# Leucocyte Segmentation and Classification

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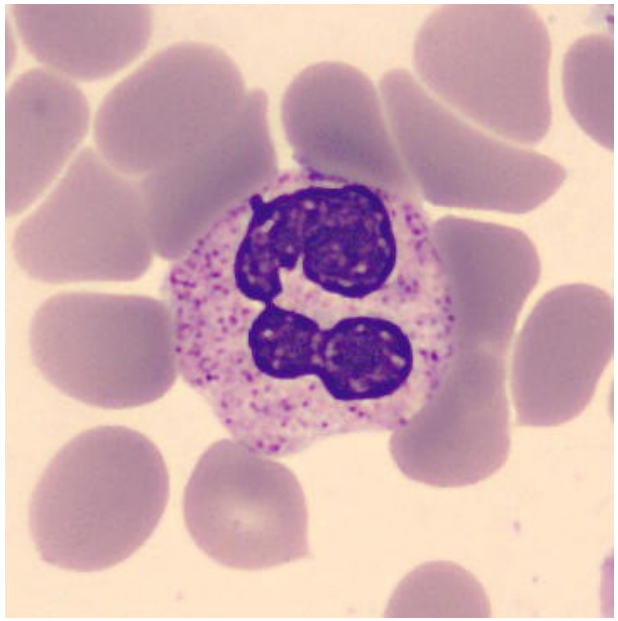
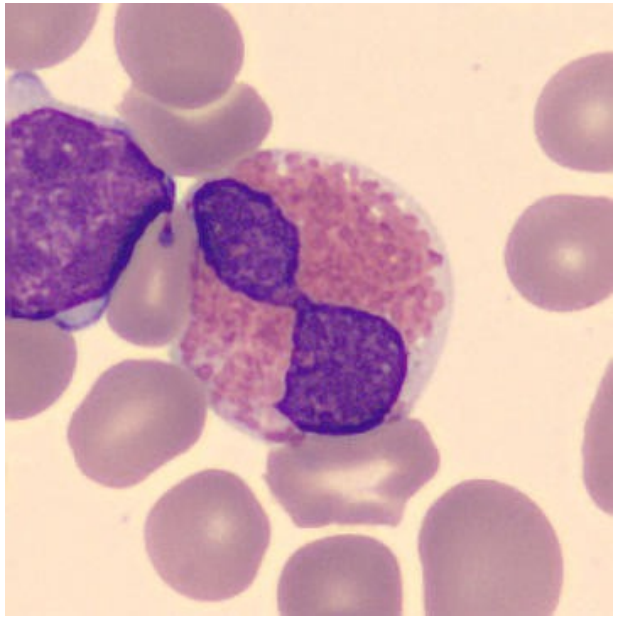
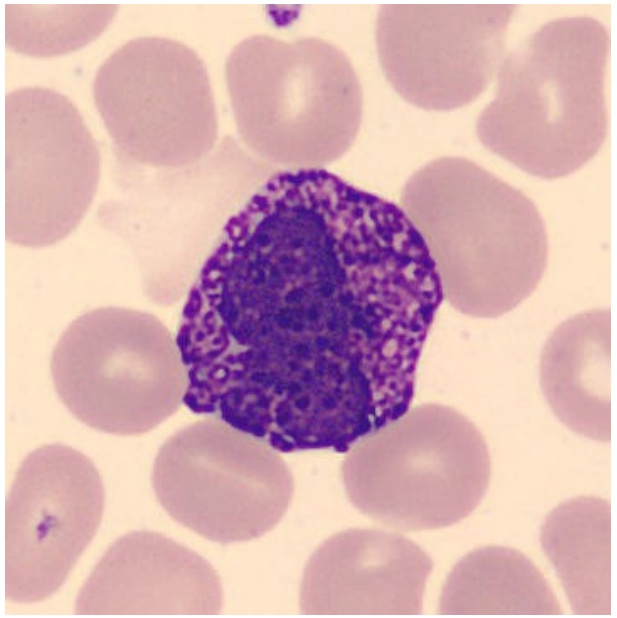
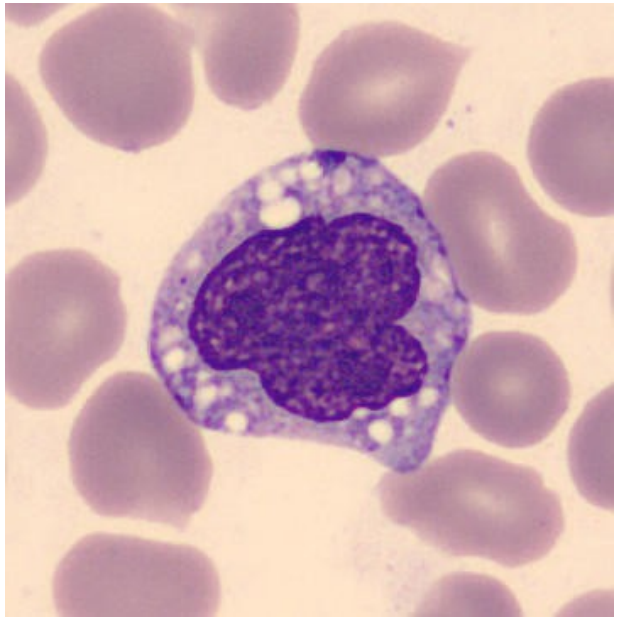
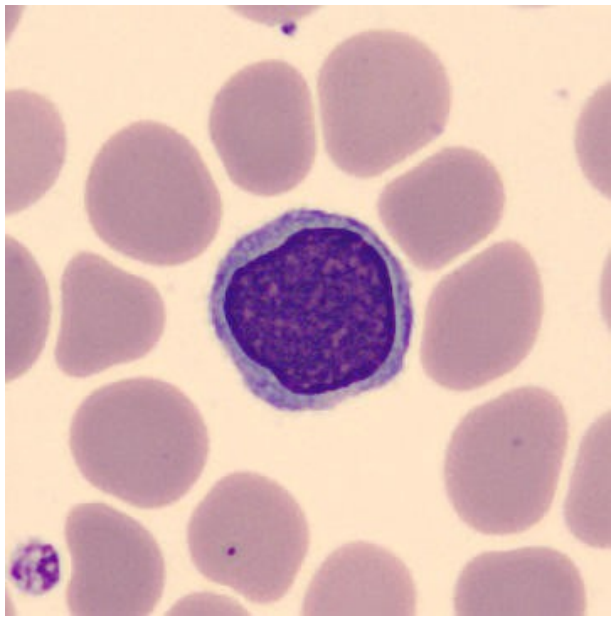
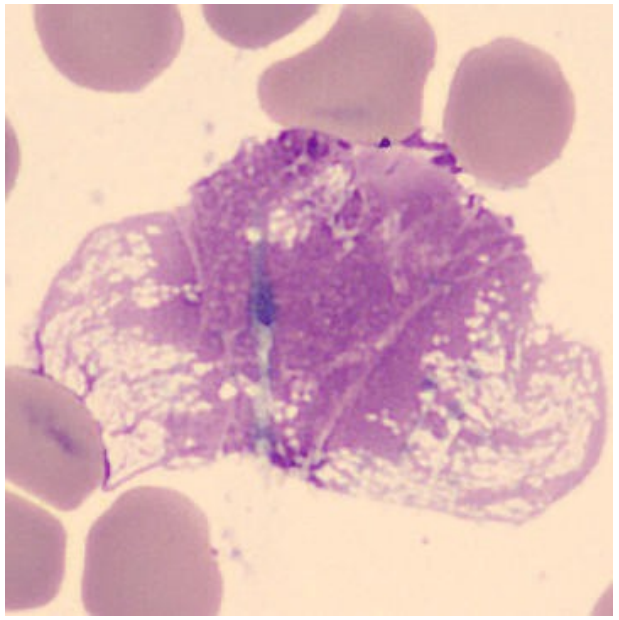
# Goals of project

- Input images are acquired from optical microscope scanning leucocytes in smear blood. Centroids of leucocytes or of its clumps are determined and rectangle around this centroid is saved.
- First goal is to segment leucocytes from image.
- Second goal is to create algorithm classifying leucocytes to appropriate group.
- Then verify reliability of classification algorithm on testing data (different from training data).

# Input Images

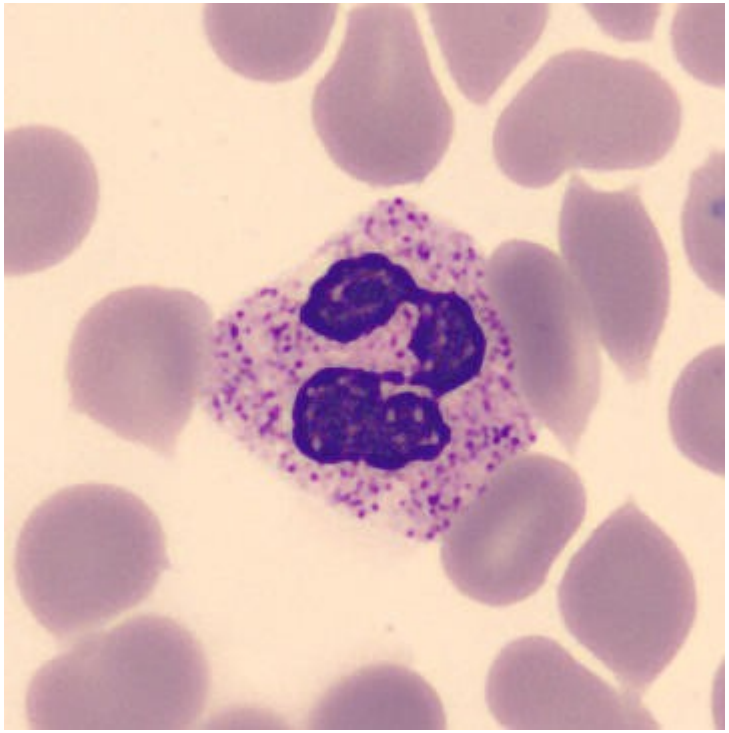







# Results of Project

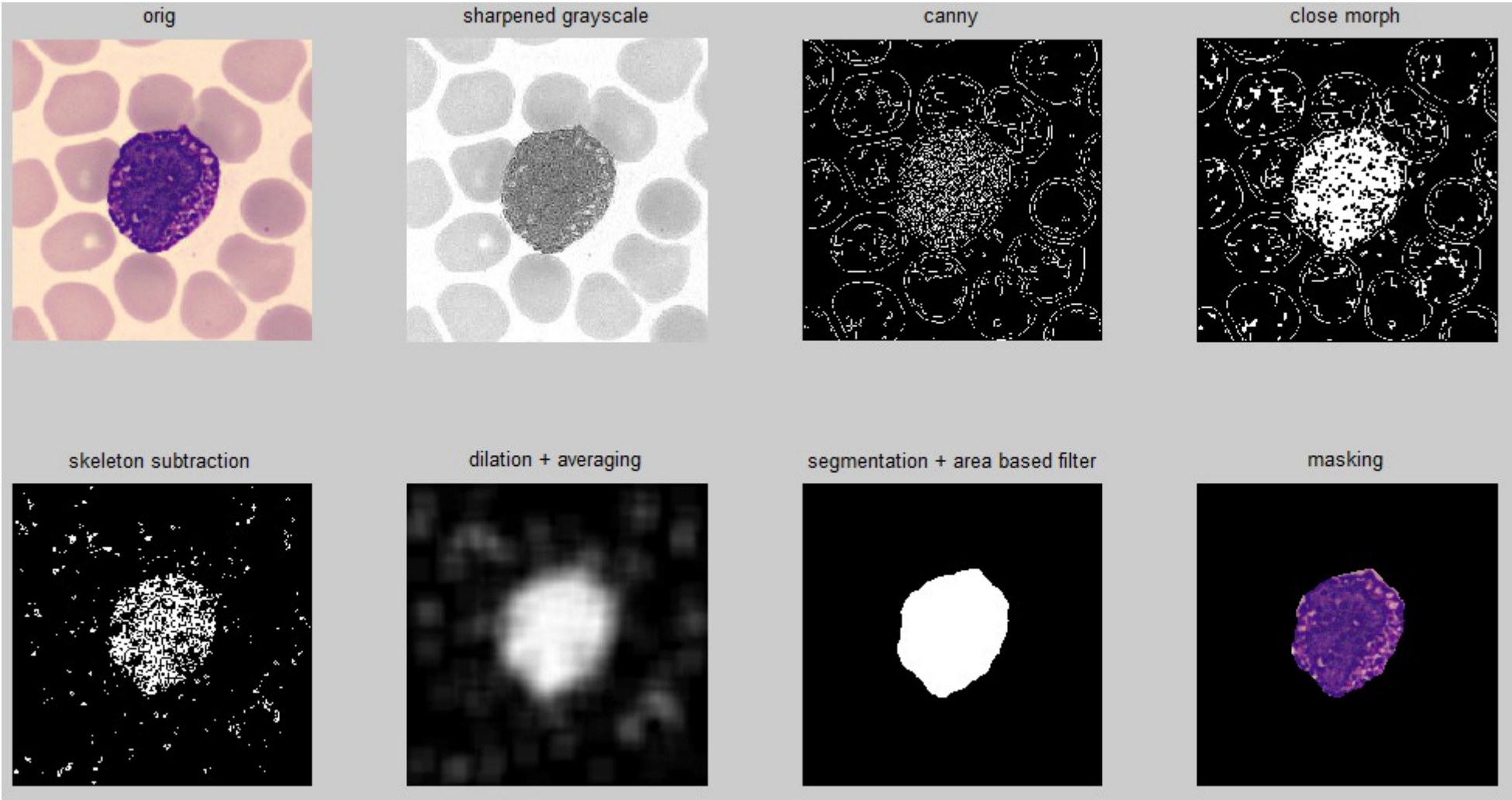
- Classification based on extracted features:
  - each type has its own characteristic fetures (not unique for just one class)
  - we are looking for features distinguishing two classes
- STEP 1: Segmentation
  - to be able to measure characteristic fetures, proper segmantation is neccessary
- STEP 2: Classification
  - empirically chosen features are computed for each leucocyte
  - classification based on decision-tree

# Step 1: Segmentation (1/3)

- surface of leucocyte is covered with texture containing colors of surroundings – thresholding useless
- erythrocytes are smooth – disadvantage could be taken as advantage
  - texture could be defined as noise
  - noisy-area detection defines leucocyte

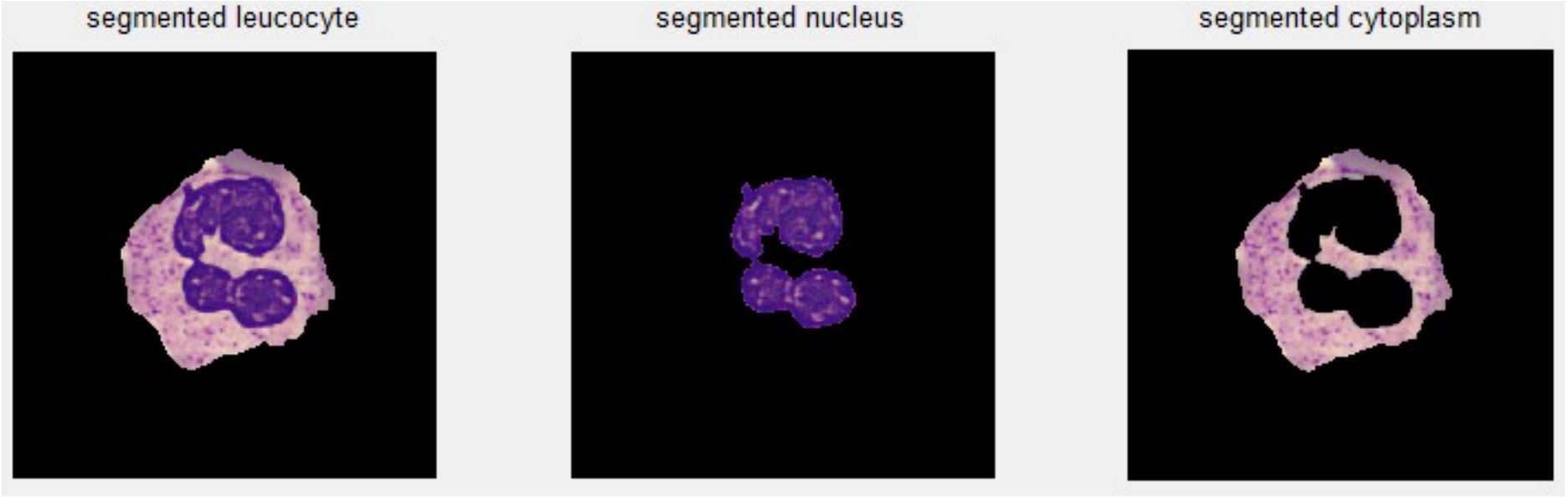


# Step 1: Segmentation (2/3)



# Step 1: Segmentation (3/3)

- nucleus can be easily distinguished from rest of leucocyte by thresholding



# Step 2: Classification (1/3)

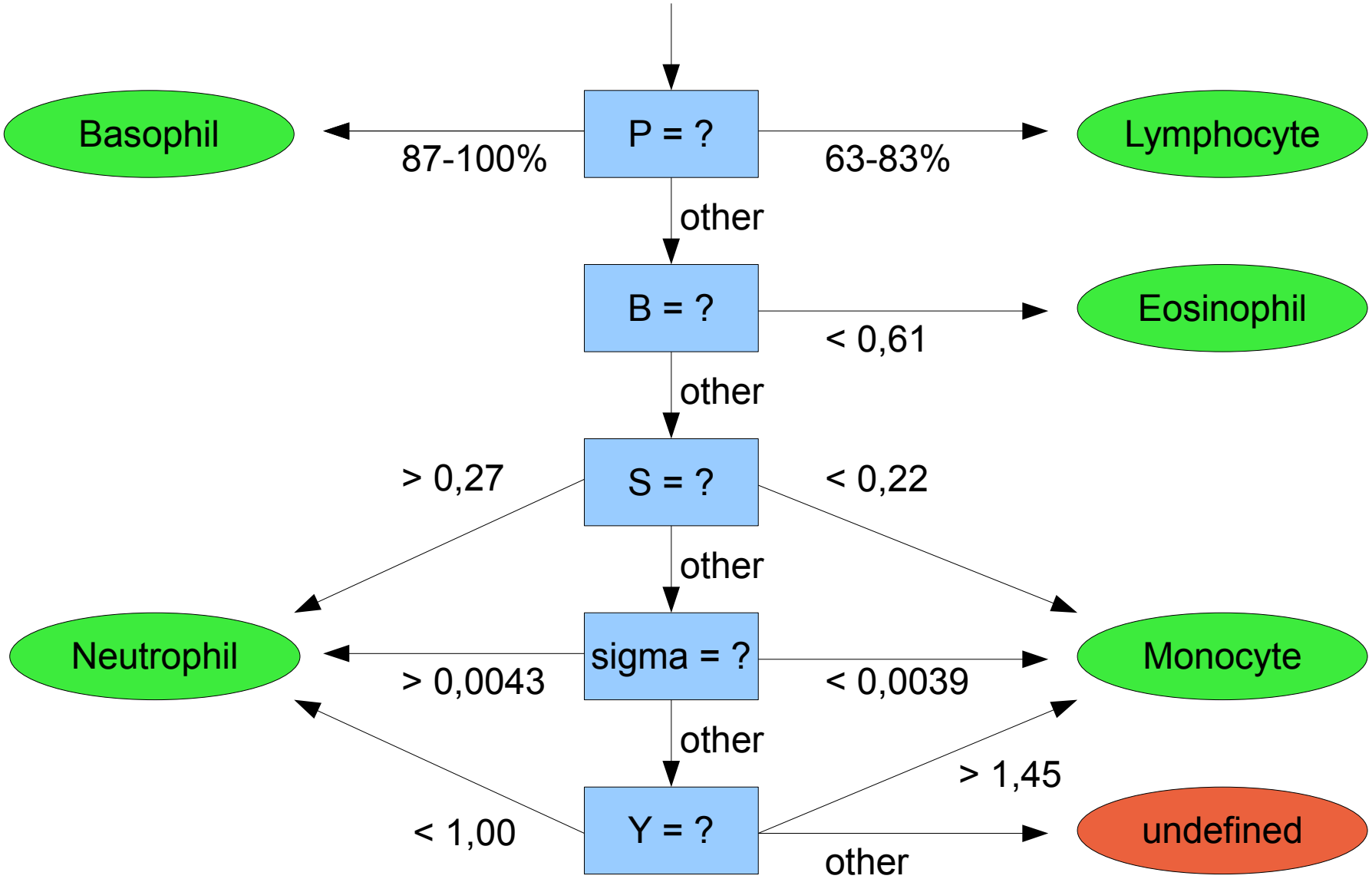
- totally 1837 samples available
  - 1377 samples used for training
  - 460 samples used for verifying (testing of accuracy)
- in case of each sample, features are extraxted:
  - size of leucocyte and its nucleus → nucleus coverage of cell
  - average cytoplasm color – various color models
  - statistical spread of feature values in each class

# Step 2: Classification (2/3)

| příznak | Neutrofil | Monocyt | Eosinofil | Bazofil | Lymfocyt |
|---|---|---|---|---|---|
| pokrytí buňky jádrem | 20 – 45 % | 40 – 63 % | 20 – 43 % | 87 – 100 % | 63 – 83 % |
| prům. barva cytopl – R | 0,69 – 0,83 | 0,65 – 0,82 | - | - | - |
| prům. barva cytopl – G | 0,45 – 0,66 | 0,51 – 0,70 | - | - | - |
| prům. barva cytopl – B | 0,62 – 0,71 | 0,65 – 0,72 | max. 0,61 | - | - |
| prům. barva cytopl – H | 0,65 – 0,85 | 0,43 – 0,88 | - | - | - |
| prům. barva cytopl – S | 0,22 – 0,36 | 0,18 – 0,27 | - | - | - |
| prům. barva cytopl – V | 0,69 – 0,83 | 0,69 – 0,82 | - | - | - |
| prům. barva cytopl – Y | max. 1,45 | min. 1,00 | - | - | - |
| sigma (Cb-Cr)/(Cb+Cr) | min. 0,0039 | max. 0,0043 | - | - | - |

- Note: Basophil really covers about 20-33% of cell, but because of high density of dark granulas, it seems to be entirely covered by nucleus.

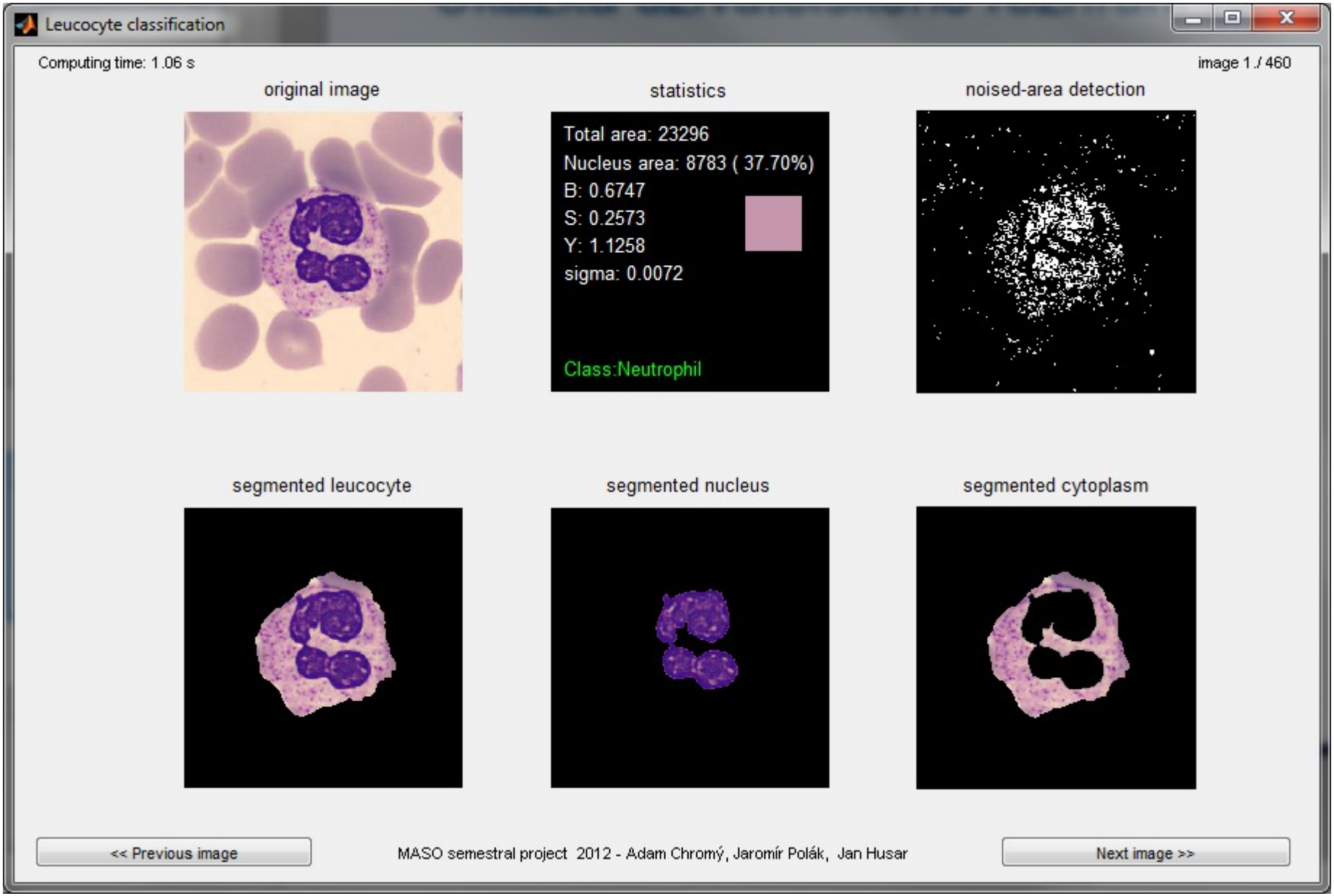
# Step 2: Classification (3/3)



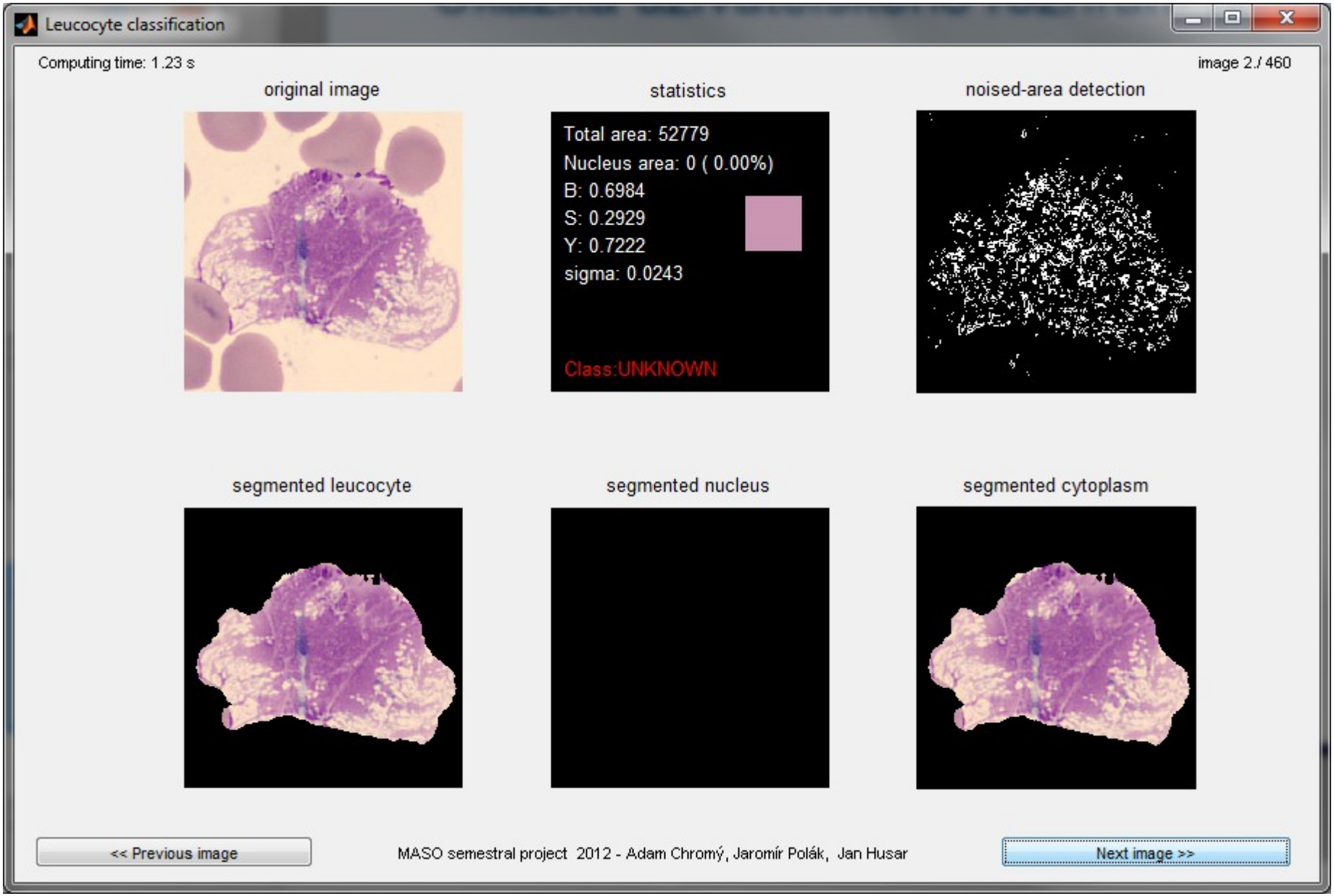
# Algorithm Reliability

- 460 testing samples from various smear bloods
- wrong classification at 46 cases – eg. 90% reliability
  - dead cells or scattered epithelium – classified to random class (18x)
  - large lymphocyte and monocyte – difficult to distinguish also for trained human (11x)
  - very bright neutrophil and monocyte (10x)
  - lymphocyte segmentation error – wrong features extracted (7x)

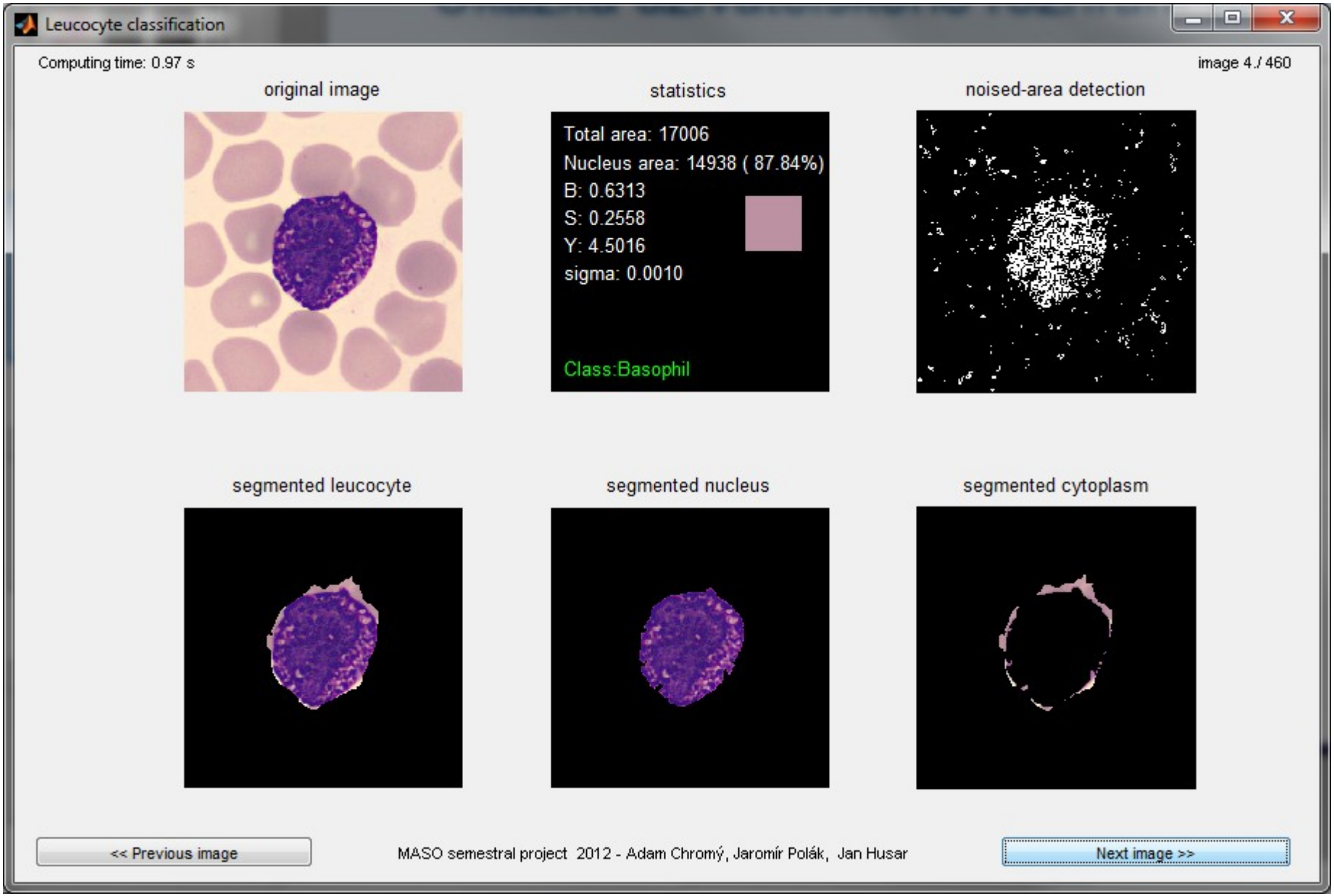
# User Interface Demonstration (1/6)



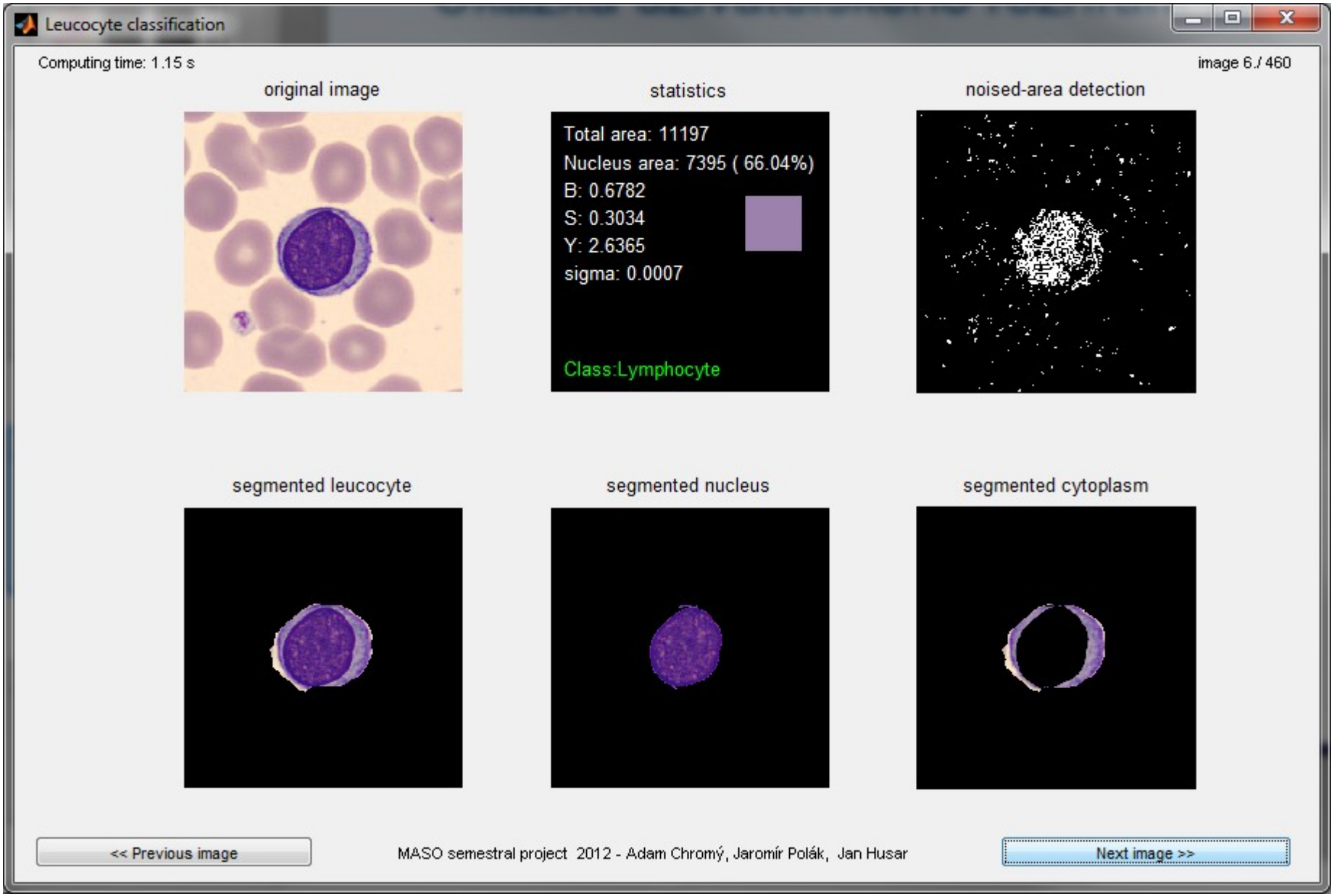
# User Interface Demonstration (2/6)



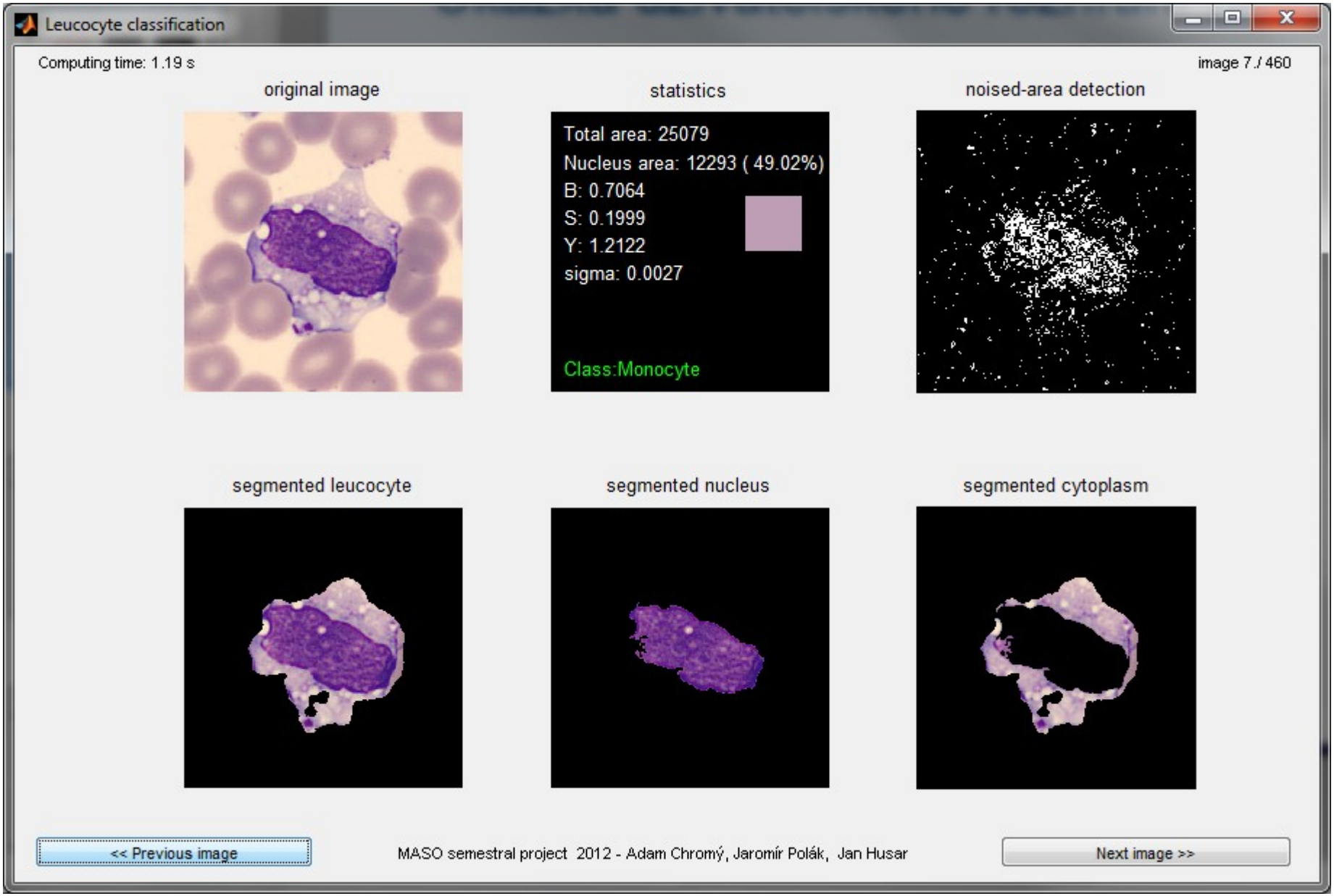
# User Interface Demonstration (3/6)



# User Interface Demonstration (4/6)



# User Interface Demonstration (5/6)



# User Interface Demonstration (6/6)

# Conclusion

- classifier realized as decision-tree based on extracted features
- about 90% reliability
- there is big chance for improvements:
  - detection of dead cells
  - probability-based approach to features (fuzzy classification)

Děkuji za pozornost

# Reference


- http://old.lf3.cuni.cz/histologie/atlas/demo/73/index.htm
- http://en.wikipedia.org/wiki/White_blood_cell#Overview_table
- http://www.zshk.cz/files/trochahematologie.pdf