

Cell nuclei segmentation: support vector machine

*Project proposal by
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Second Milestone

Implement Support Vector machine

First Milestone

Implement Dice score

Third Milestone

Implement Pre-processing

Our data

Timeline



Our Data

28 images of nuclei

- *N2DH-GOWT1*

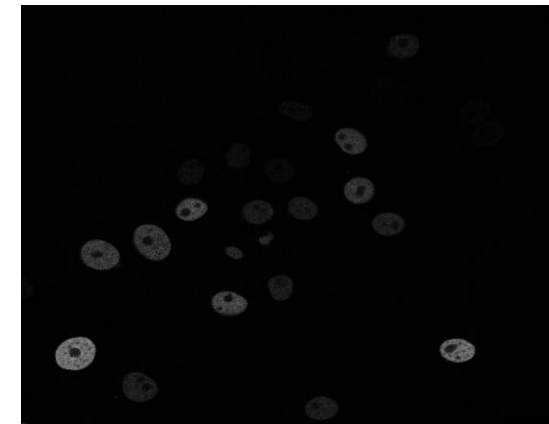
GFP transfected GOWT1 mouse embryonic stem cells

- *N2DL-HeLa*

Histone 2B (H2B)-GFP expressing HeLa cells

- *NIH3T3*

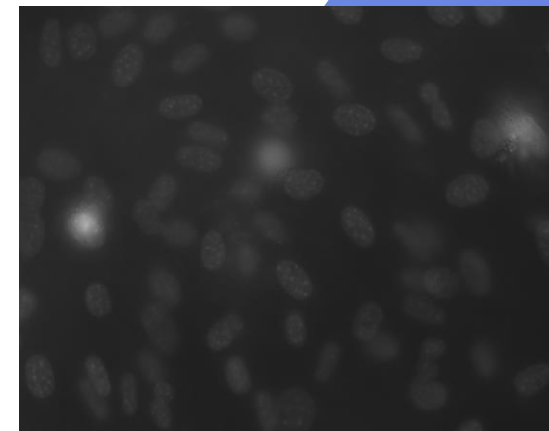
mouse embryonic fibroblast – CD tagged (EGFP)



N2DH-GOWT1



N2DL-HeLa

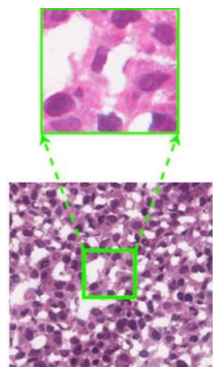


NIH3T3

(1) Osuna, E. et al. 2007. Large-Scale Automated Analysis of Location Patterns in Randomly Tagged 3T3 Cells

(2) Maska, M. et al. 2014. A benchmark for comparison of cell tracking algorithms

Our goal



Input Image

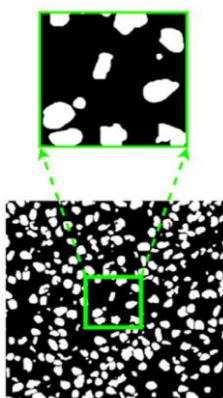
Input: Microscopic images

Preprocessing & filtering

Segmentation:

Support vector machine

Data mining: Counting nuclei



Segmented Mask

Output: Segmented image & number of nuclei

Our goal

Input: Microscopic images

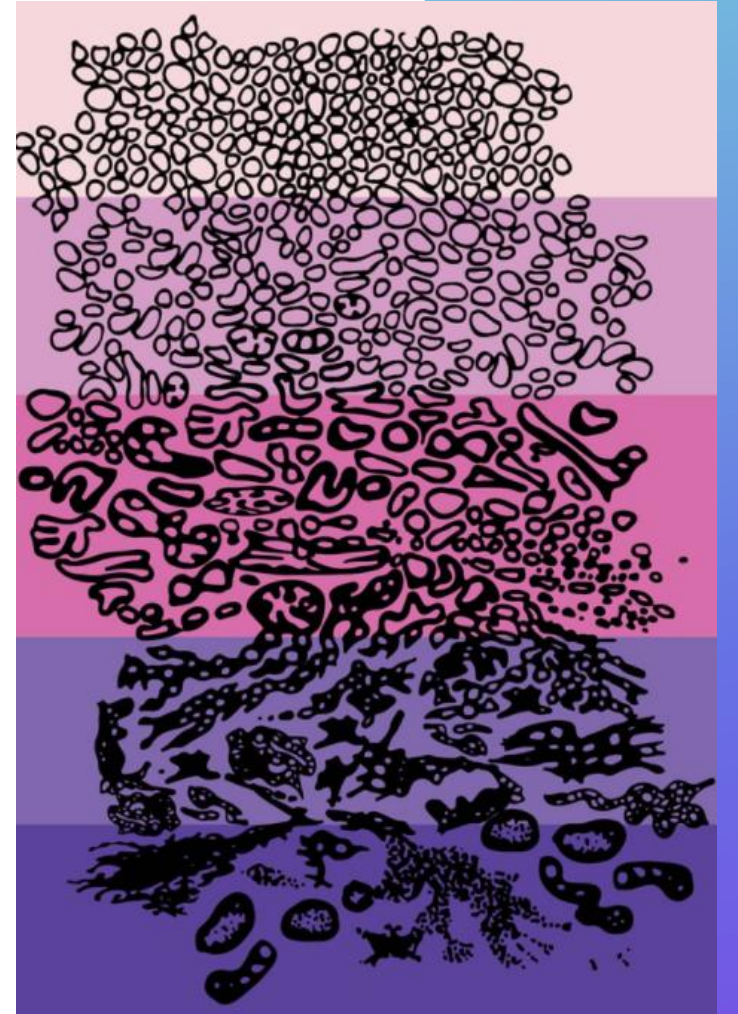
Preprocessing & filtering

Segmentation:
Support vector machine

Data mining: Counting nuclei

Output: Segmented image & number of nuclei

quantify degree of malignancy (= grading)



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Third Milestone

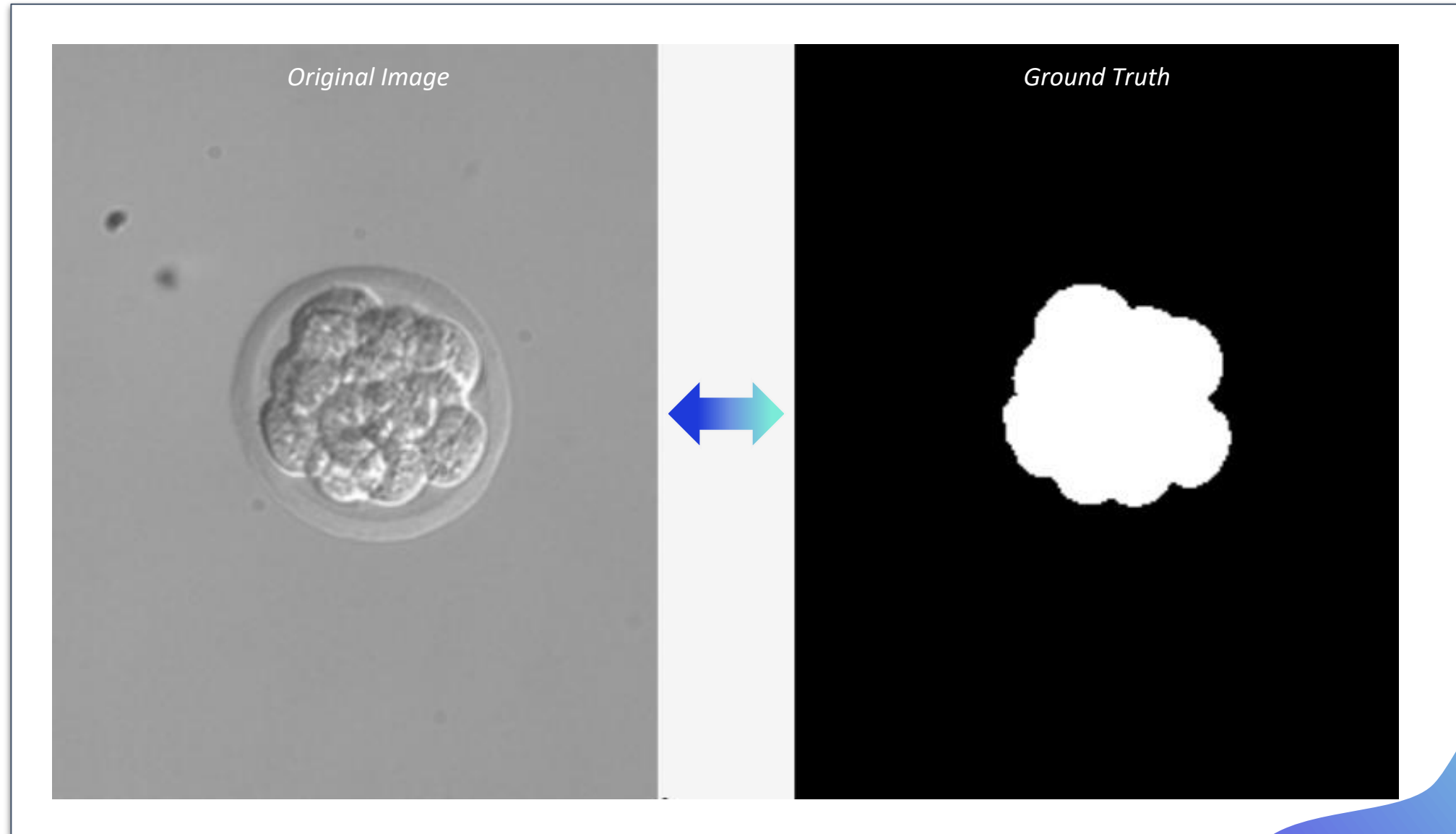
Implement Pre-processing

Our data

Timeline

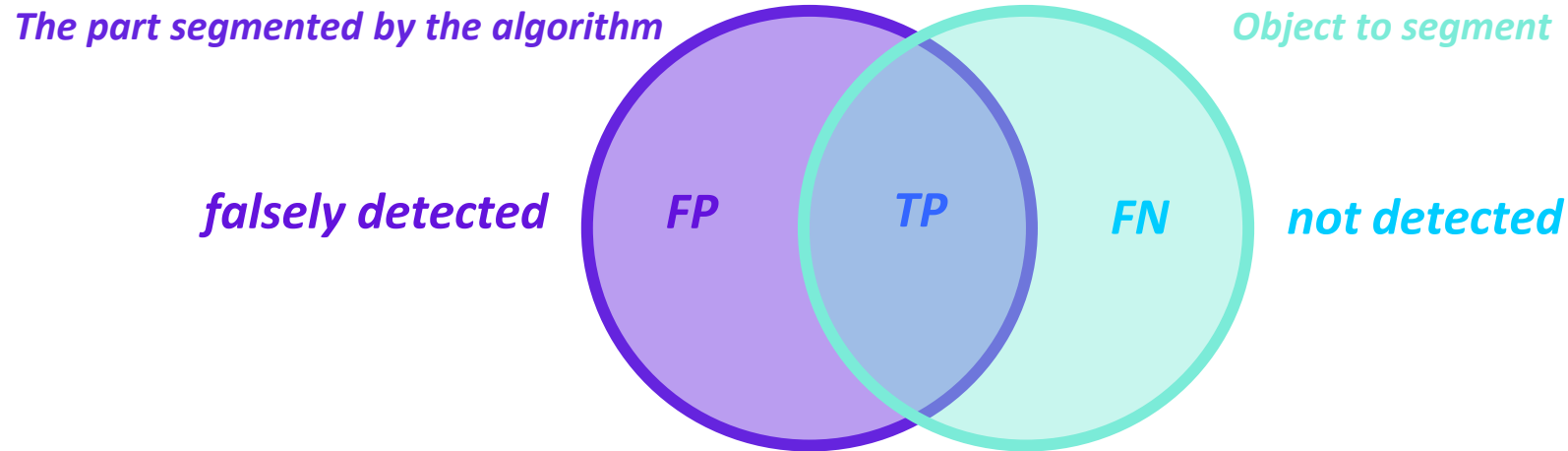


Determining Our Image Segmentation Quality



Dice Score

Evaluating the quality of the segmentation quantitatively

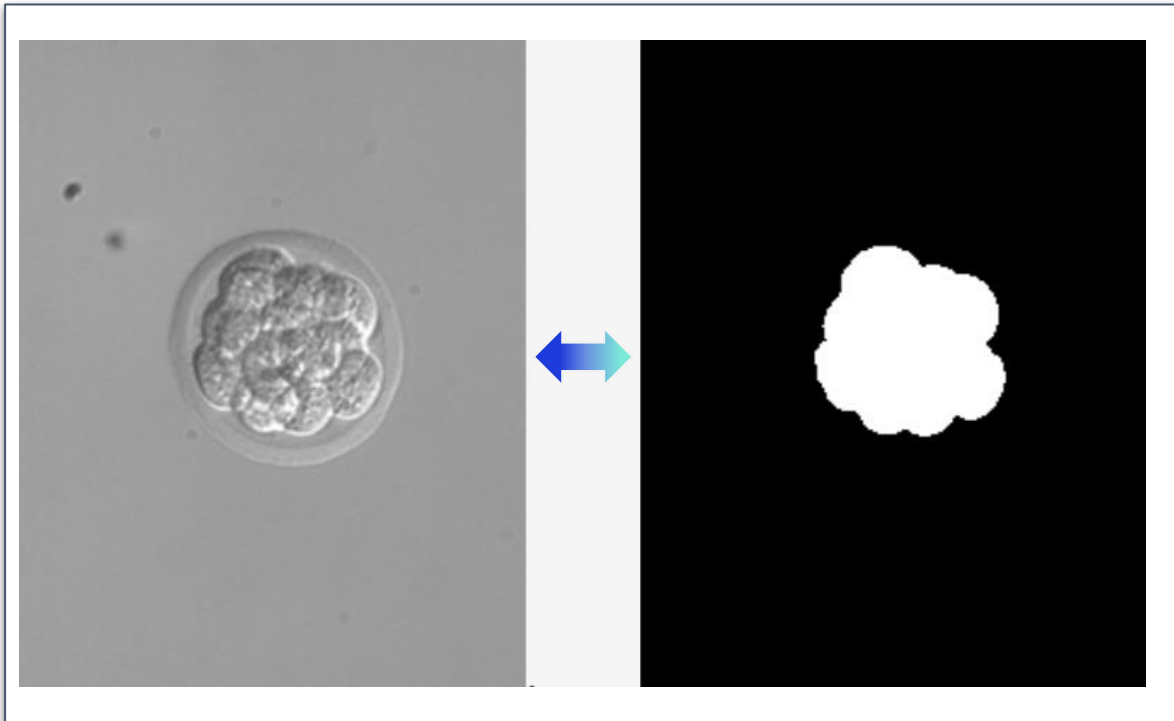


————•
$$\text{IoU} = \frac{\text{Intersection}}{\text{Union}} = \frac{TP}{TP+FP+FN}$$

————•
$$\text{Dice} = \frac{2 * \text{Intersection}}{\text{Union} + \text{Intersection}} = \frac{2 TP}{2 TP + FP + FN}$$

————•
$$\text{Loss} = 1 - \text{Dice} \in [0;1]$$

Dice Score



Planned analysis steps

- *Write code for Dice-Score function*
- *Unit-testing*
- *Write code for synthetic images*

Characteristics of the first Milestone

- *Measure for evaluating our model*

Second Milestone

Implement Support Vector machine

First Milestone
Implement Dice score

Third Milestone
Implement Pre-processing

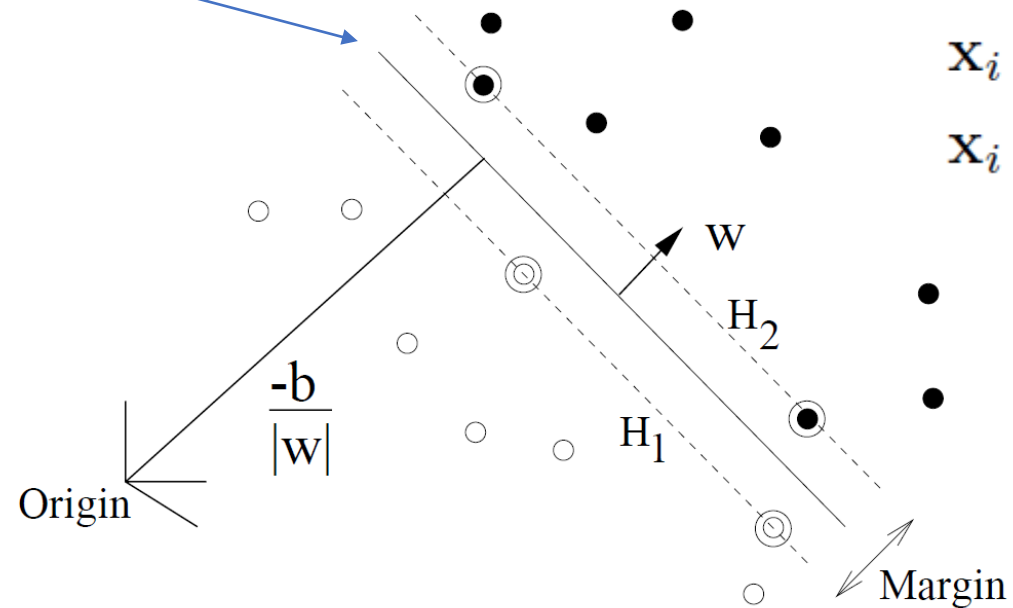
Our data

Timeline



Support Vector machine

decision function \rightarrow hyperplane

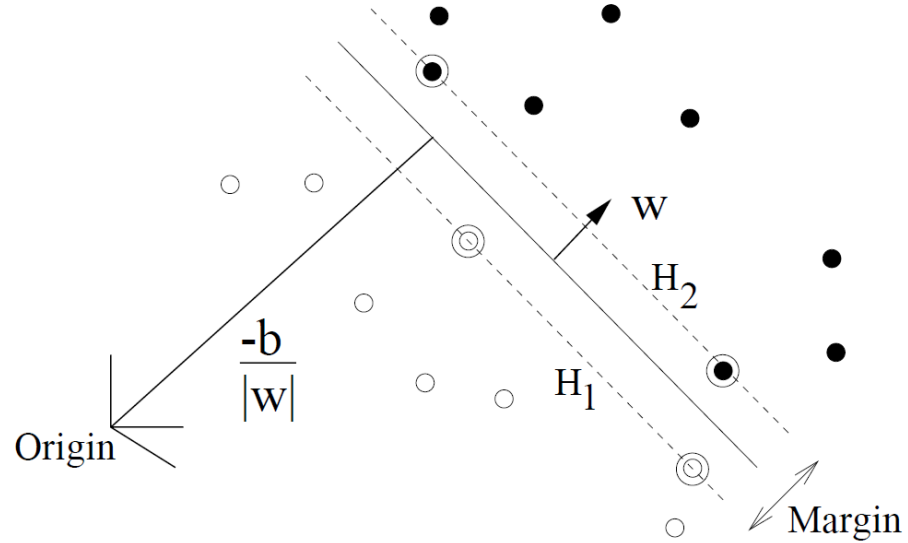


$$\mathbf{x}_i \cdot \mathbf{w} + b \geq +1 \quad \text{for } y_i = +1$$

$$\mathbf{x}_i \cdot \mathbf{w} + b \leq -1 \quad \text{for } y_i = -1$$

- Phase 1: training phase
- Phase 2: generalization phase

Support Vector machine



$$\mathbf{x}_i \cdot \mathbf{w} + b \geq +1 \quad \text{for } y_i = +1$$

$$\mathbf{x}_i \cdot \mathbf{w} + b \leq -1 \quad \text{for } y_i = -1$$

Planned analysis steps

- *Implement a support vector machine*
- *evaluate the performance of our SVM*

Characteristics of the second Milestone

- *label pixels as ,cell nucleus' or ,background'*

Second Milestone

Implement Support Vector machine

First Milestone

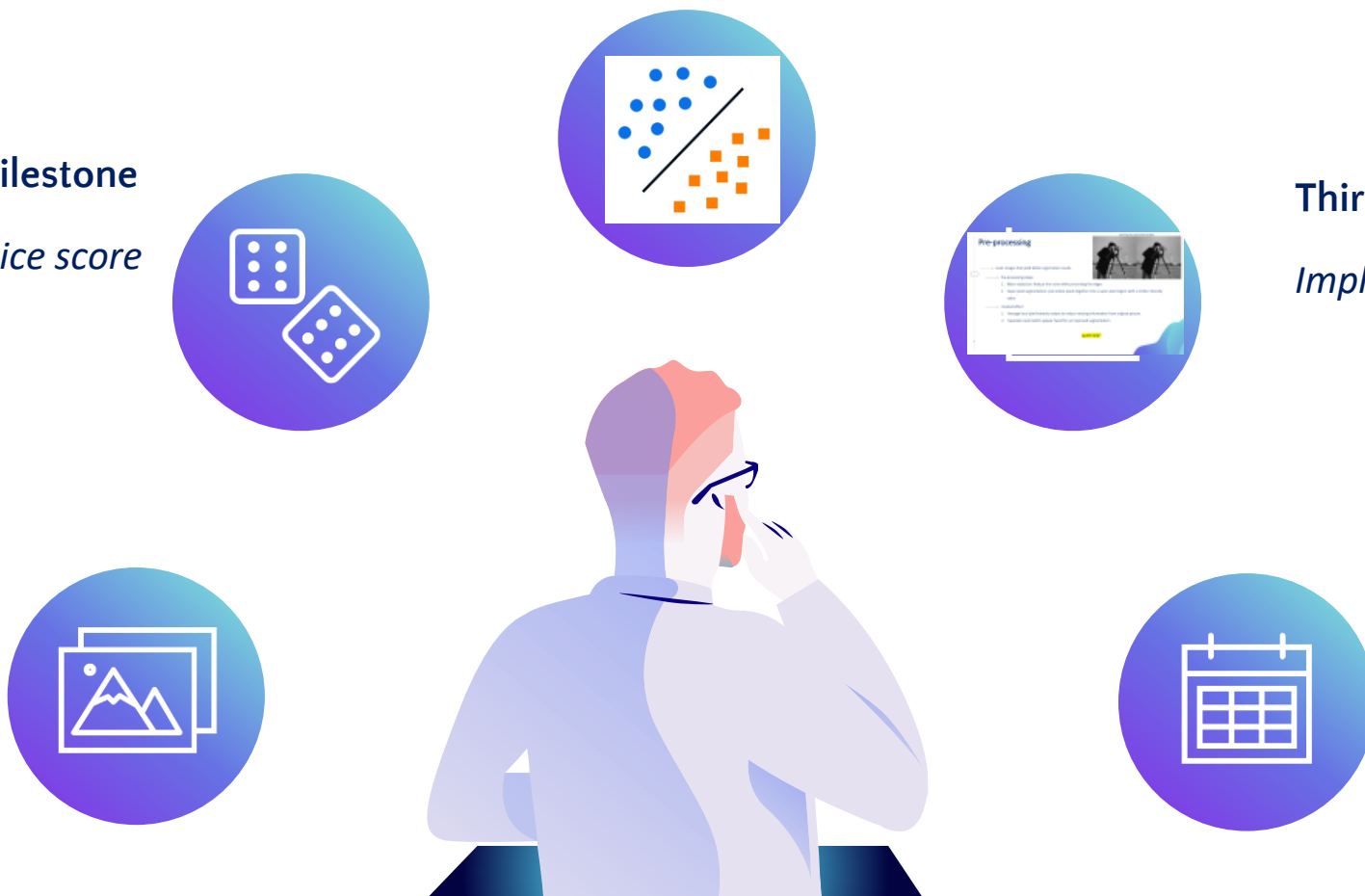
Implement Dice score

Third Milestone

Implement Pre-processing

Our data

Timeline



Pre-processing

- Pre-processing steps:

1. Noise reduction
2. Super-pixel segmentation

- Desired effect:

1. Average local pixel intensity values
2. Separate nuclei which appear fused

Original Image (Left) Vs. Gaussian Filtered Image (Right)



<https://www.mathworks.com/help/images/ref/imgaussfilt.html>

Pre-processing

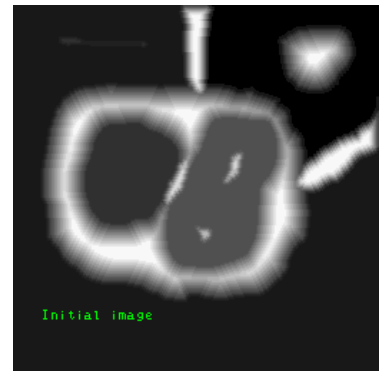
Original Image (Left) Vs. Gaussian Filtered Image (Right)



Planned analysis steps

—• *Methods:*

1. *2D Gaussian filter*
2. *Gradient-ascend-based super pixel algorithms, e.g. Watershed*



<http://www.cmm.mines-paristech.fr/~beucher/wtshed.html>

Characteristics of the third Milestone

- ### —• *Improve Dice Score of segmentation method through better image quality*

Second Milestone

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Third Milestone

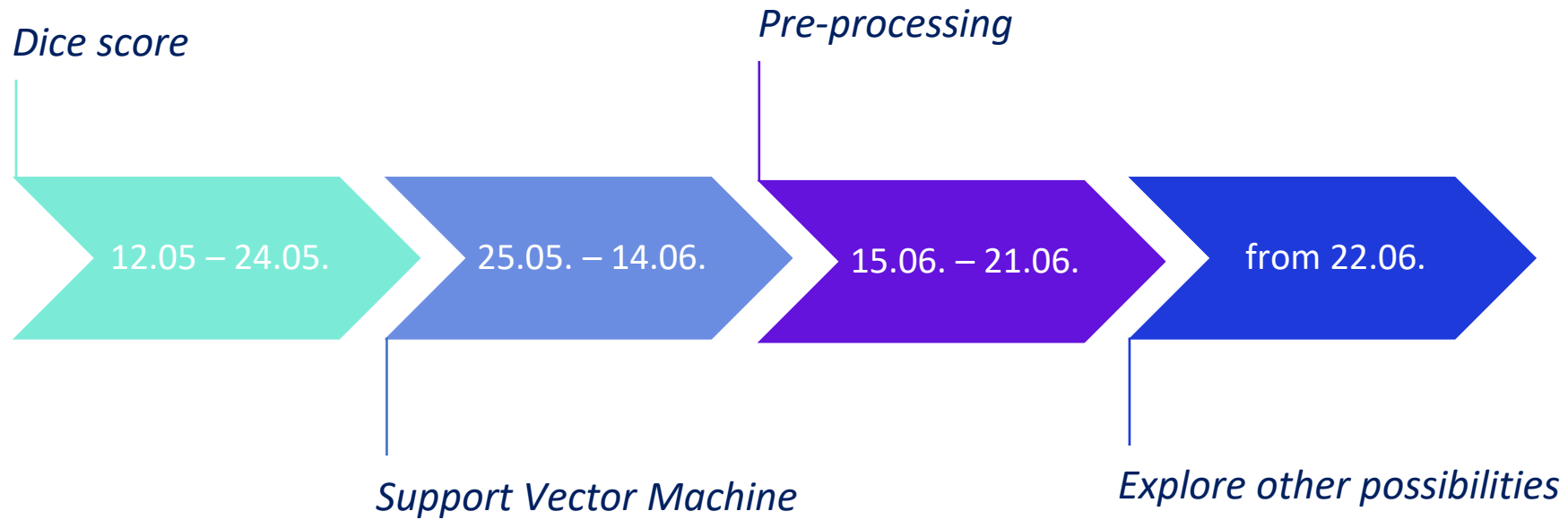
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Timeline



**Thank you for
listening!**



Other options to be explored

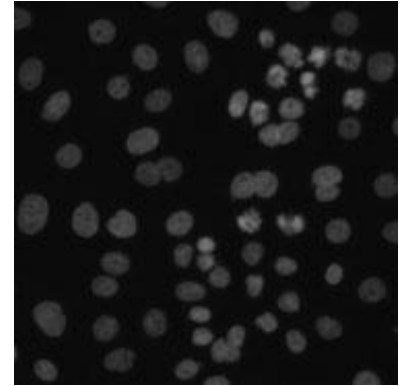
- testing model on further data → compare results

(e.g. Broad Bioimage Benchmark Collection 001)

→ used in: Nosova SA, Turlapov VE (2019) Detection of Brain Cells in Optical Microscopy Based on Textural Features with Machine Learning Methods. Program Comput Soft 45, 171–179

- advanced pre-processing

e.g. high-pass filter



<https://bbbc.broadinstitute.org/BBBC001>

