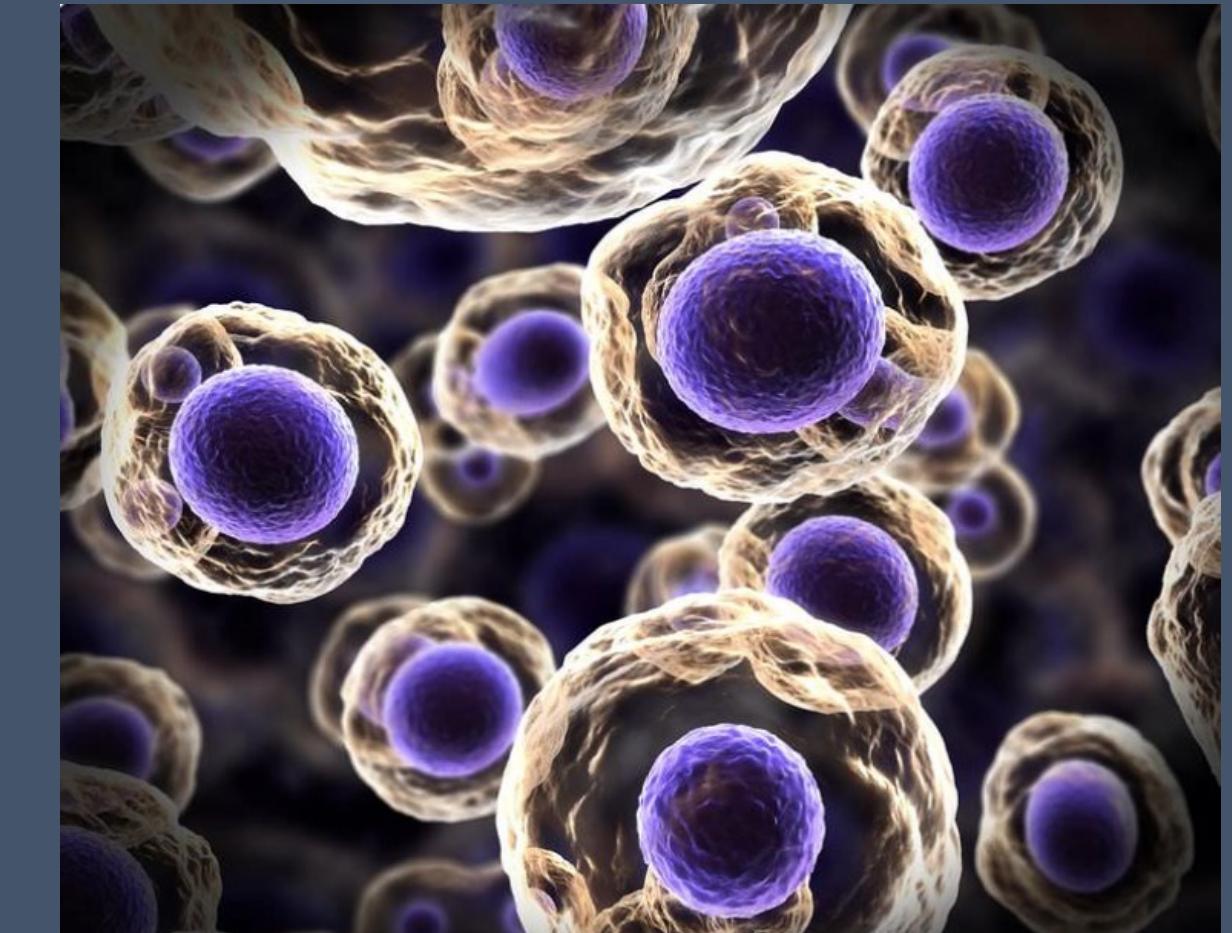


Implementation and evaluation of Otsu's thresholding

Project proposal

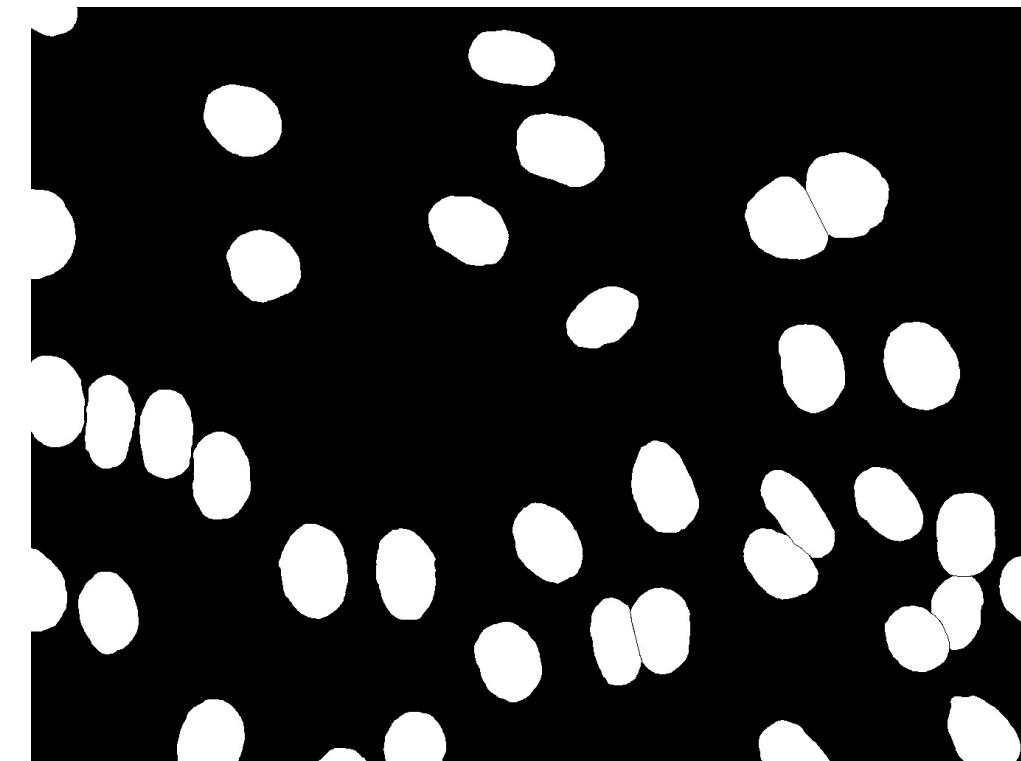
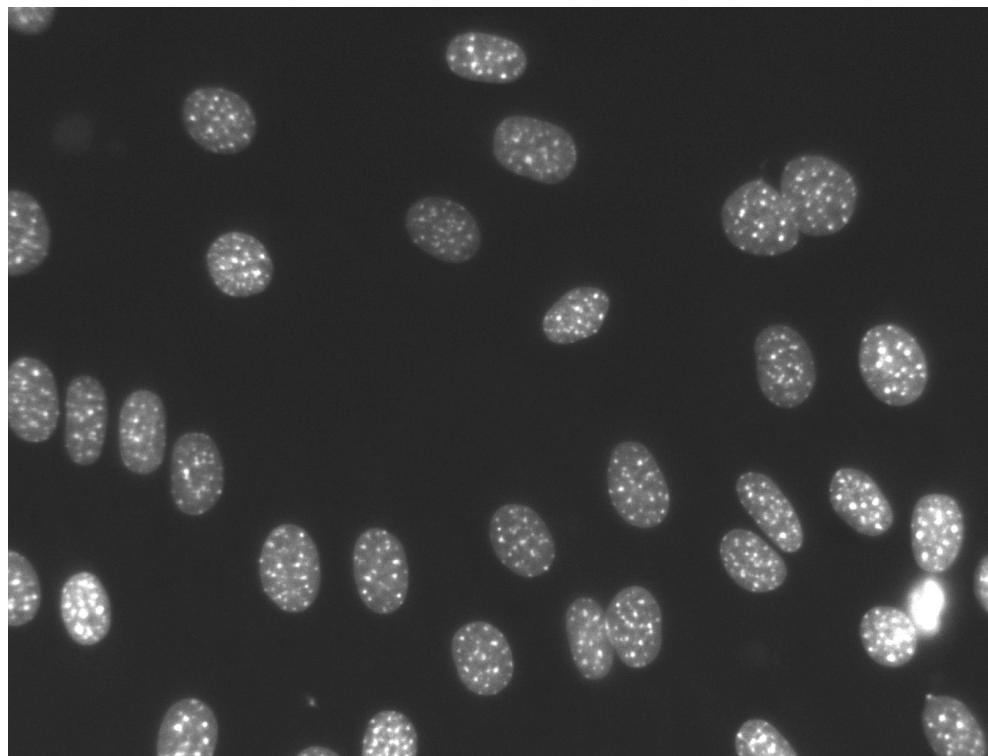
Elizaveta Chernova, Veronika Schuler,
Laura Wächter, Hannah L. Winter

12.05.2021



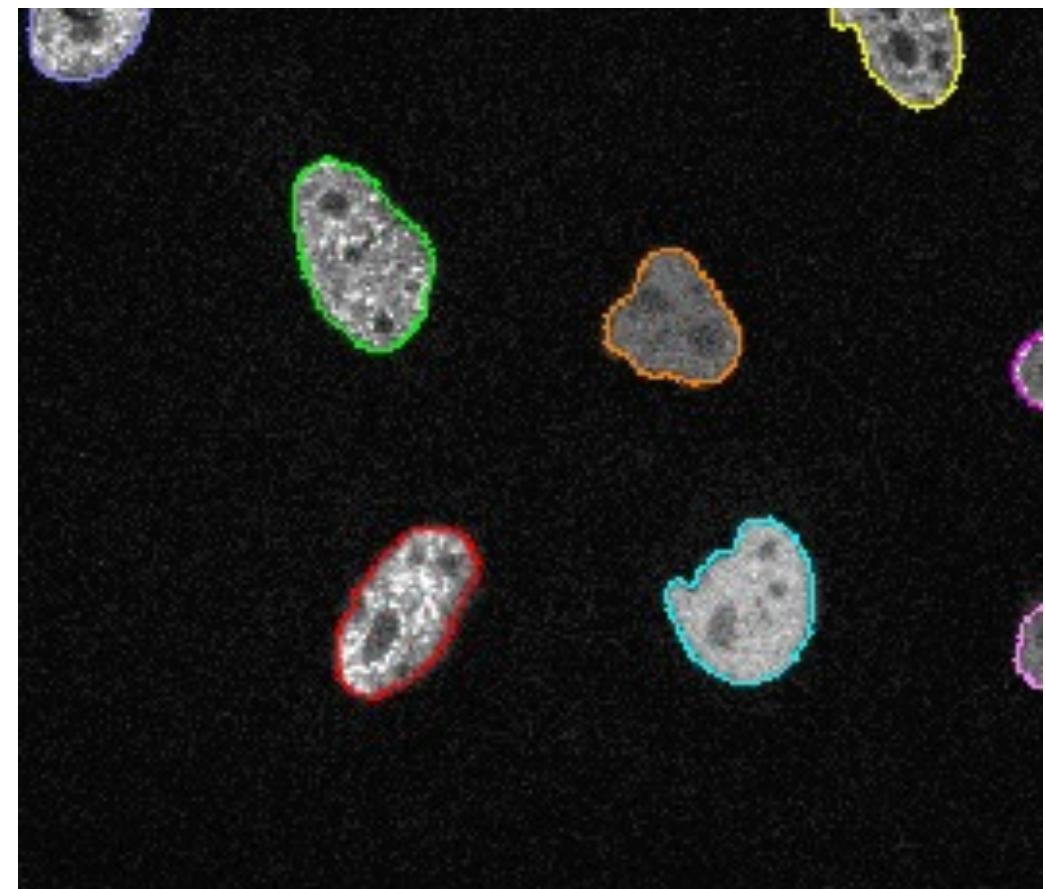
Cell nuclei segmentation

Image segmentation



Applications

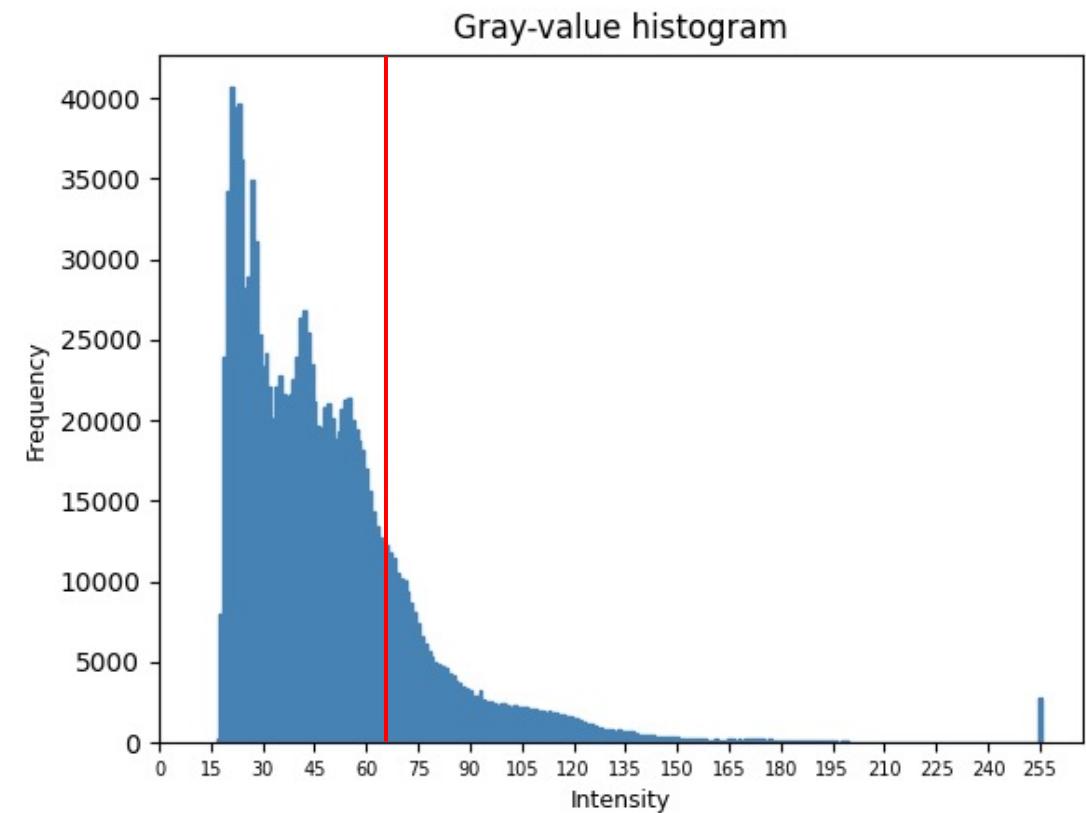
- High-throughput cytometry
 - Cell size
 - Cell counting
 - Cell-cycle determination
- Cell tracking



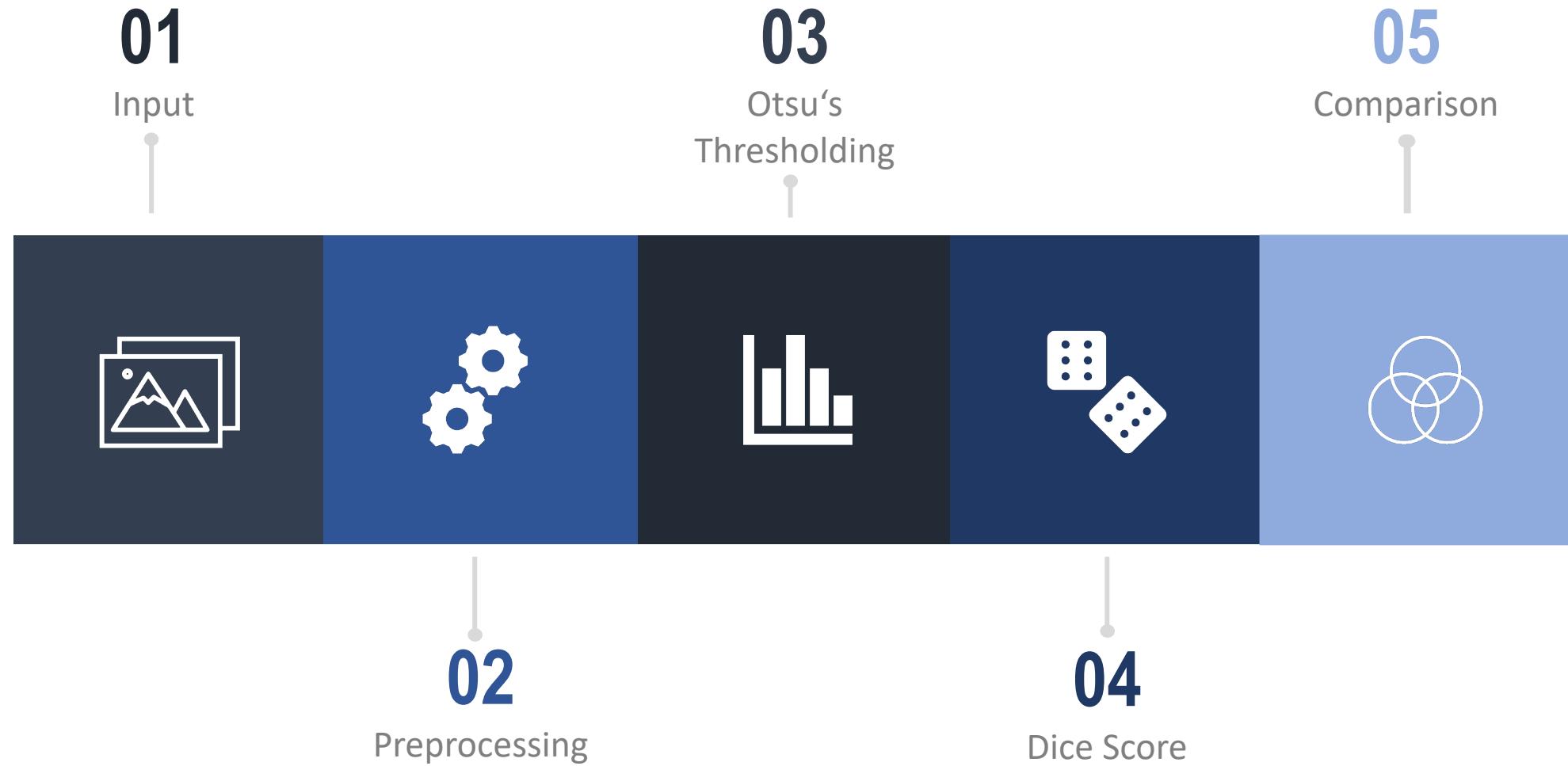
Methods

- Thresholding → Intensity clipping

Otsu's thresholding

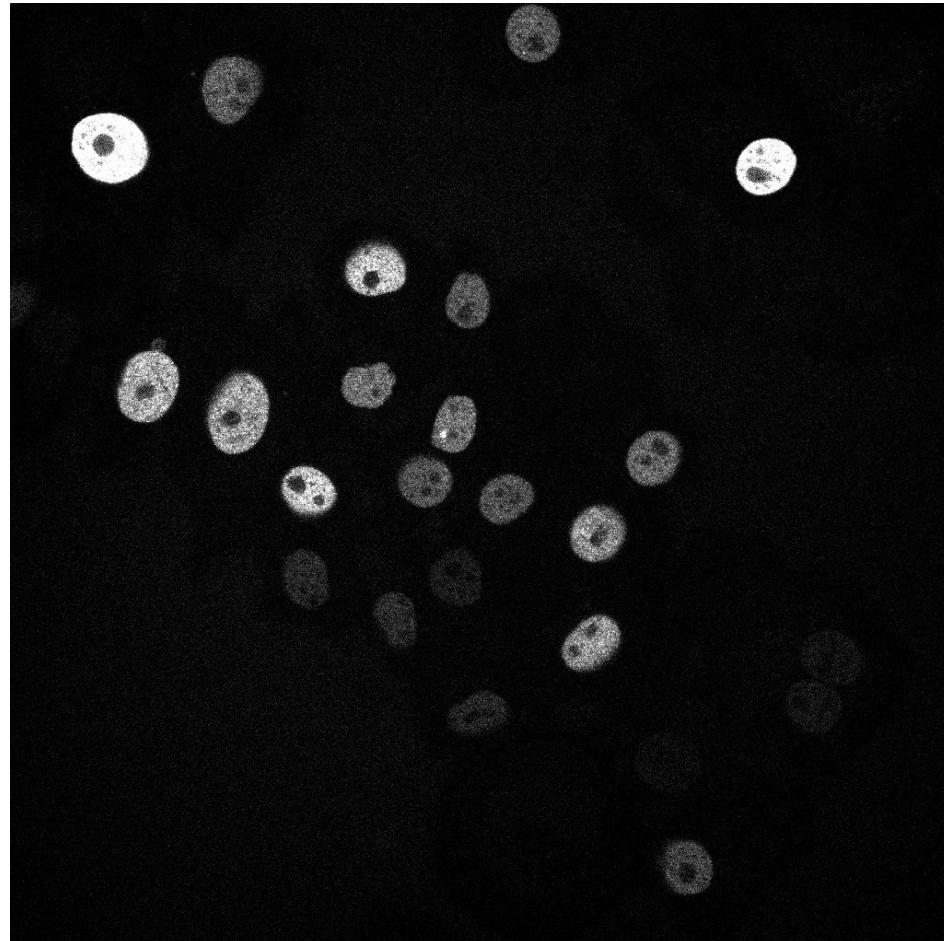


Workflow





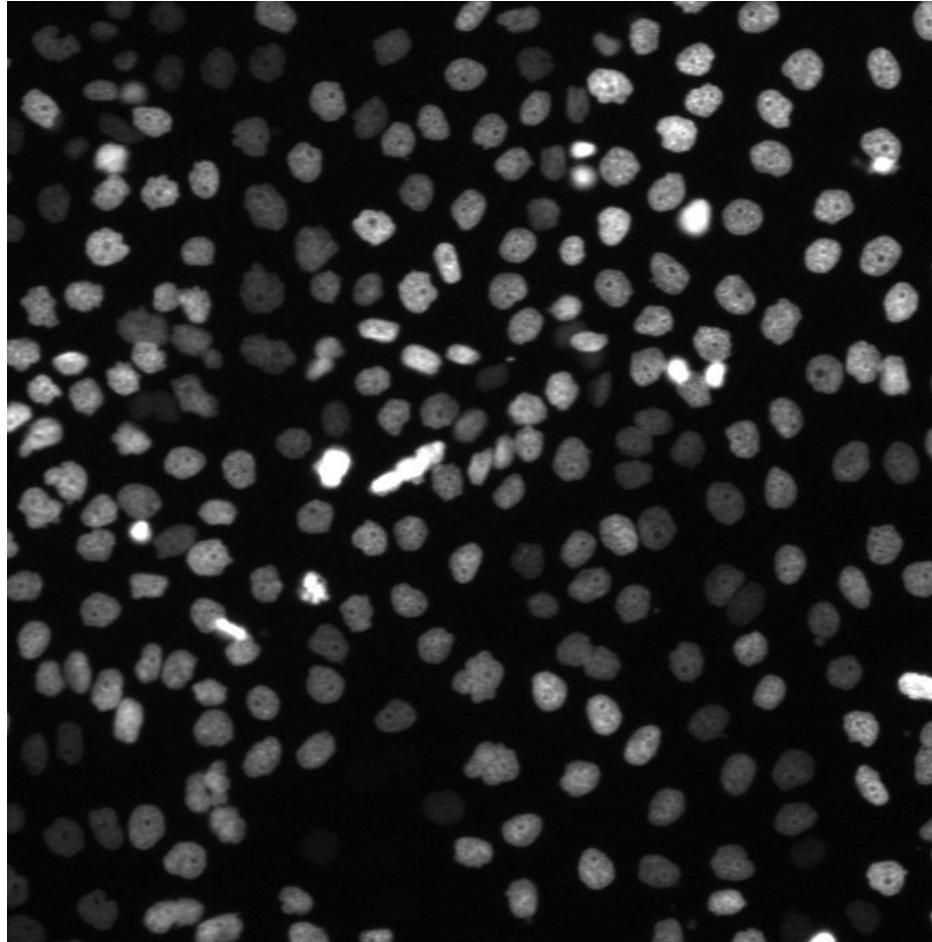
Input 1: N2DH-GOWT1 cells



- GFP-Gowt1 mouse embryonic stem cells
- Time-laps confocal microscopy and GFP-staining
- Investigate genomic integrity of the cells



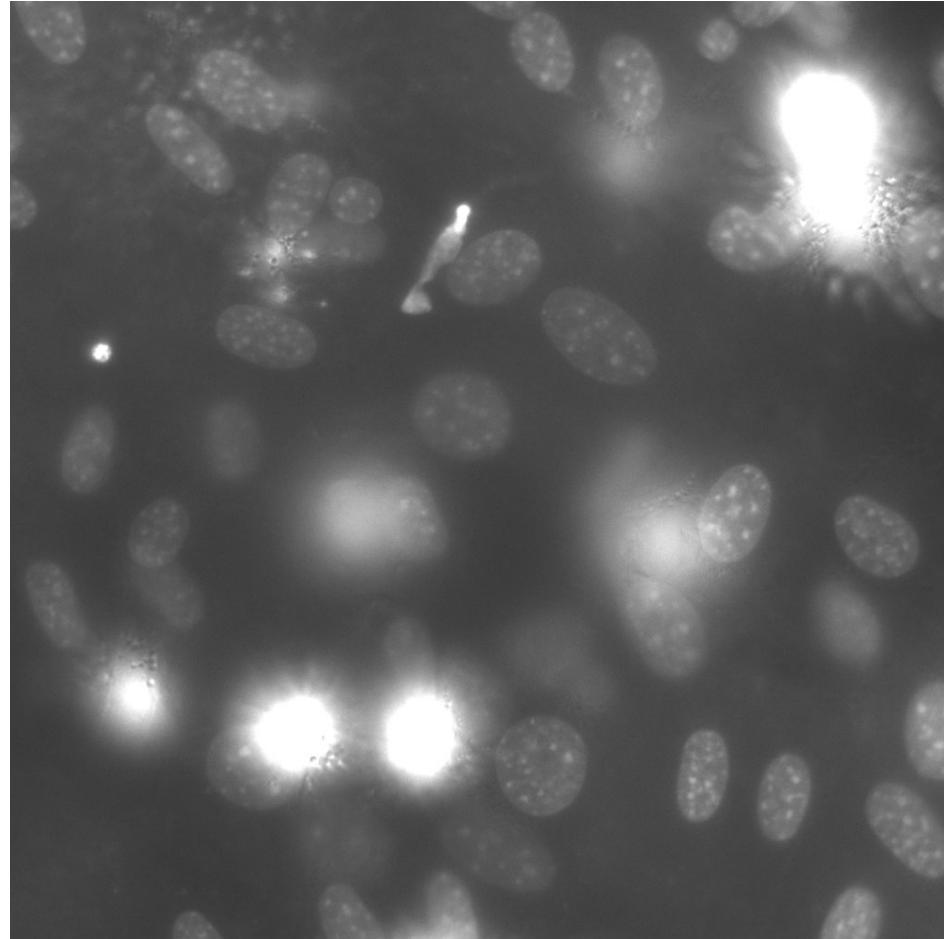
Input 2: N2DH-HeLa cells



- Human epithelial cells of cervical cancer
- Live imaging of fluorescently labelled chromosomes
- Phenotypic profiling of the human genome



Input 3: NIH3T3 cells

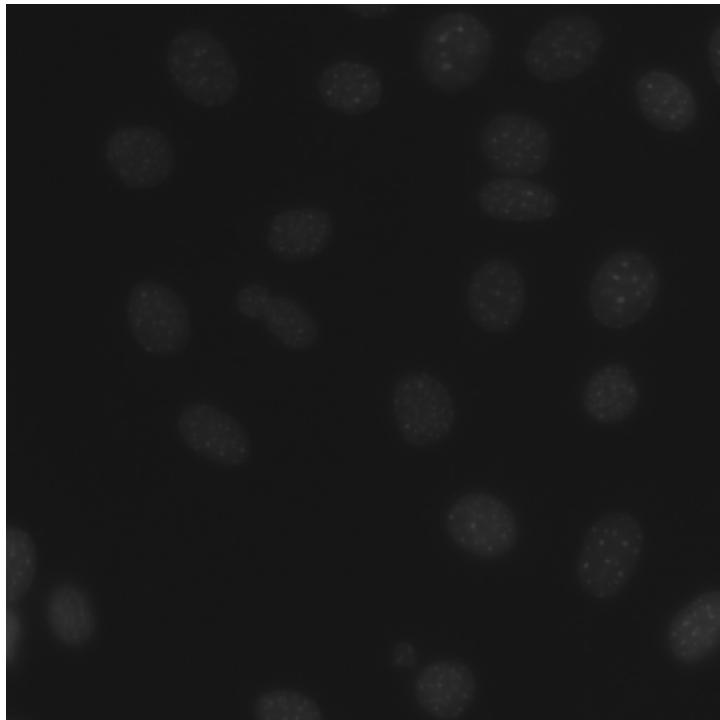


- Several mouse embryonic fibroblast cells
- Fluorescence microscopy images
- Evaluation of image analysis pipelines

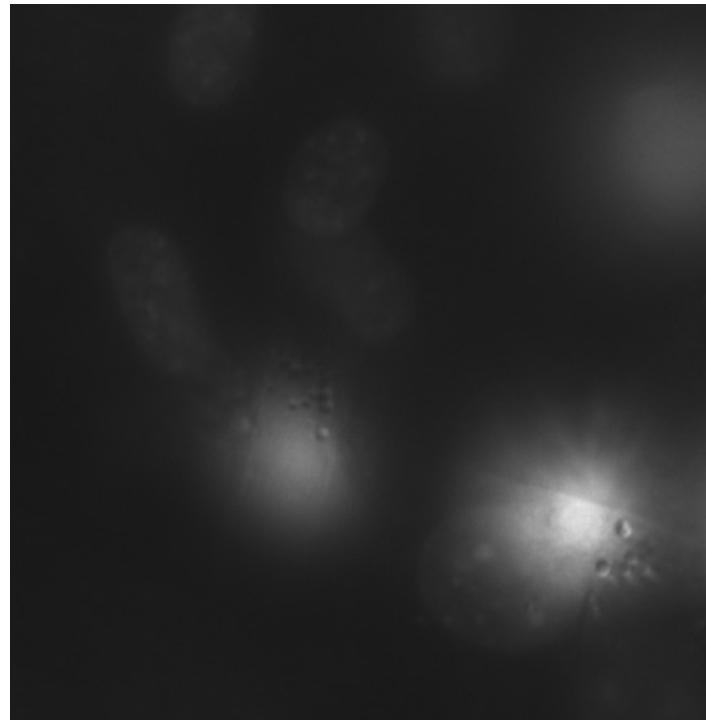


Problems

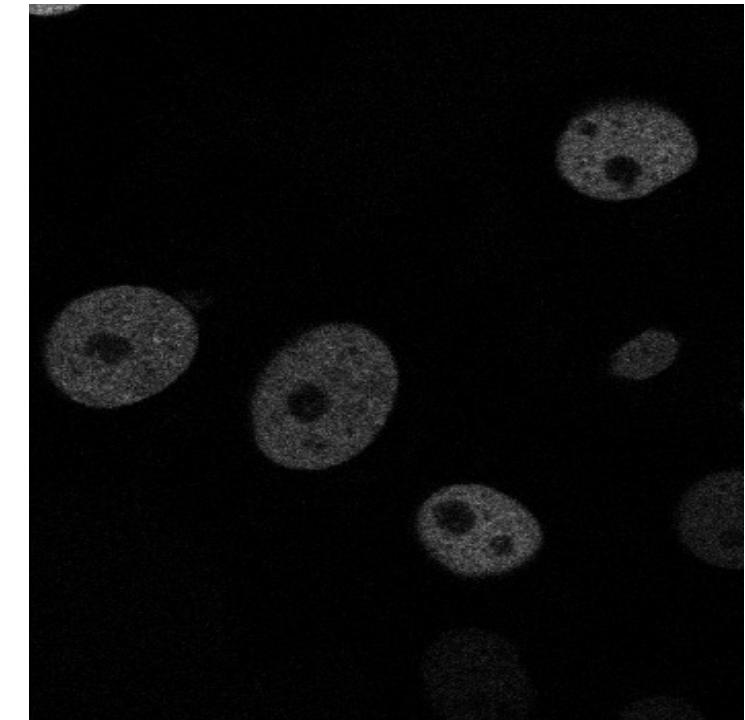
Low contrast



Reflections



Random noise

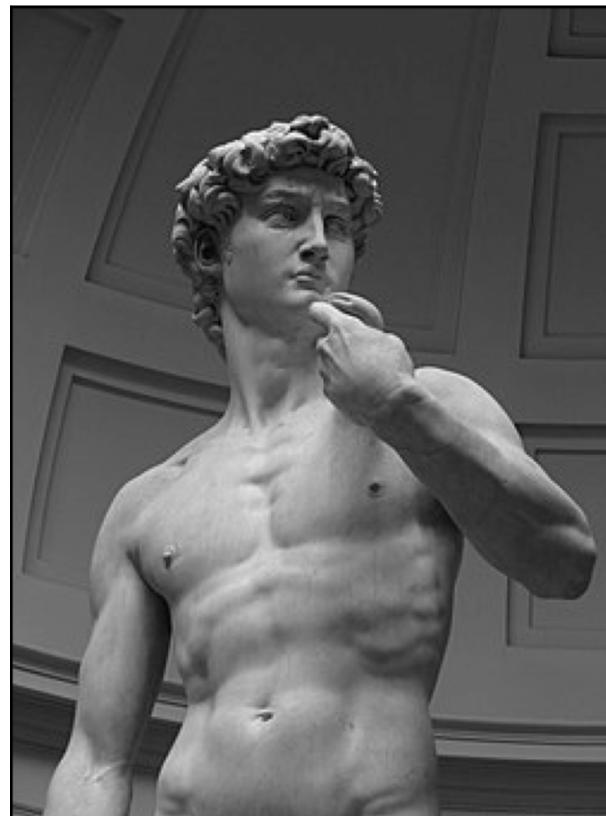




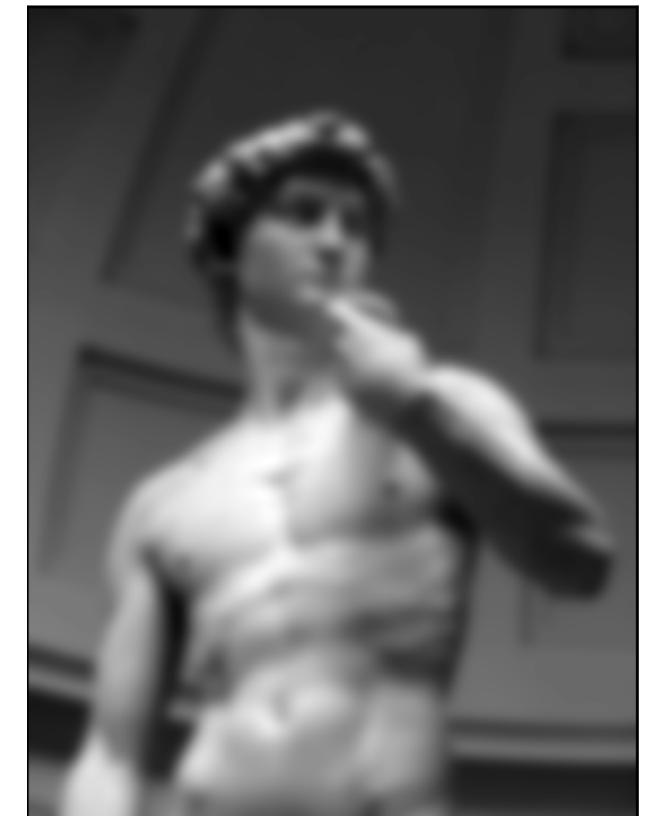
Preprocessing

Solutions:

- Random noise
→ **Gauss filter, median filter**
- Reflections
- Low contrast



Original



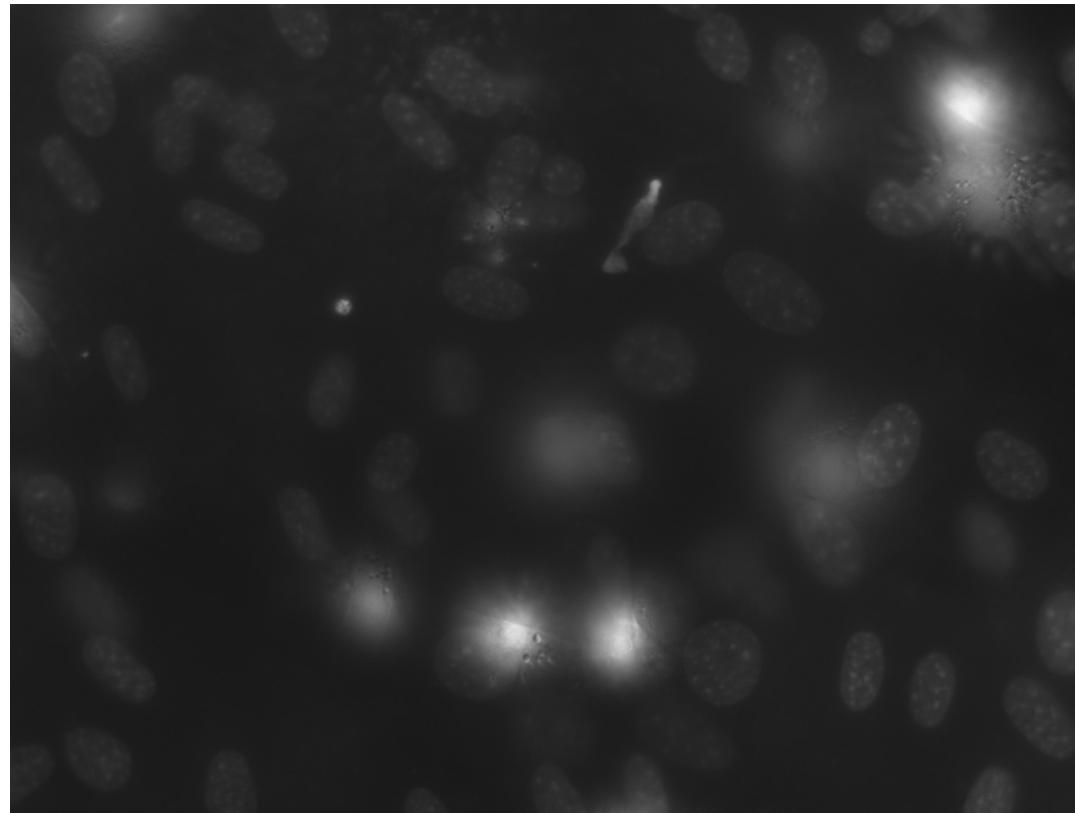
Gauss filter ($\sigma = 3$)



Preprocessing

Solutions:

- Random noise
→ **Gauss filter, median filter**
- Reflections
→ **Thresholding**
- Low contrast

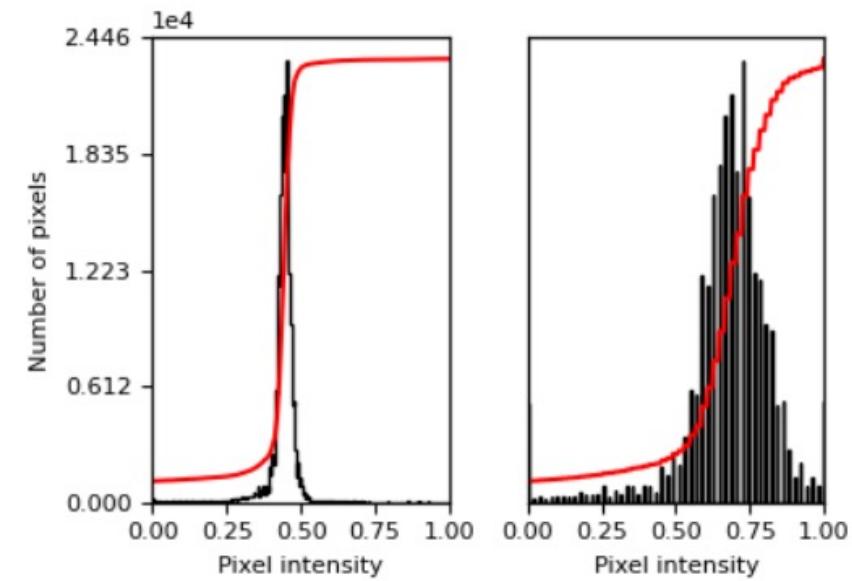




Preprocessing

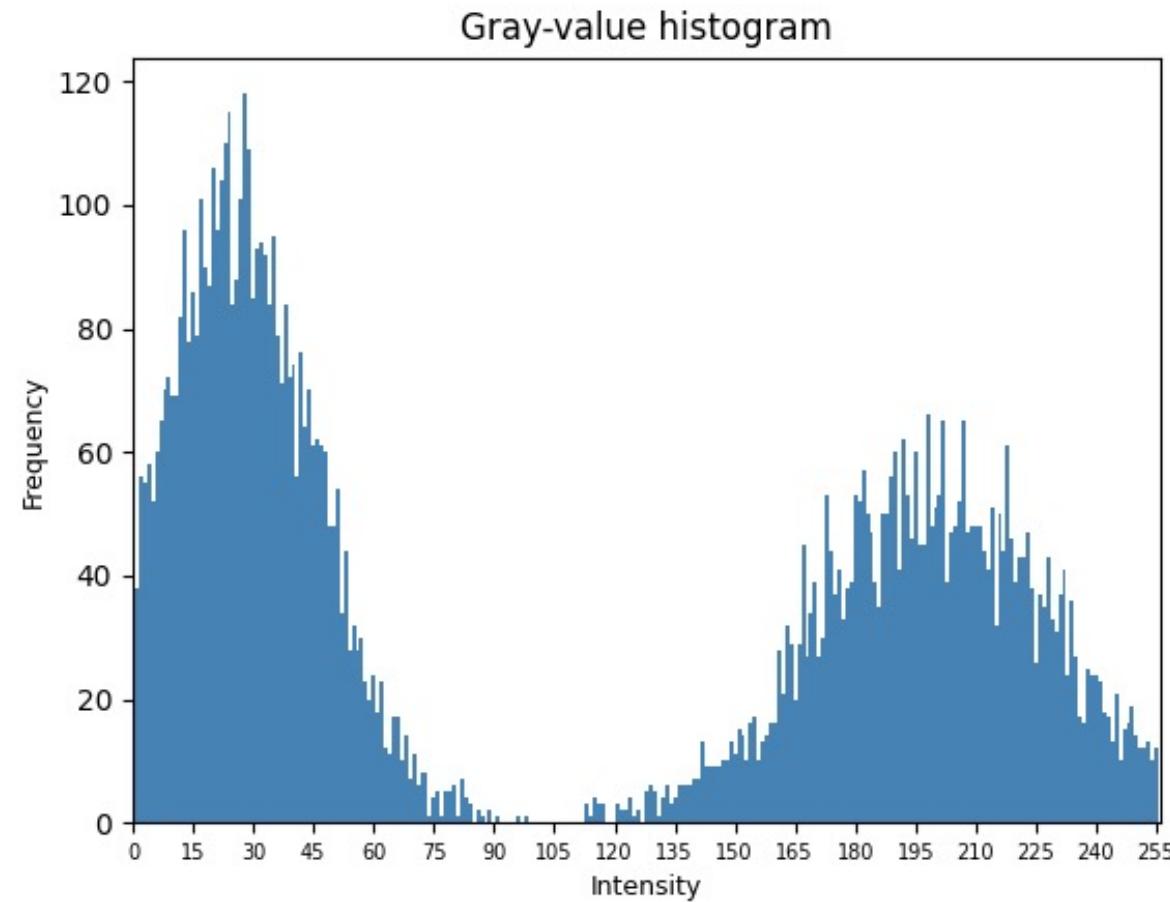
Solutions:

- Random noise
→ **Gauss filter, median filter**
- Reflections
→ **Thresholding**
- Low contrast
→ **Histogram stretching**



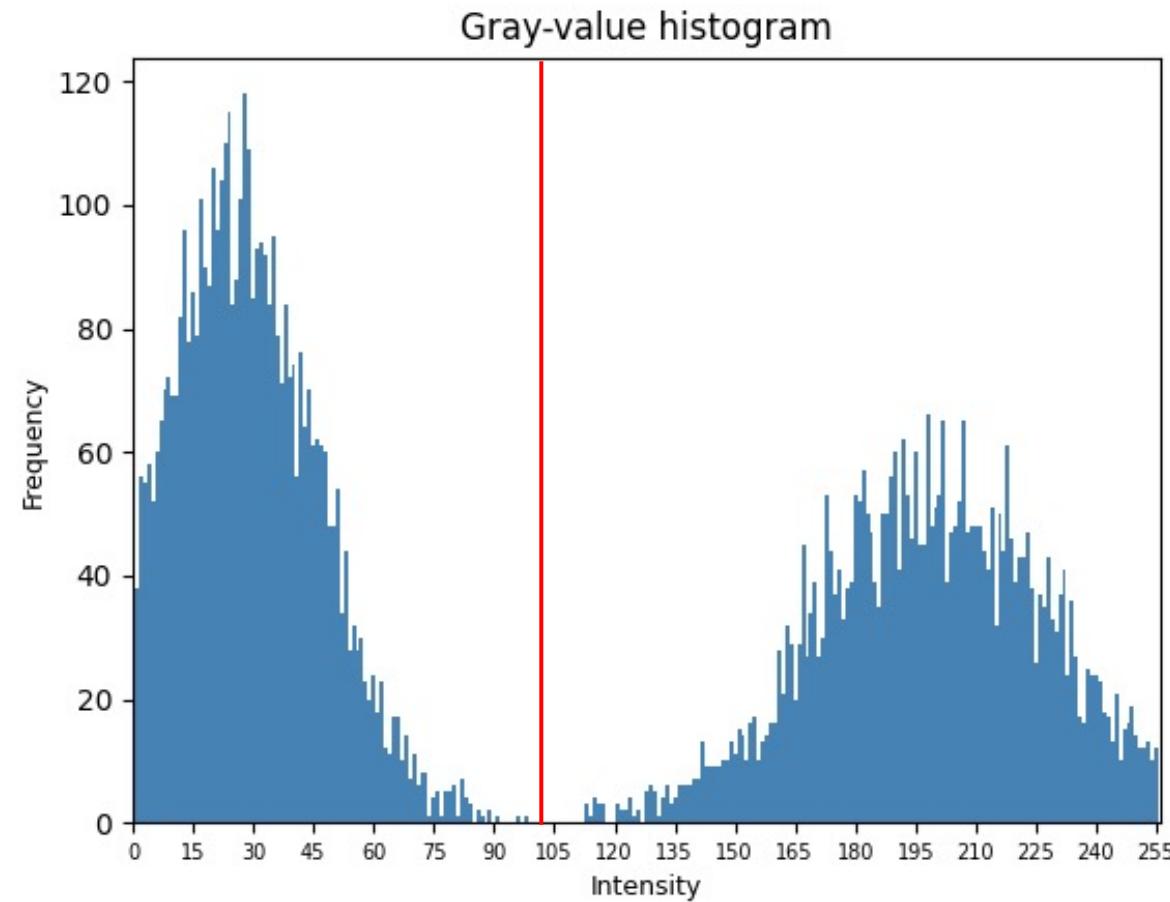


Otsu's Thresholding



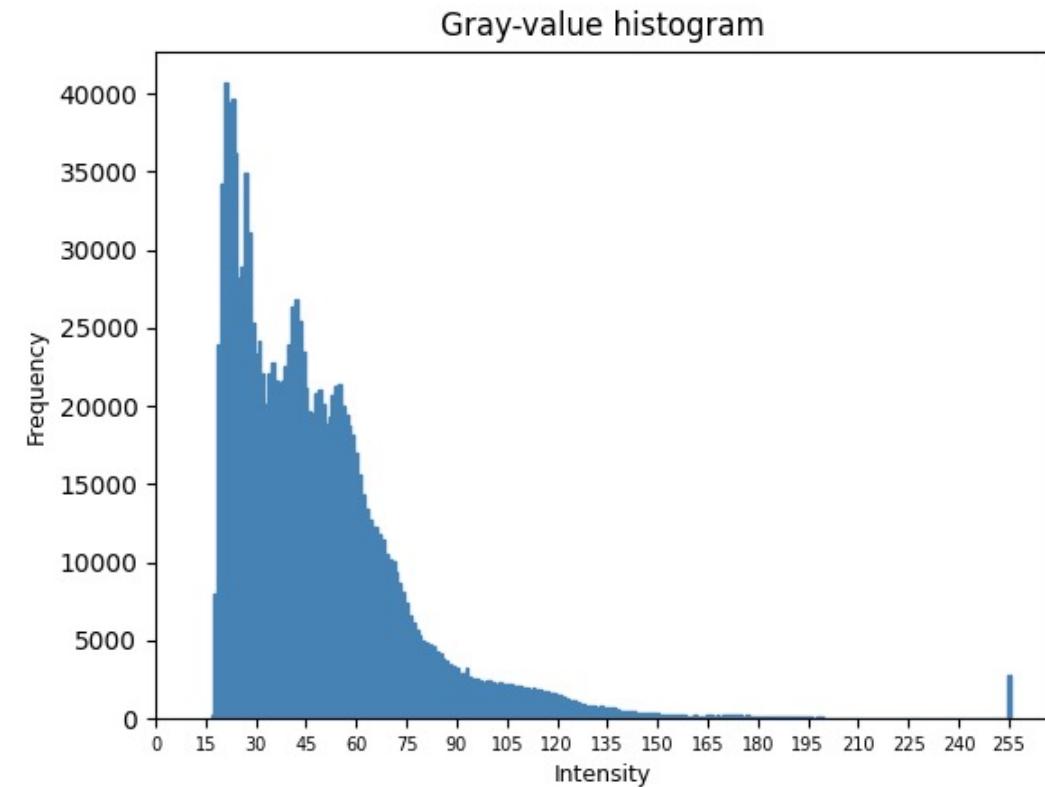
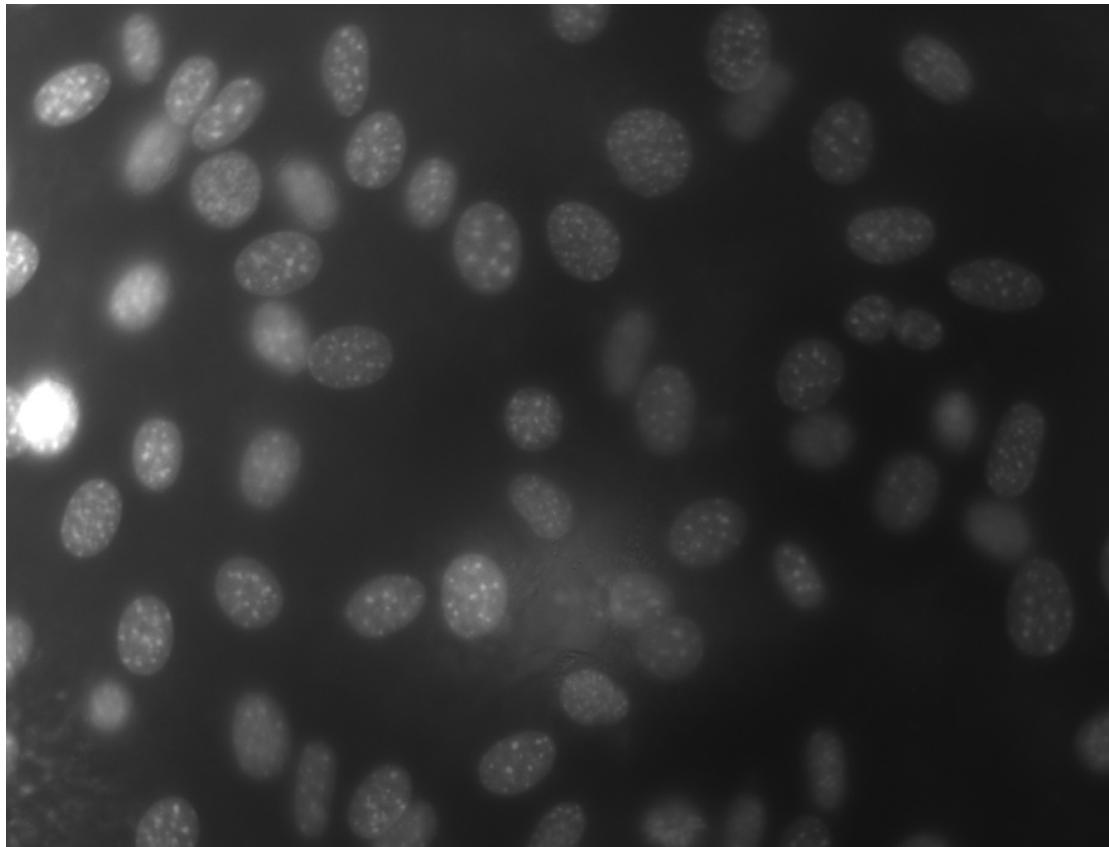


Otsu's Thresholding





Otsu's Thresholding



Threshold value $k \in [0, 255]$



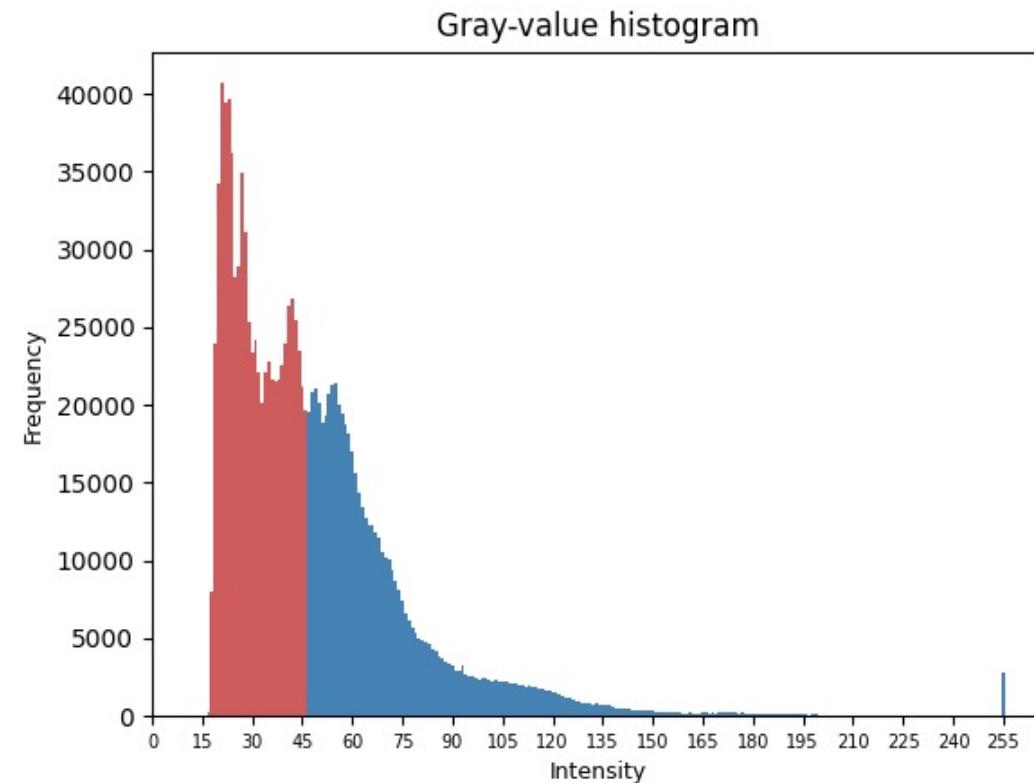
Otsu's Thresholding

Between-class variance

$$\sigma_B = \omega_0 \omega_1 (\mu_1 - \mu_0)^2$$

$\omega_{0,1}$ = probability of class occurrence

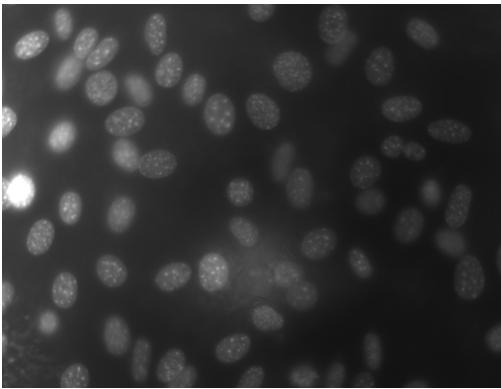
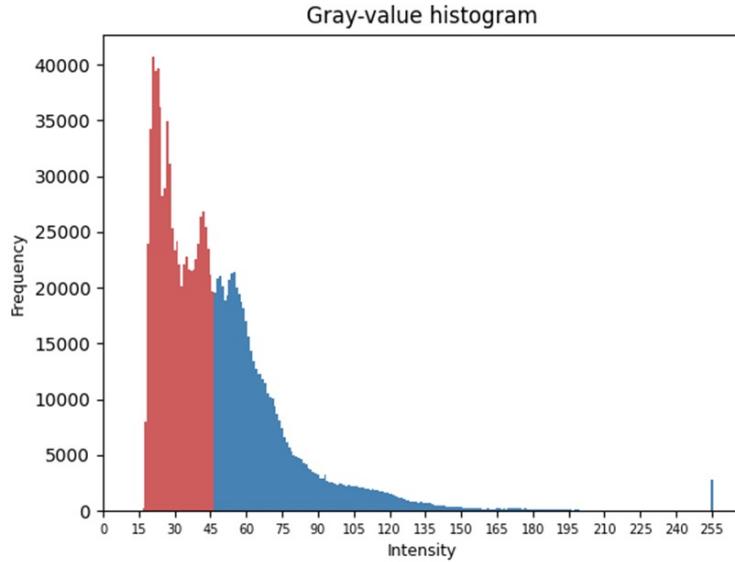
$\mu_{0,1}$ = mean intensity values



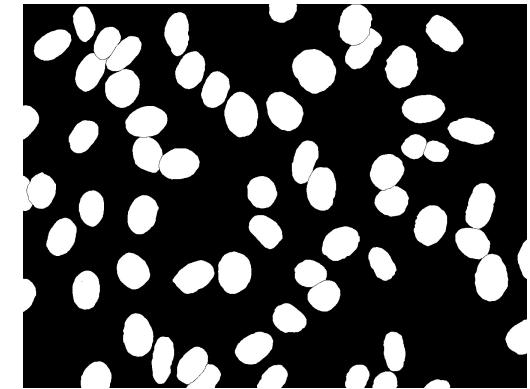
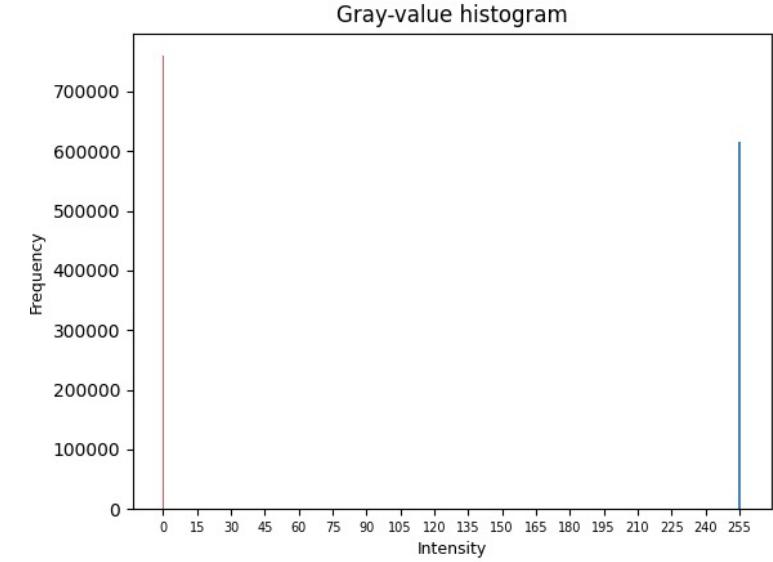
Threshold value $k \in [0, 255]$



Image clipping

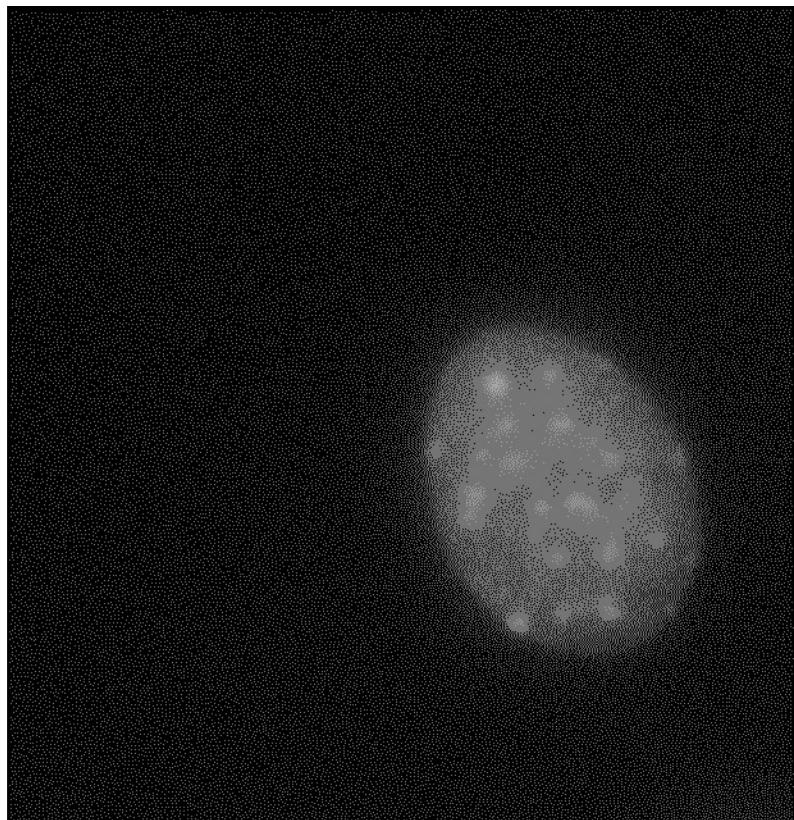


$$g_{\text{clip}}(x, y) = \begin{cases} 0 & \text{if } g(x, y) \leq k \\ 255 & \text{if } g(x, y) > k \end{cases}$$

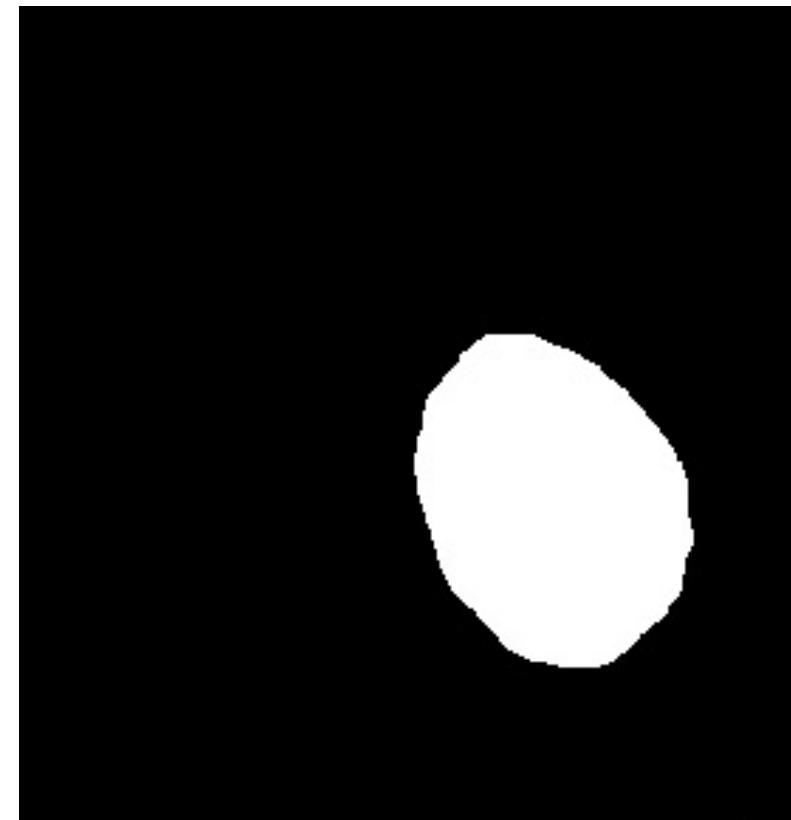




Implementation of the Dice Score



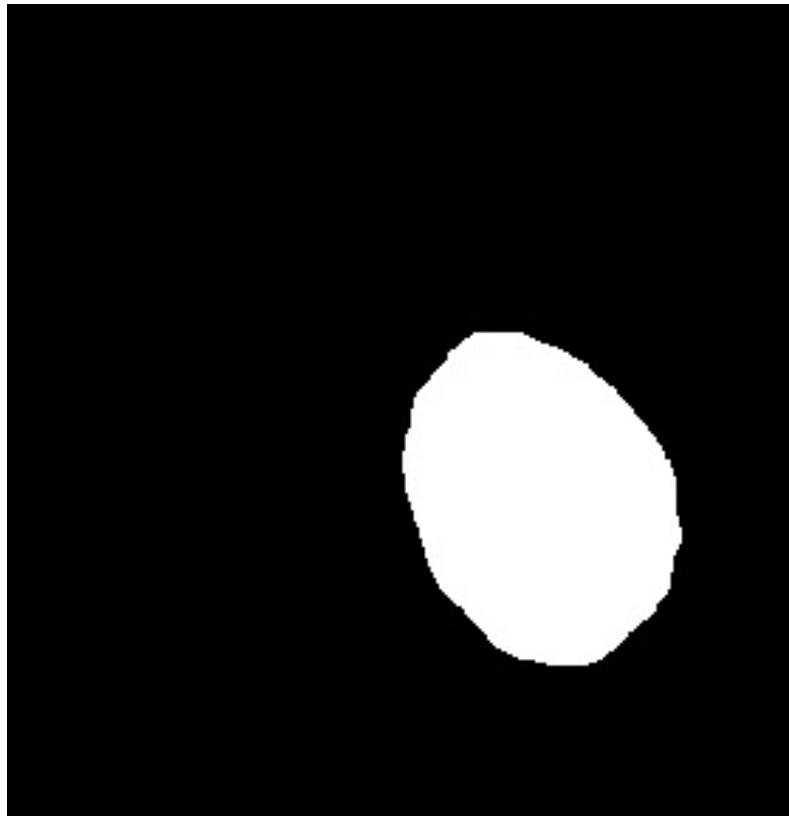
Original image



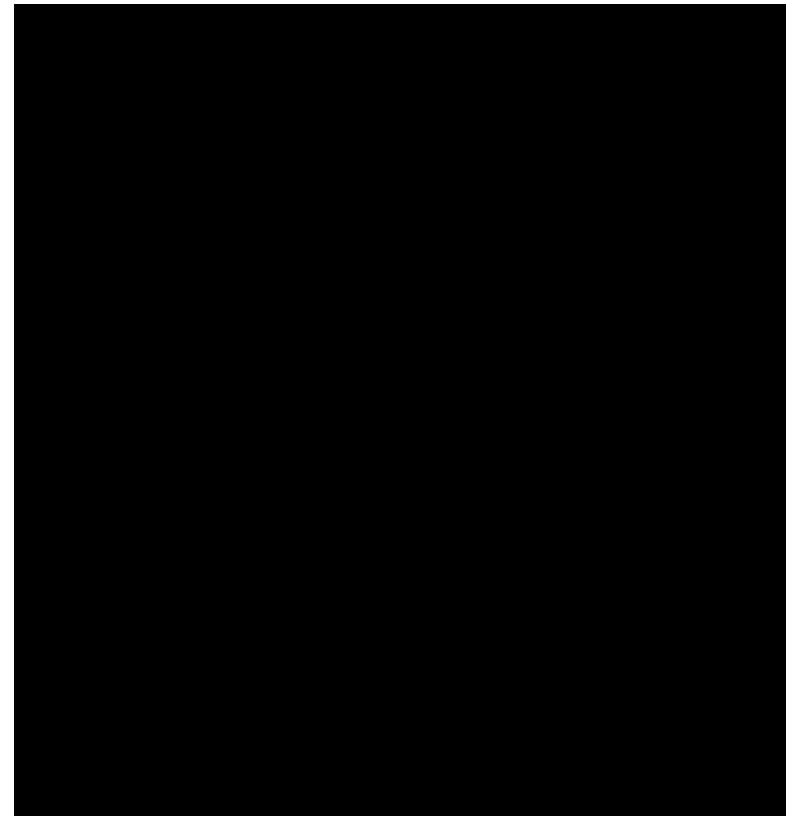
Ground truth



Implementation of the Dice Score



Ground truth



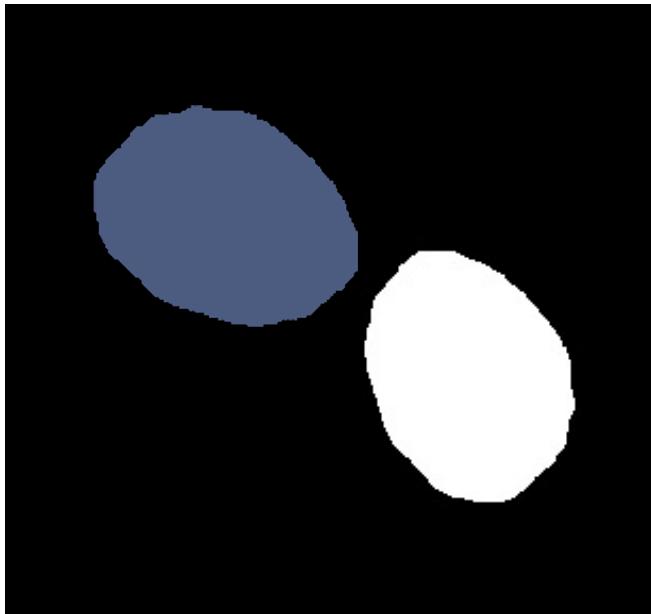
Prediction

≈80 % accuracy

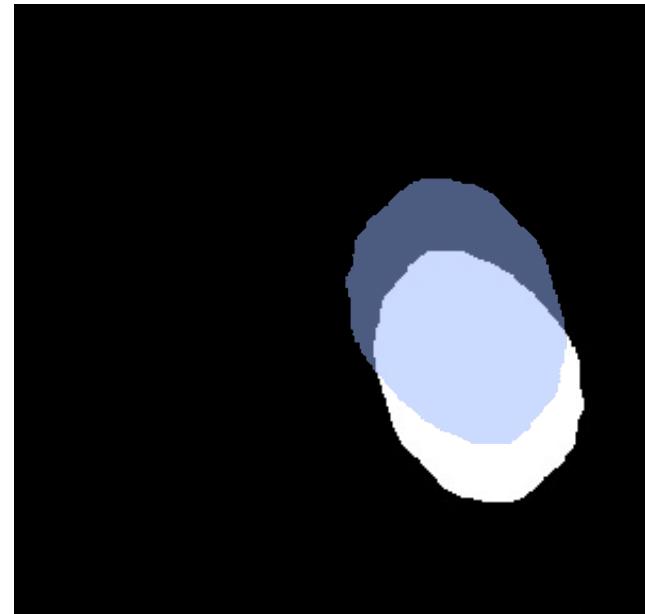


Implementation of the Dice Score

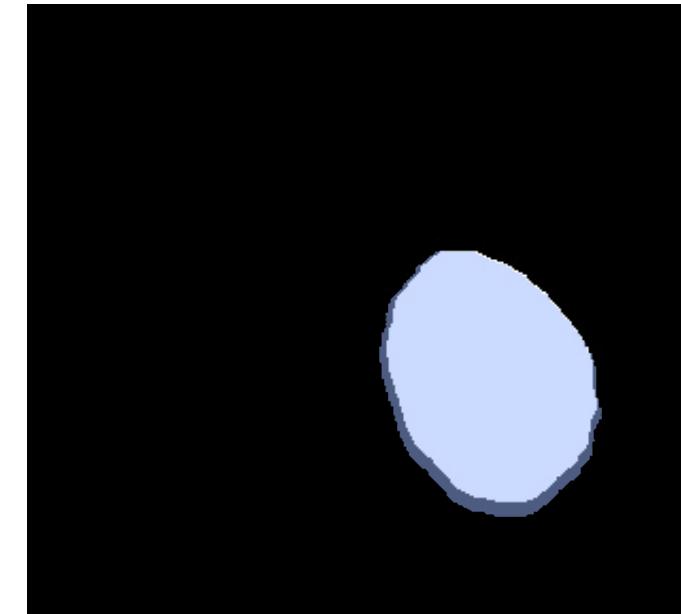
Bad prediction



Good prediction

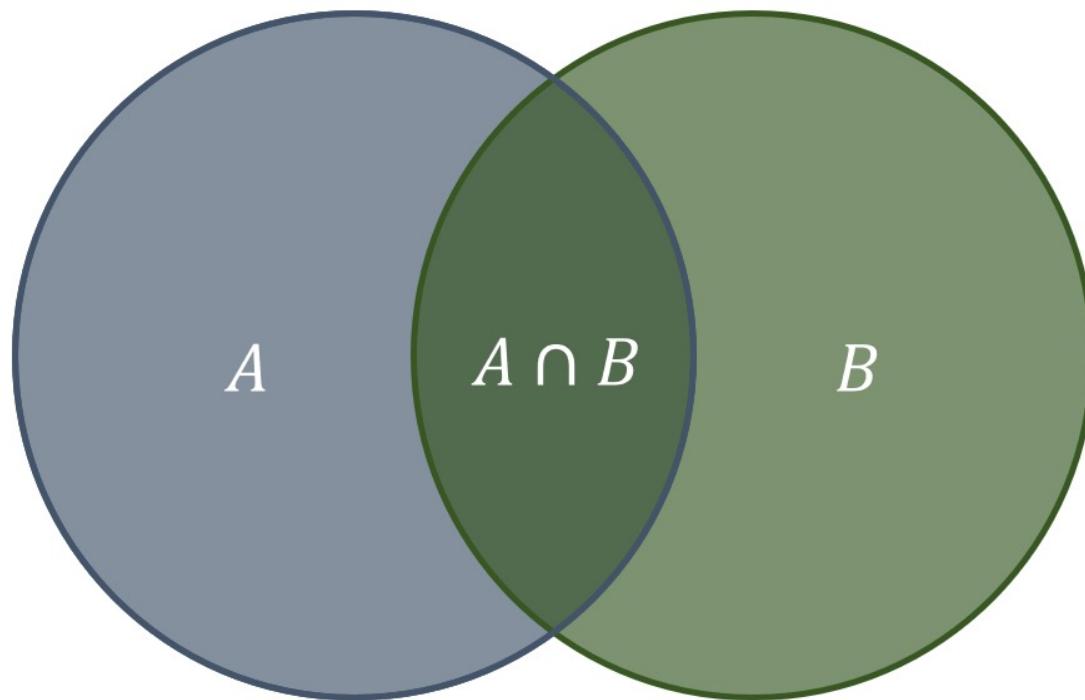


Very good prediction





Implementation of the Dice Score

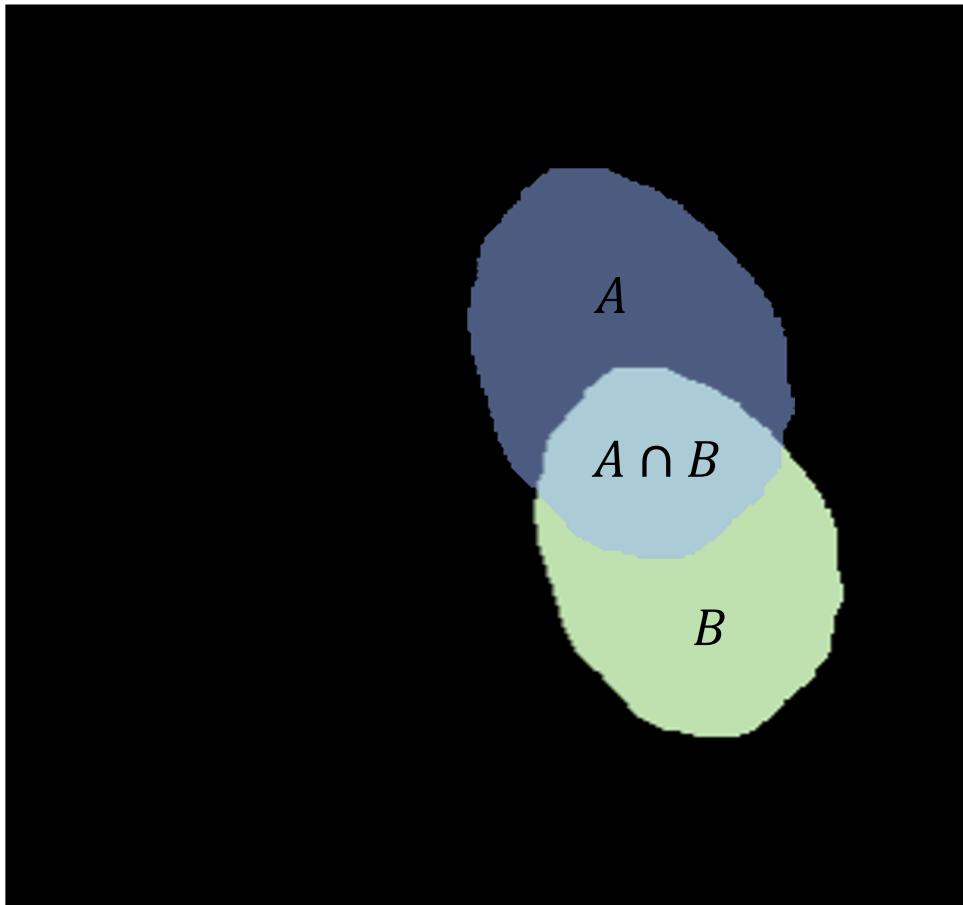


A: Predicted shape
B: Ground truth

$$DSC = \frac{2 \times |A \cap B|}{|A| + |B|}$$



Implementation of the Dice Score

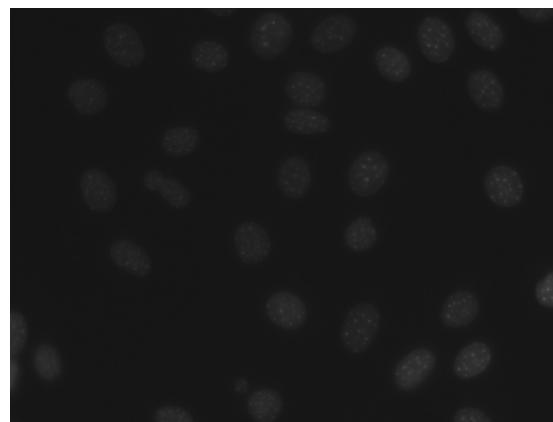


$$DSC = \frac{2 \times |A \cap B|}{|A| + |B|}$$



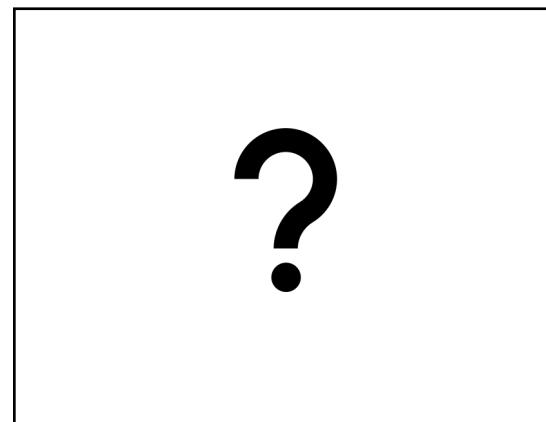
Implementation of the Dice Score

Our goal: compare ground truth images with our results



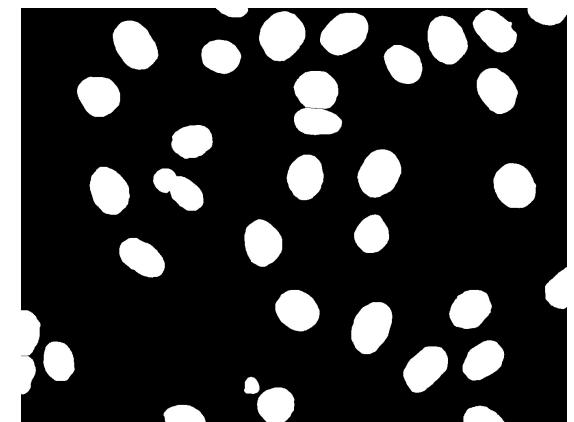
Original image

Otsu's
thresholding
→



Our result

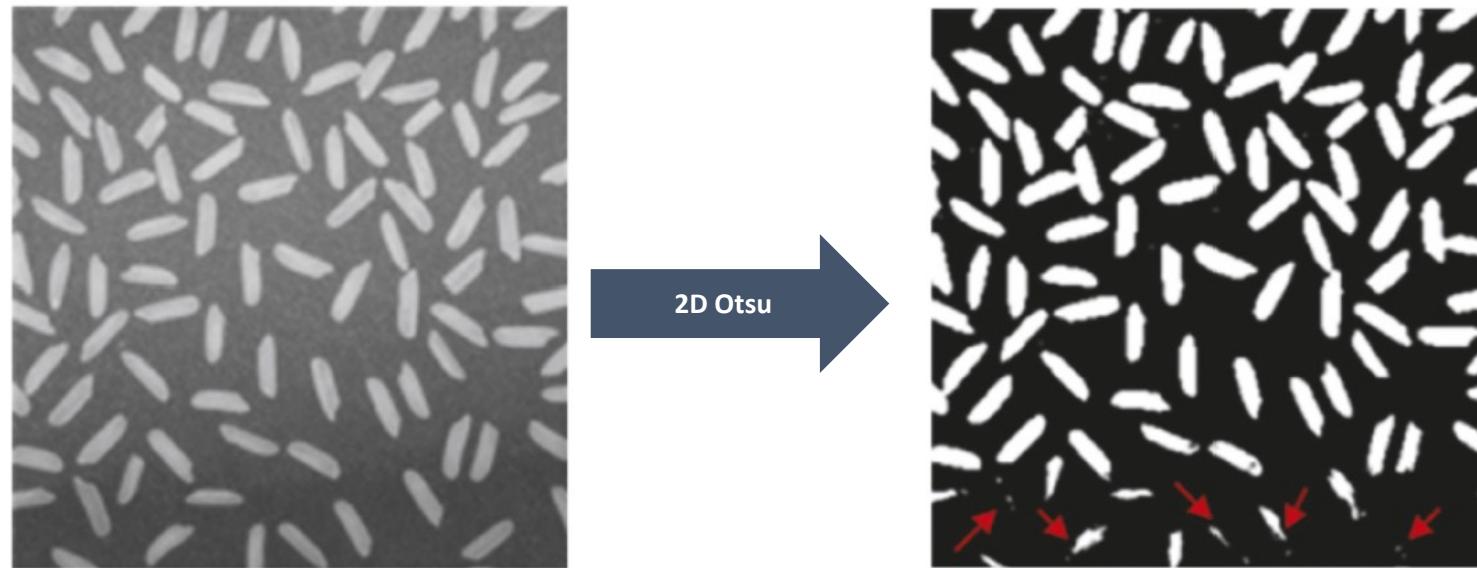
← comparison



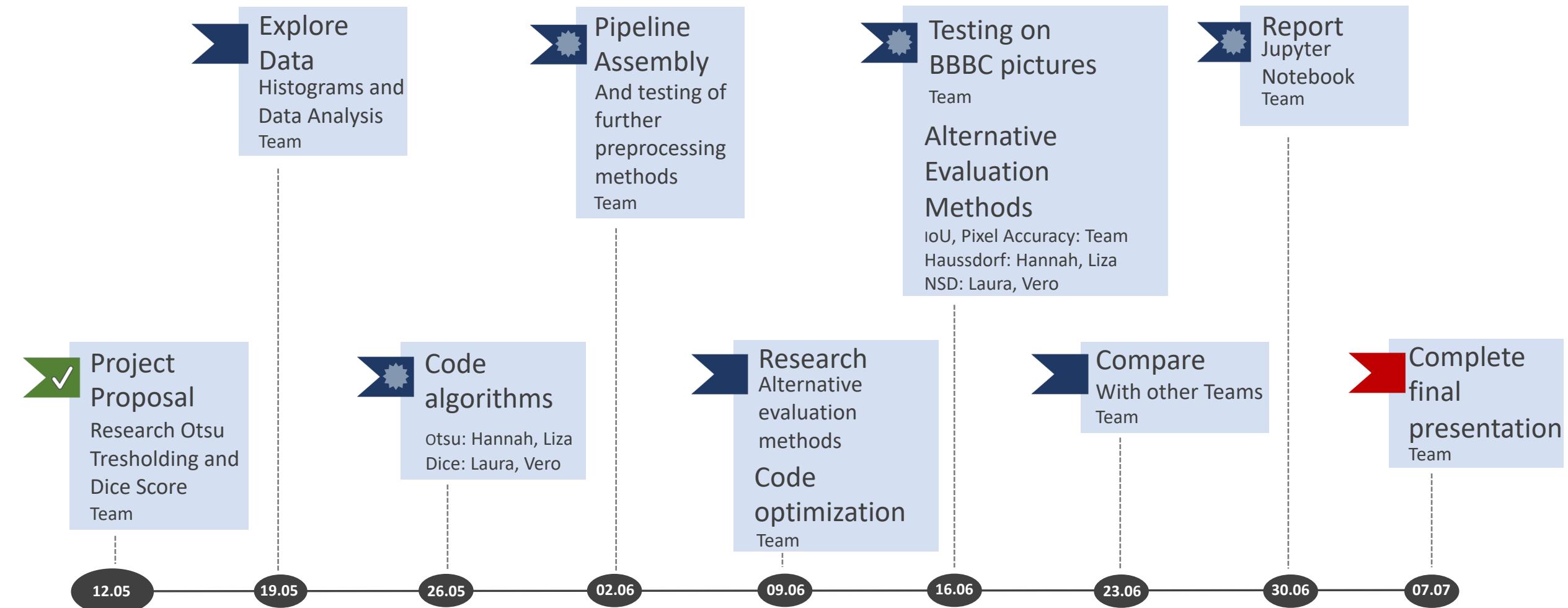
Ground truth

Further ideas

- 2D Otsu
- Algorithm for counting cells



Timeline





Thank you
for your
attention!

Laura Wächter, Hannah Winter, Elizaveta Chernova, Veronika Schuler

Additional slide – Histogram stretching

a = 0, b = 255

c – lowest pixel intensity in the image

d – highest pixel intensity in the image

$$P_{out} = (P_{in} - c) \left(\frac{b - a}{d - c} \right) + a$$

Additional slide – Gaussian distribution

- TO DO

Additional slide – criterion measure

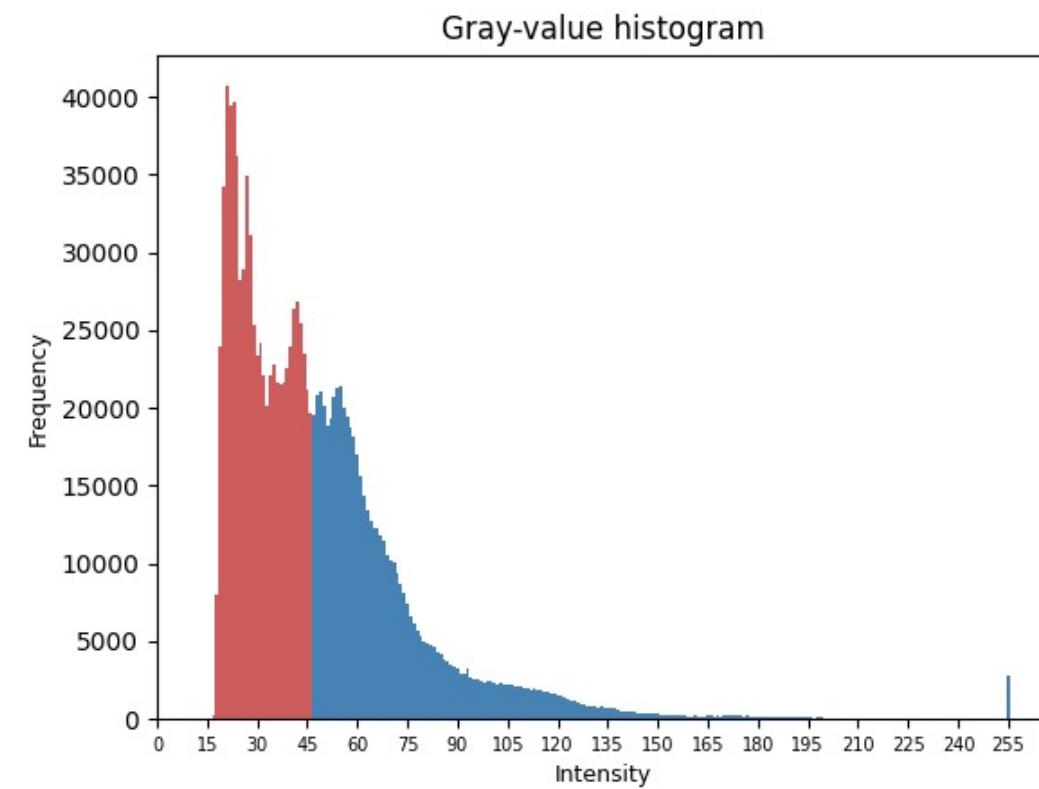
Criterion measure

$$\eta(k) = \frac{\sigma_B^2(k)}{\sigma_T^2}$$

σ_B = between-class variance

σ_T = total variance

$\eta(k) \in [0,1]$



Threshold value $k \in [0,255]$