

Cell nuclei segmentation

via implementation and evaluation of region growing

Data

Region
growing

Project
management

Project proposal

12th May 2021

Data Analysis MoBi SS2021

Supervisor: Dr. Karl Rohr, Christian Ritter; Tutor: Nicolas Peschke

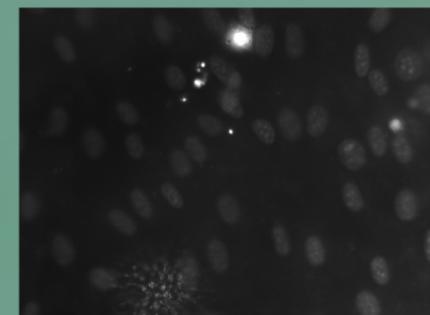
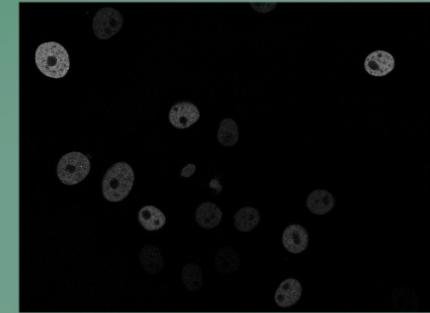
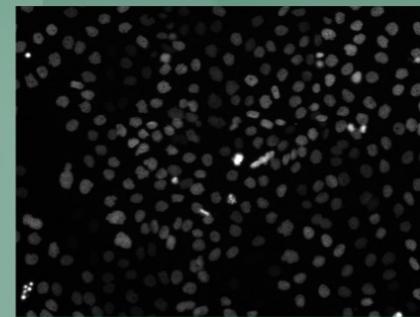
Topic 04: Biomedical image analysis

Group 04: Marie Becker, Ina Jung, Laura Kaschnitz, Johanna Möller

Data types

Ground truth

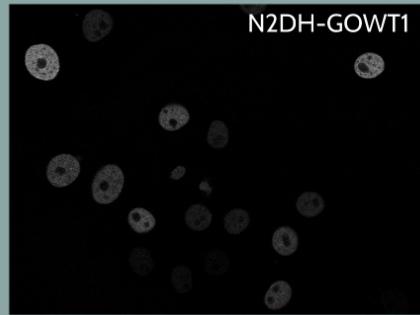
Data



Data types

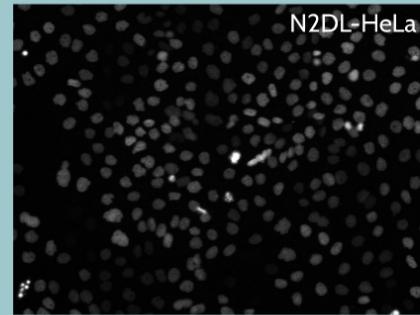
N2DH-GOWT1

- Mouse (*mus musculus*)
- Embryonic Stem Cells
- GFP: Oct4



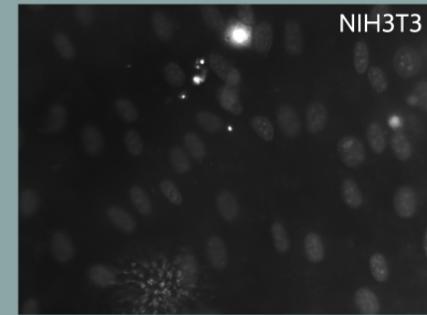
N2DL-HeLa

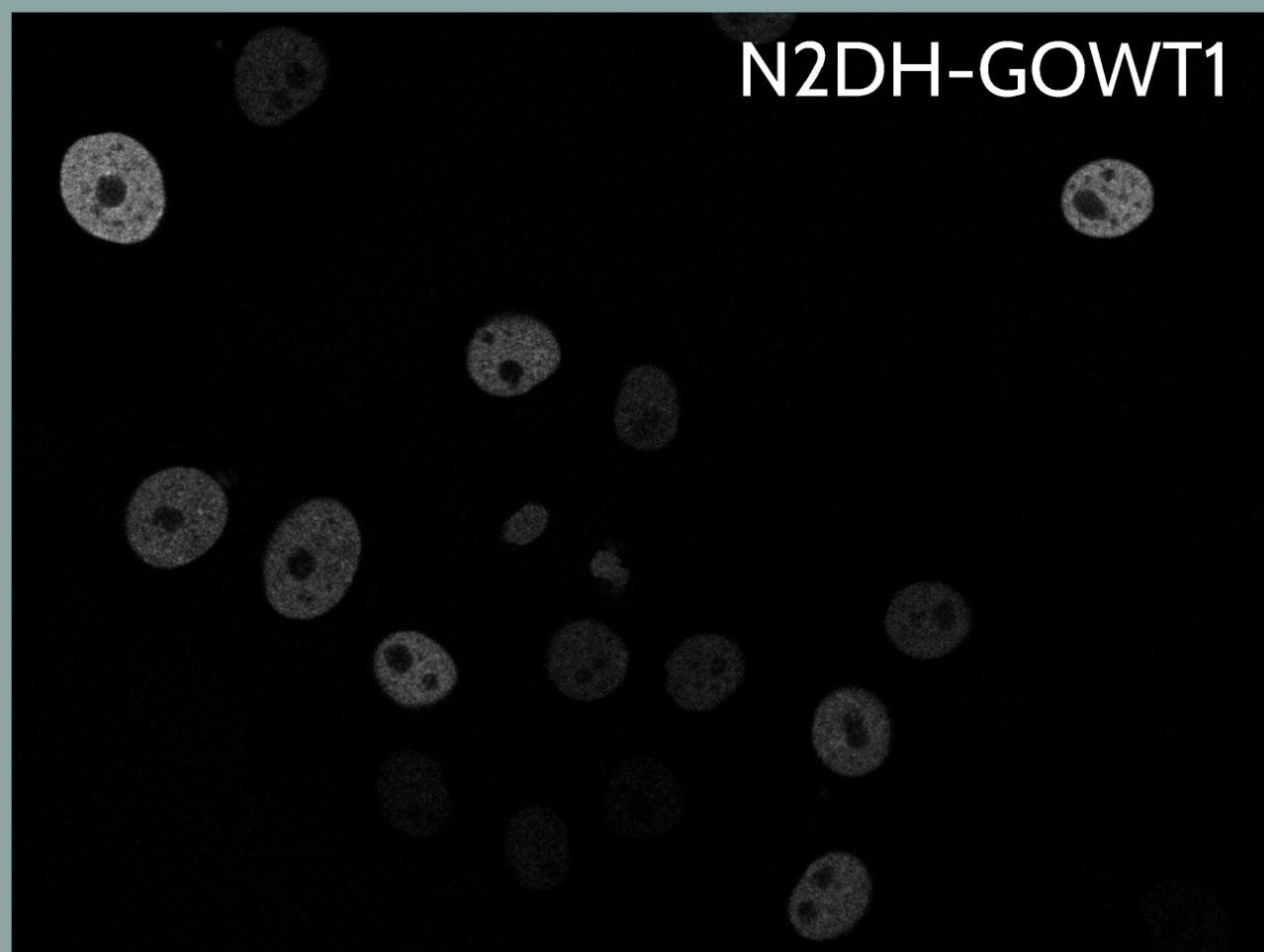
- Human (*Homo sapiens*)
- Cervix carcinoma
- GFP: Core histone 2B



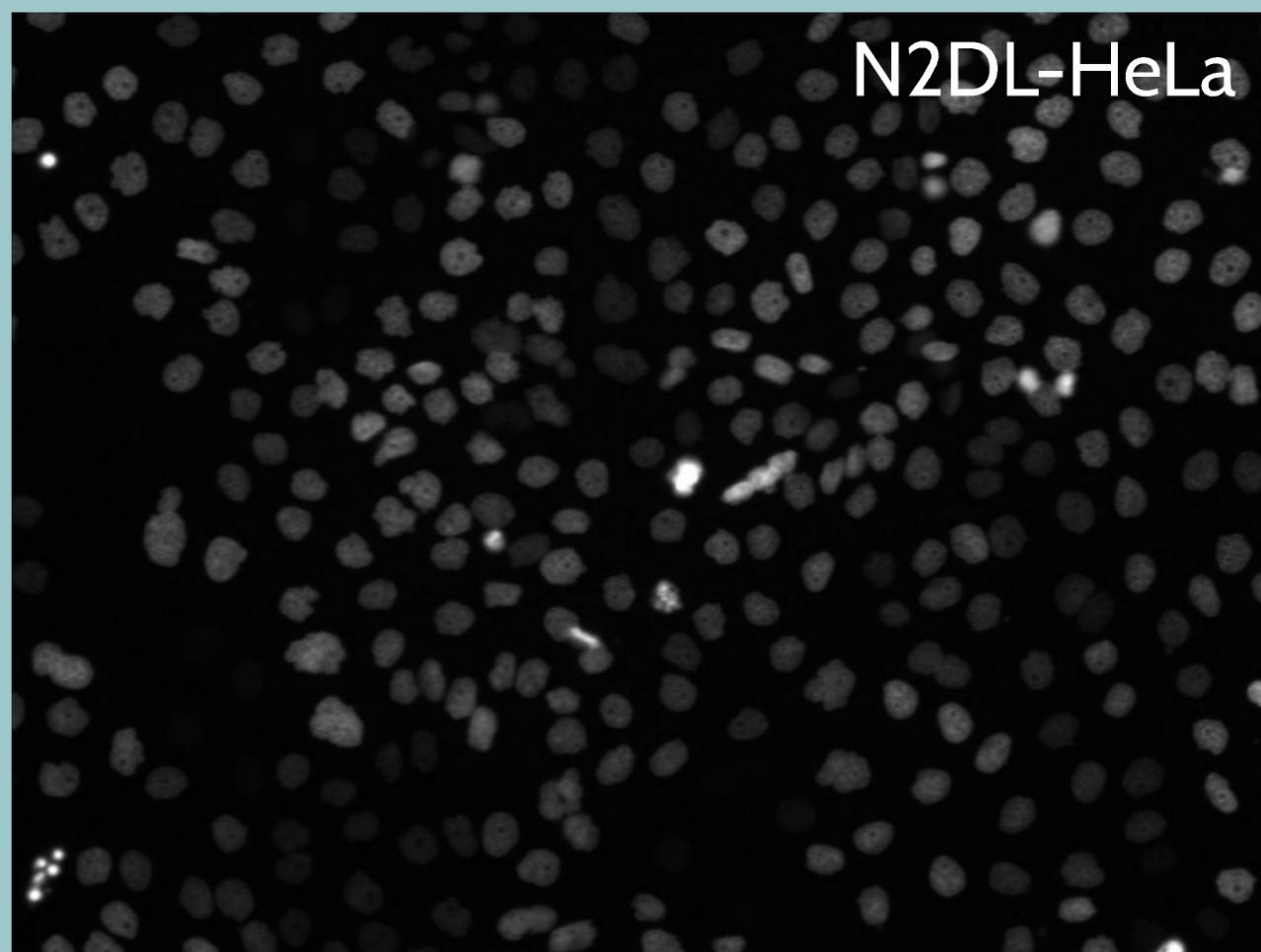
NIH3T3

- Mouse (*mus musculus*)
- Embryo fibroblast
- EGFP: CD-tagged protein



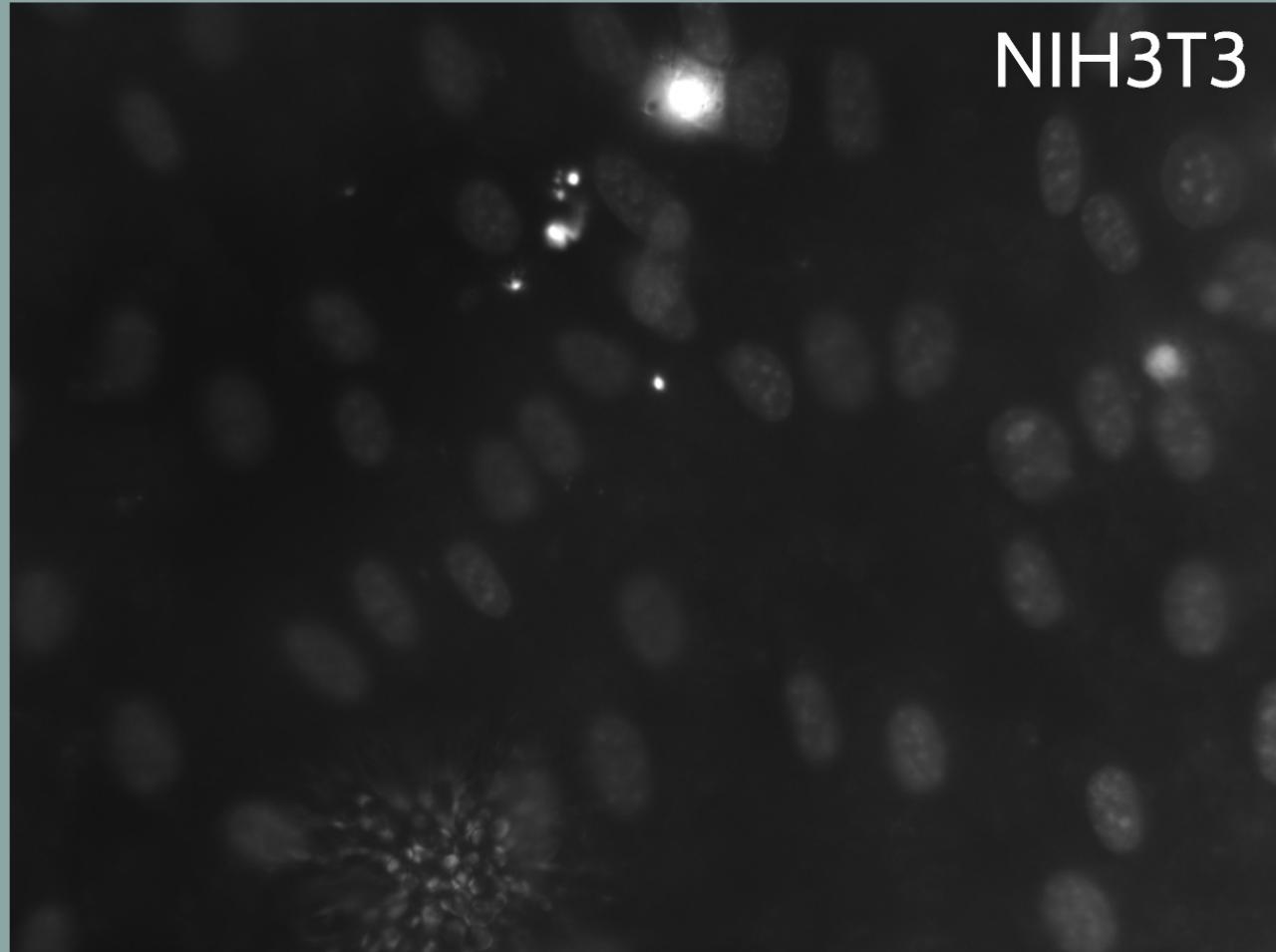


N2DH-GOWT1

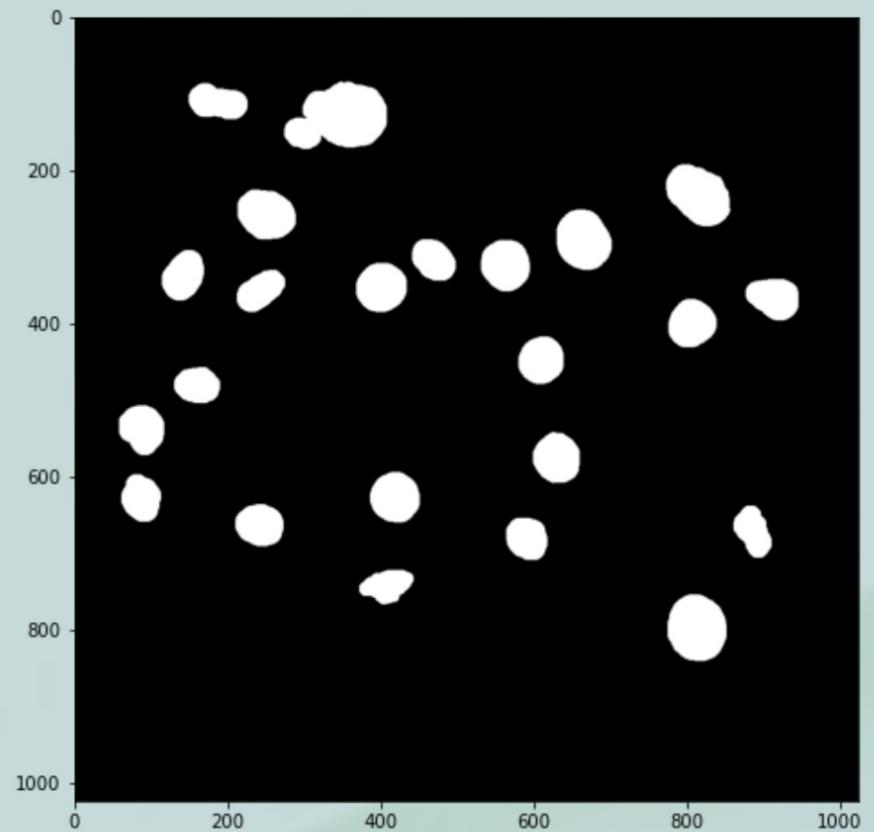
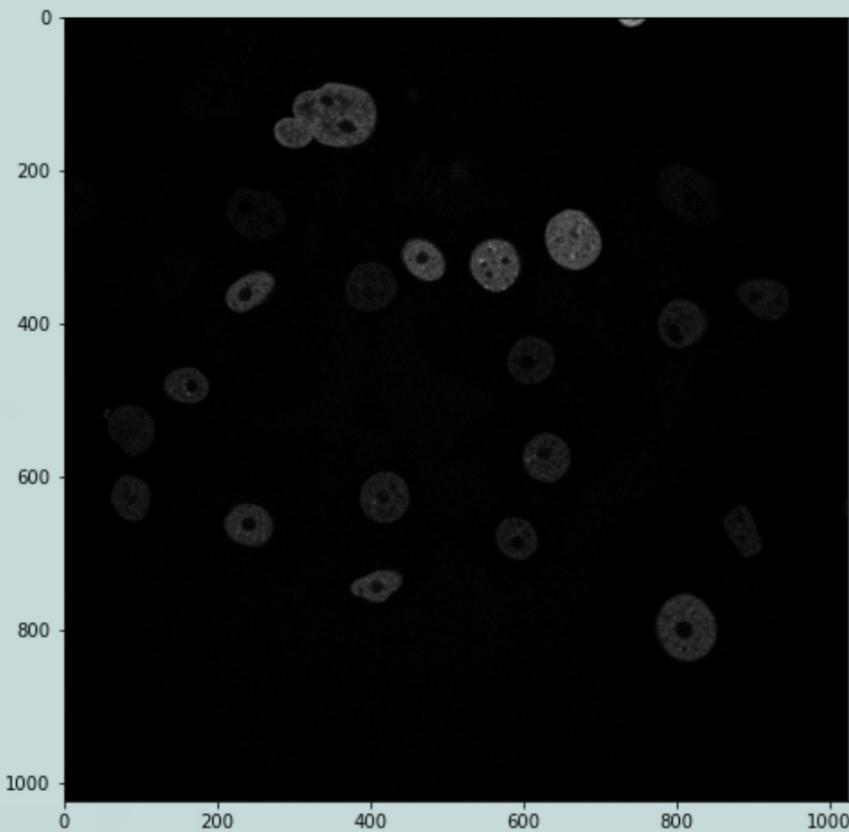


N2DL-HeLa

NIH3T3



Normal image vs. ground truth image



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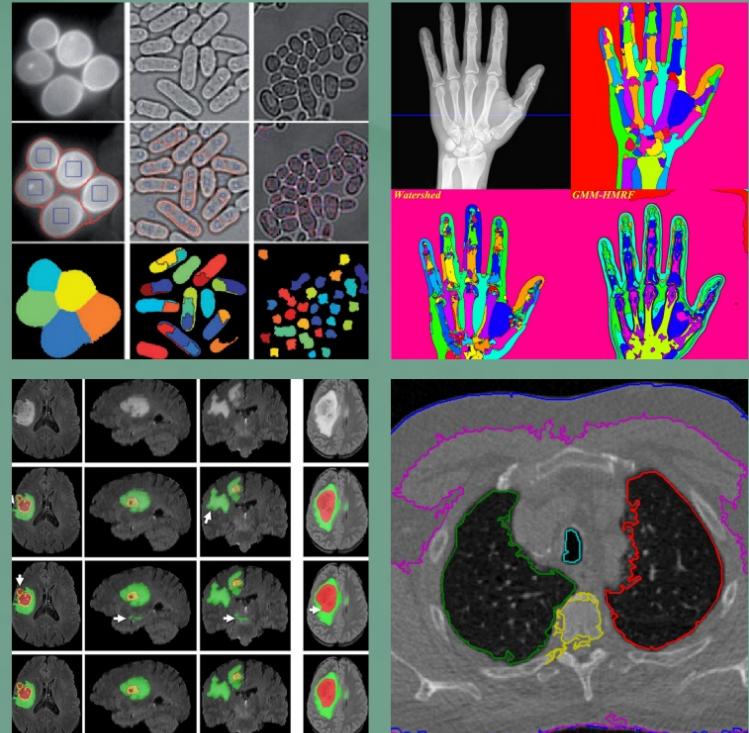
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Procedure

Region growing



Daniel (2021). Region Growing (2D/3D grayscale) (<https://www.mathworks.com/matlabcentral/fileexchange/32532-region-growing-2d-3d-grayscale>). MATLAB Central File Exchange. Retrieved May 11, 2021.

Dimopoulos, S. et al. "Accurate cell segmentation in microscopy images using membrane patterns." Bioinformatics 30 18 (2014): 2644-51.

Wang G, Li W, Ourselin S and Vercauteren T (2019) Automatic Brain Tumor Segmentation Based on Cascaded Convolutional Neural Networks With Uncertainty Estimation. Front. Comput. Neurosci. 13:56. doi: 10.3389/fncom.2019.00056

Aganj, I., Harisinghani, M.G., Weissleder, R. et al. Unsupervised Medical Image Segmentation Based on the Local Center of Mass. Sci Rep 8, 13012 (2018).

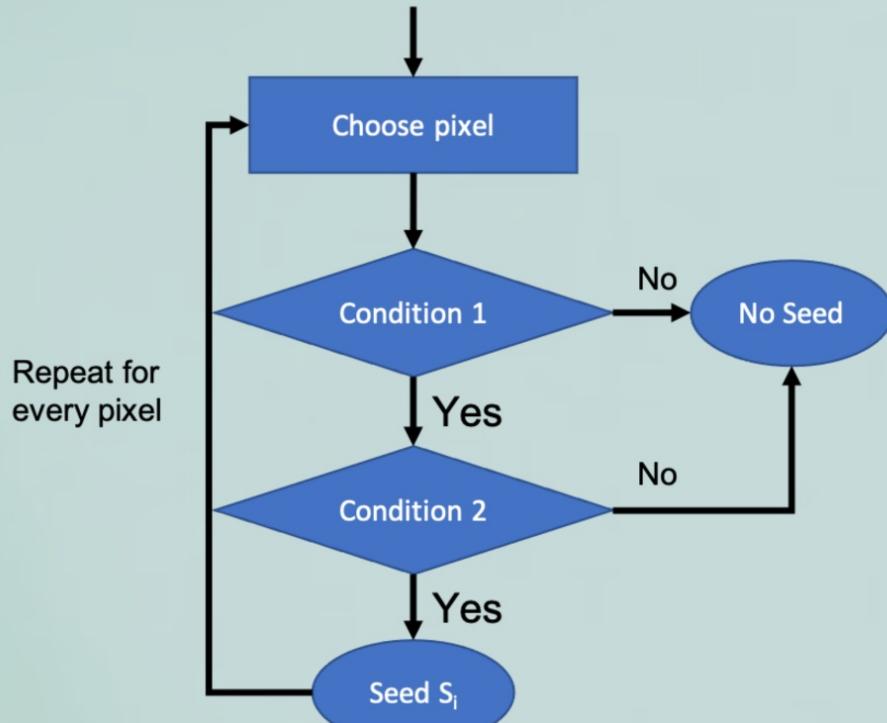
Basic procedure



Basic procedure

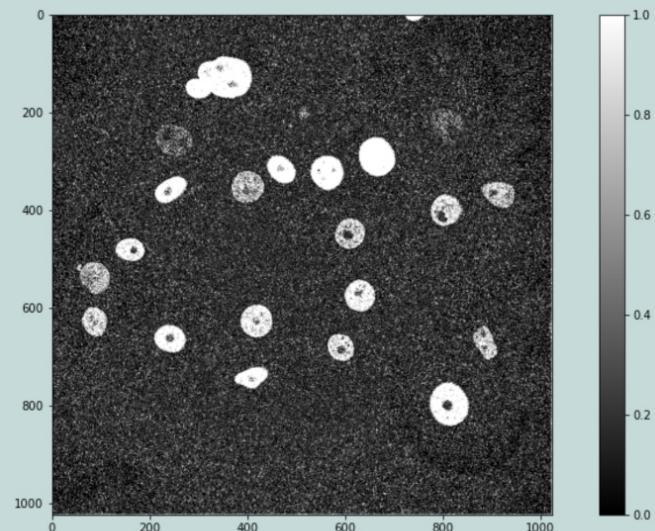


Seed selection



Condition 1 $\sigma = \sqrt{\frac{1}{9} \sum_{i=1}^9 (x_i - \bar{x})^2}$ $s = 1 - \frac{\sigma}{\sigma_{\max}}$

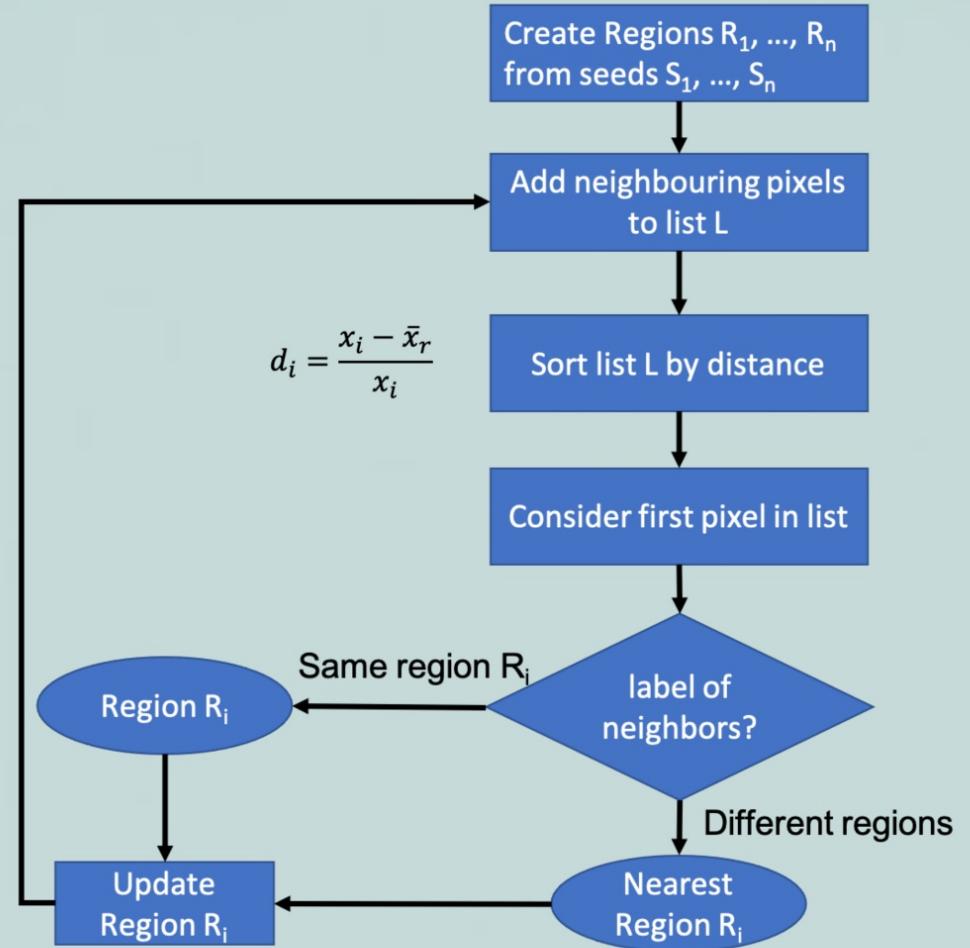
Condition 2 $d_{\max} = \max_{1 \leq i \leq 8} \left\{ d_i = \frac{x - x_i}{x} \right\}$



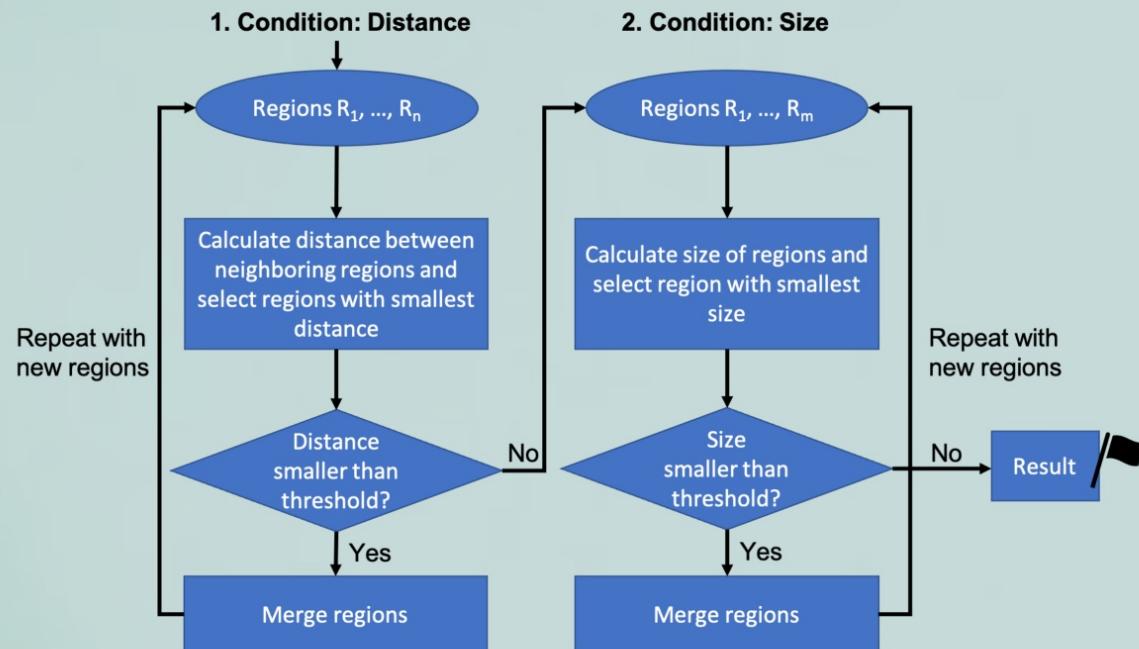
Region growing



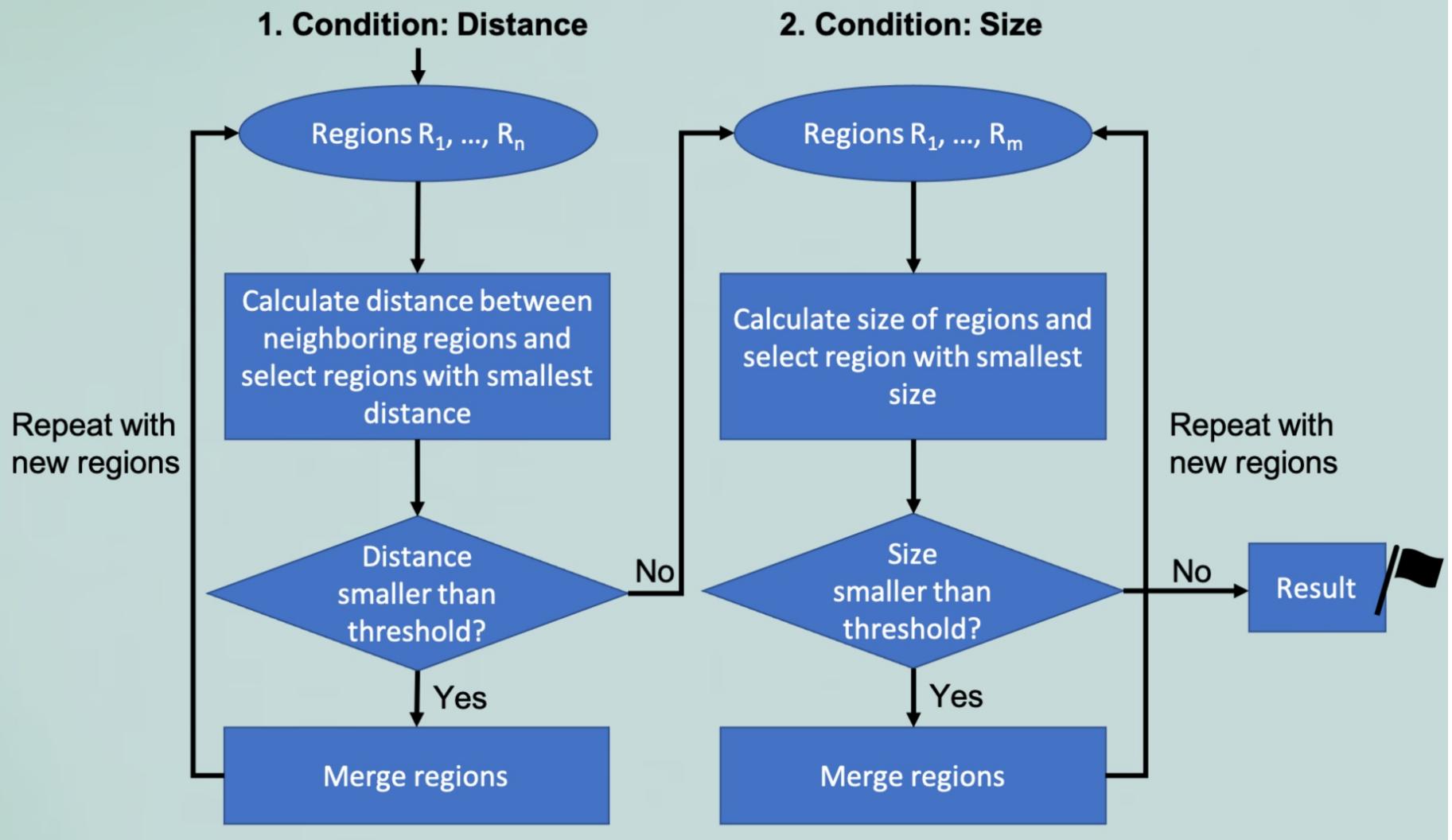
Adapted from Shih, F.Y., and Cheng, S. (2005).
Automatic seeded region growing for color image
segmentation. *Image Vis Comput* 23, 877-886.



Region merging



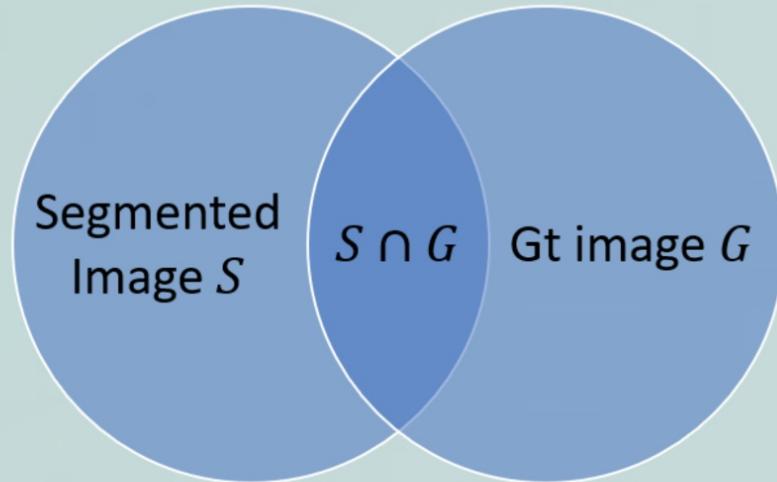
Adapted from Shih, F.Y., and Cheng, S. (2005). Automatic seeded region growing for color image segmentation. *Image Vis Comput* 23, 877-886.





Adapted from Shih, F.Y., and Cheng, S. (2005).
Automatic seeded region growing for color image
segmentation. *Image Vis Comput* 23, 877-886.

Dice score



$$DSC = \frac{2 * |S \cap G|}{|S| + |G|}$$

Consider nuclei and background individually:

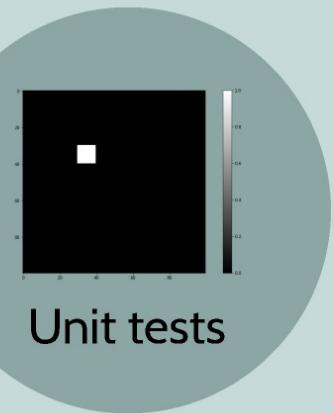
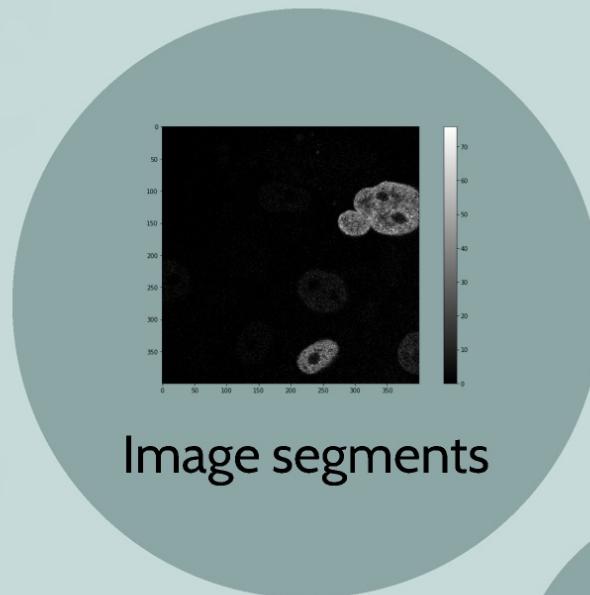
$$\overline{DSC} = \frac{1}{2} \sum_{i=1}^2 \frac{2 * |S_i \cap G_i|}{|S_i| + |G_i|}$$

Programming ideas

```
%timeit standarddeviation_old(img,3)  
%timeit standarddeviation_new(img,3)
```

1min 27s ± 5.92 s per loop (mean ± std. dev. of 7 runs, 1 loop each)
1min 51s ± 5.48 s per loop (mean ± std. dev. of 7 runs, 1 loop each)

Time measurement



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Project Management

Agile project management

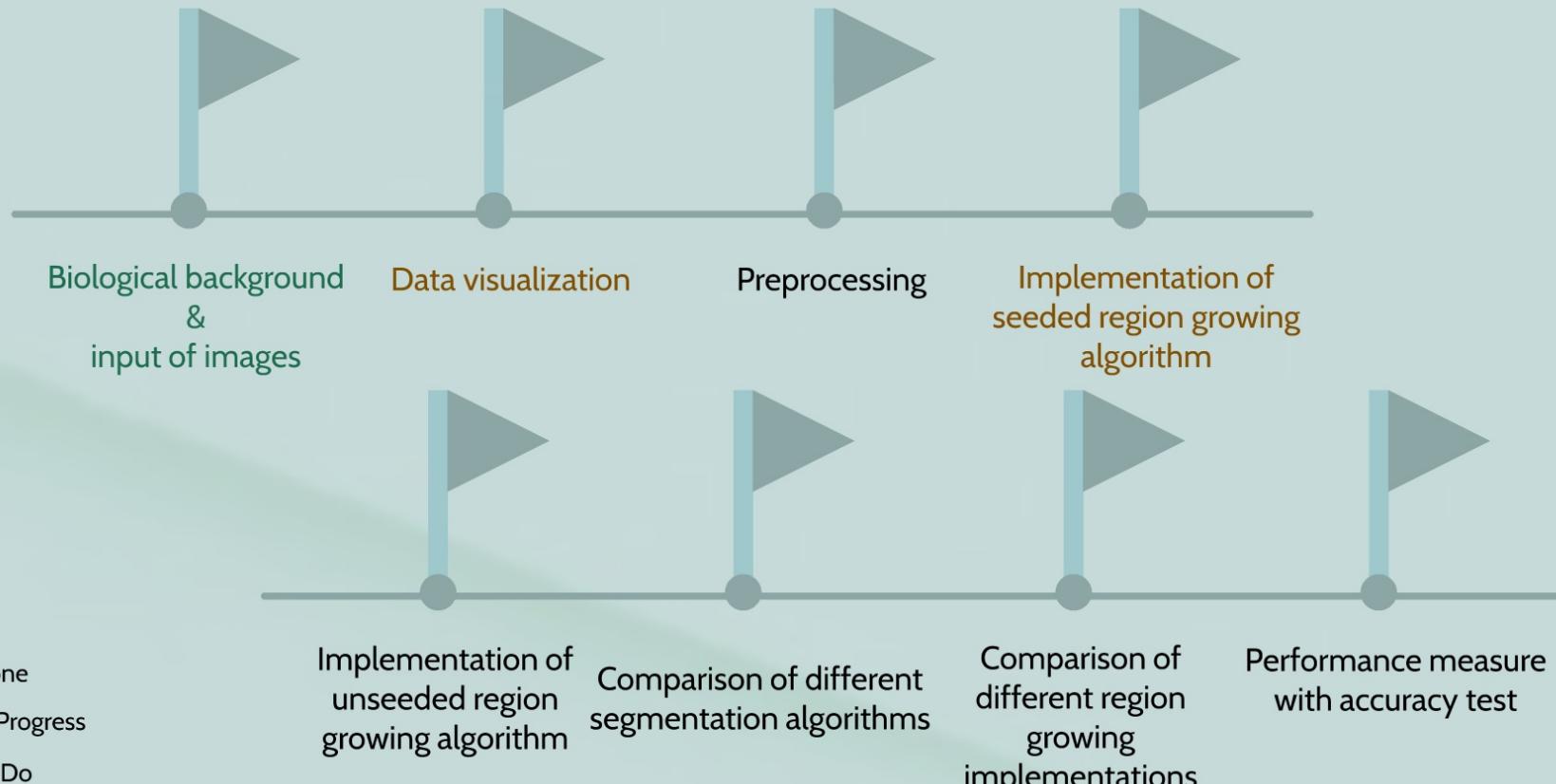
Timeline

Implementation in GitHub

Teamwork

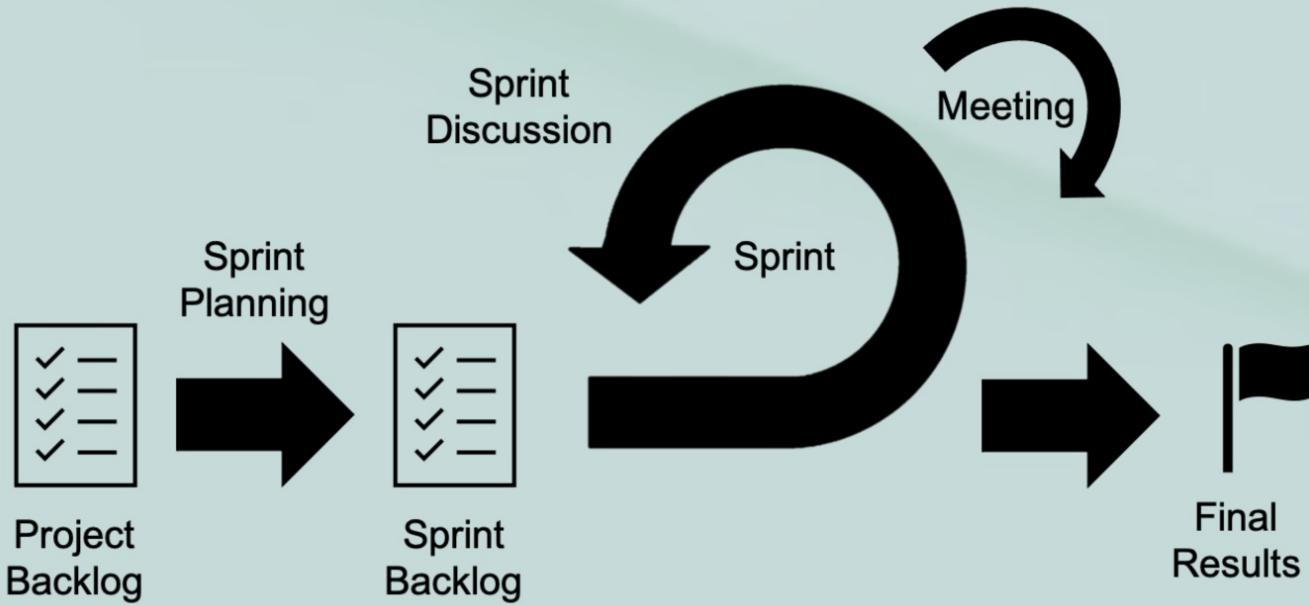
20

Milestones



Agile Project Management

Scrum



Implementation in GitHub

ToDo

- 14 To do
 - Region growing algorithm #8 opened by marie3003
↳ 4. Implement seeded region growing alg...
 - Region merging algorithm #9 opened by marie3003
↳ 4. Implement seeded region growing alg...
 - Compare different image segmentation methods
- Automated as To do

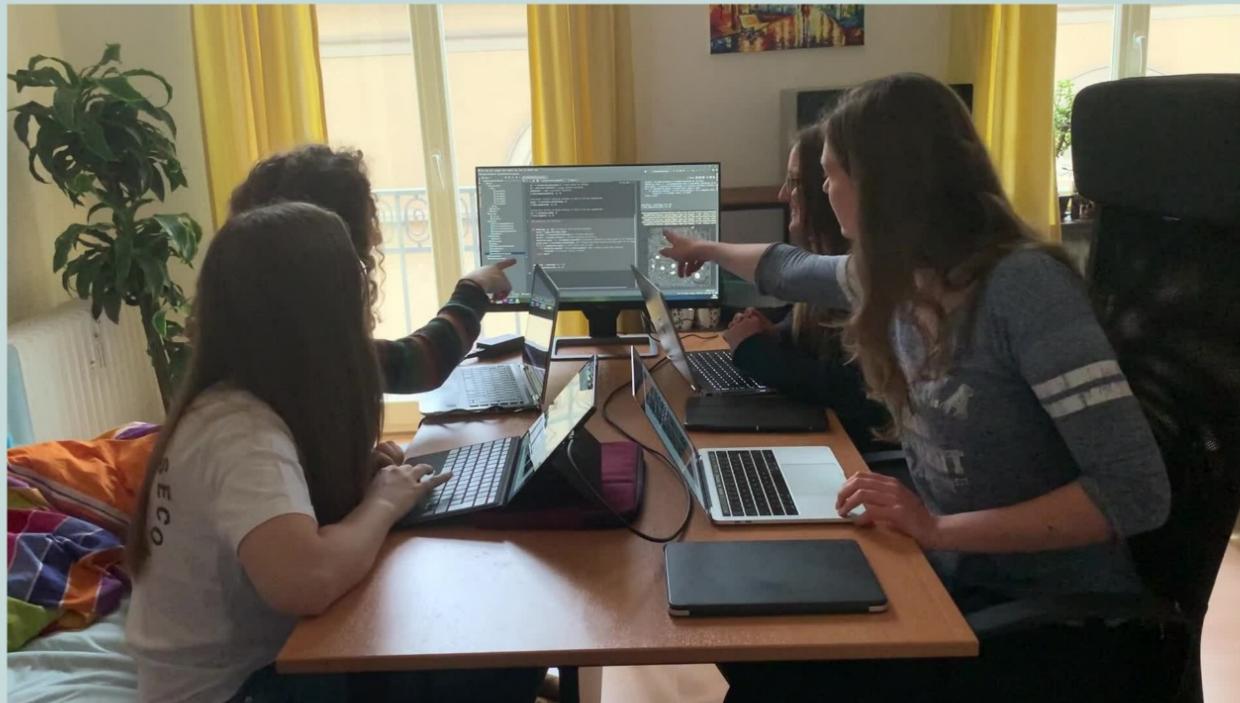
Sprint 1

- 8 Sprint1
 - 0. Presentation
 - Introduction into the method #19 opened by LauraKaschnitz
↳ 0. Presentation
 - Presentation of current results #22 opened by marie3003
↳ 0. Presentation
 - Milestones, Sprints - Structure of the project

Done

- 3 Done
 - Automatic seed detection algorithm #7 opened by marie3003
↳ 4. Implement seeded region growing alg...
 - Upload images #26 opened by johannamoeller
↳ 1. Biological Background and Input of Im...
 - Layout #25 opened by LauraKaschnitz
↳ 0. Presentation

Pair programming



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