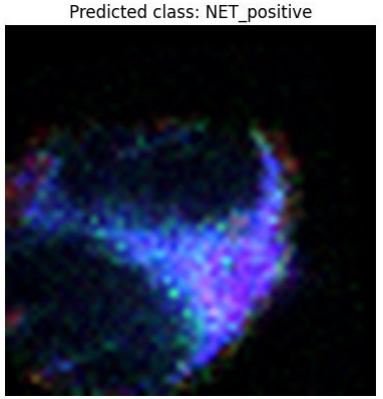
Best model: subimaging

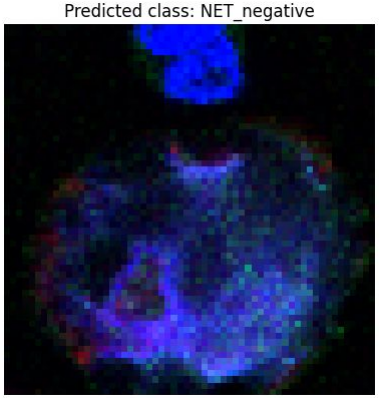
Results: VGG16, F1 Metrics



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



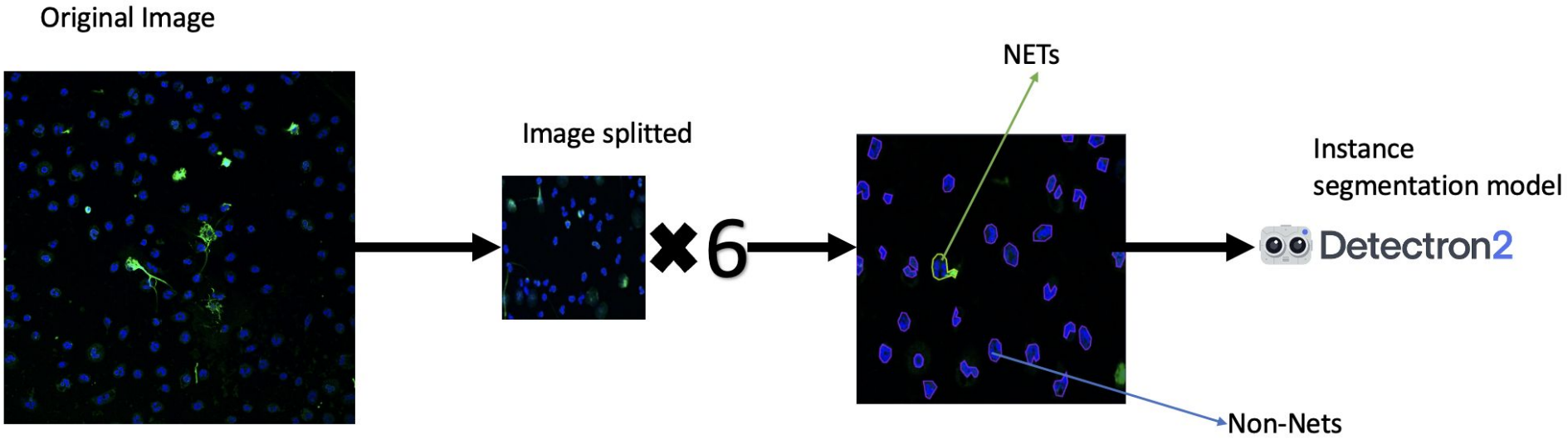




Model 2: Instance segmentation

Image segmentation using detectron2

Model pipeline



Model Performance

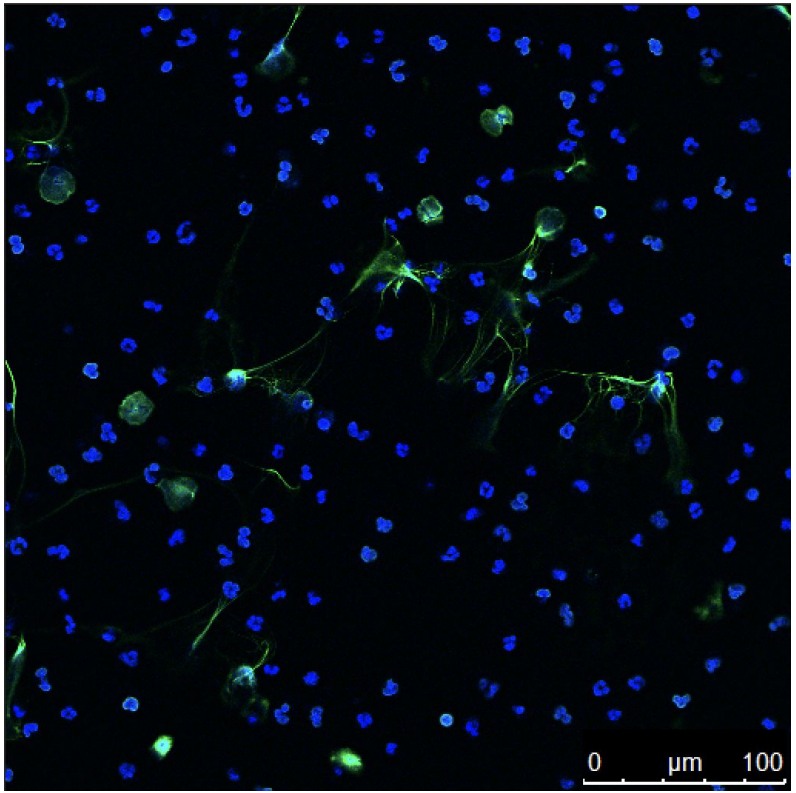
```
Accumulating evaluation results...
DONE (t=0.02s).
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.571
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.759
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.671
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.328
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.656
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.171
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.061
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.352
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.634
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.362
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.712
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.263
[06/06 14:38:16 d2.evaluation.coco_evaluation]: Evaluation results for bbox:
|   AP   |  AP50  |  AP75  |  APs   |  APm   |  APl   |
|:------:|:------:|:------:|:------:|:------:|:------:|
| 57.115 | 75.888 | 67.085 | 32.785 | 65.619 | 17.144 |
[06/06 14:38:16 d2.evaluation.coco_evaluation]: Per-category bbox AP:
| category           | AP   | category   | AP     | category   | AP     |
|:-------------------|:-----|:-----------|:-------|:-----------|:-------|
| microscopic_images | nan  | NETs       | 44.660 | non-net    | 69.570 |
```

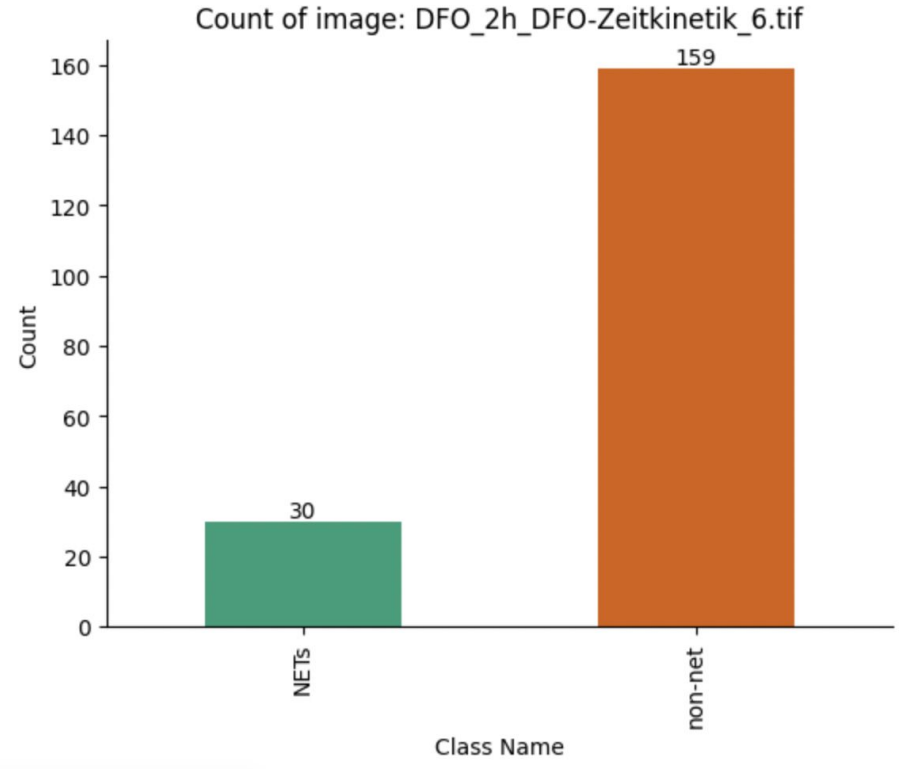
Best model: image segmentation

Instance segmentation of splitted image DFO_2h_DFO-Zeitkinetik_6

Best model: image segmentation

DFO_2h_DFO-Zeitkinetik_6





Outlook

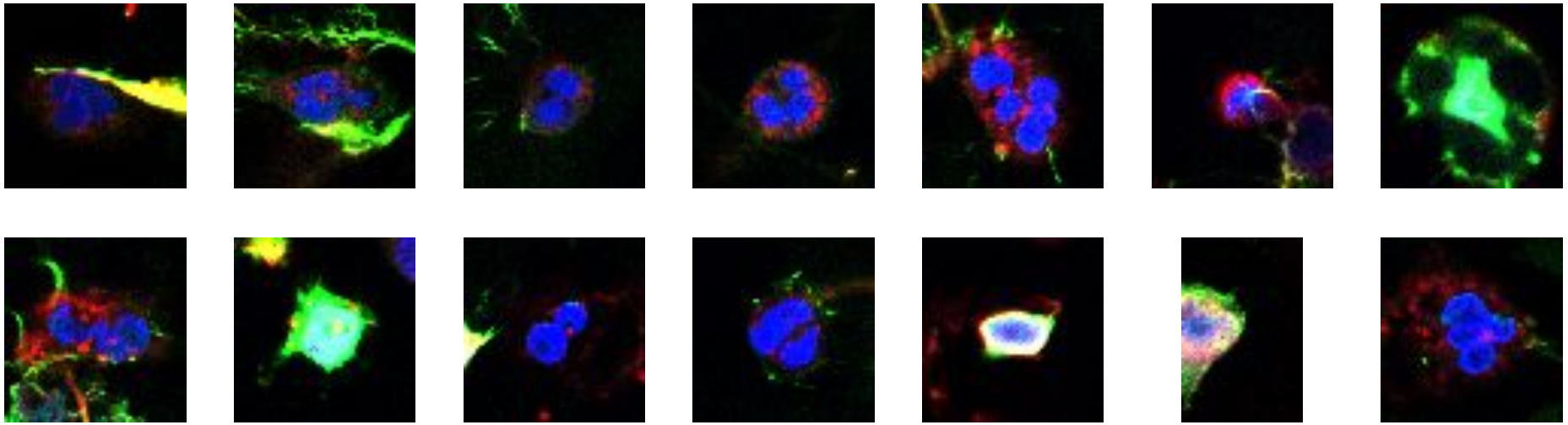
- Model 1:
  - Work against overfitting (regularisation)
- Model 2:
  - Try yolo again with now available annotations
- Try DB scan as a third alternative
- Prepare webapp (turning into python script, streamlit)
- Potential problems:
  - Heterogeneity of the dataset and the NETs

Thank you

Detailed image overview

	CTR stimulated	PMA stimulated	
RGB	12	7	19
GB	9	10	19
	21	17	38

NET heterogeneity



Problems with the NETs…