PHOT 533: Biomedical image analysis and image processing

Final exam questions

Michaël Barbier, Spring semester (2023-2024)

Grading of the course

The project (and possible extension) will count for 50% of your grade. Points are given on the combined effort of the project and the oral explanation of it during the final exam.

The final exam comprises 50% of your grade and consists of 8 open questions. You will first answer the exam questions on paper and afterwards you explain your written answers individually.

Exam questions

Question 1: Image acquisition

Light captured by a camera is often taken as RGB color. When printing (with ink) however, often a different color scheme is used: Cyan, Magenta, Yellow, Black (CMYK). What is the relation between them or reason behind this?

### Question 2: Image acquisition

Staining tissue results often in nonlinear color intensities. This means that a cell of the tissue being twice as "brown" might not have twice the stained protein. Another challenge is that the color can change e.g. the "brown" color becomes black for very strong stained parts. How is this a problem for extracting the amount of protein using image processing? [optional] Can you think of a way to still get unbaised results up to a certain level?

Question 3: Image resolution

What properties of a microscope setup determine the point spread function (PSF) in the lateral direction?

Question 4: Image properties

The following images have different pixel sizes, what issues you can predict during image processing when the provided images have a too large pixel size?

Original image   4 times binned   8 times binned
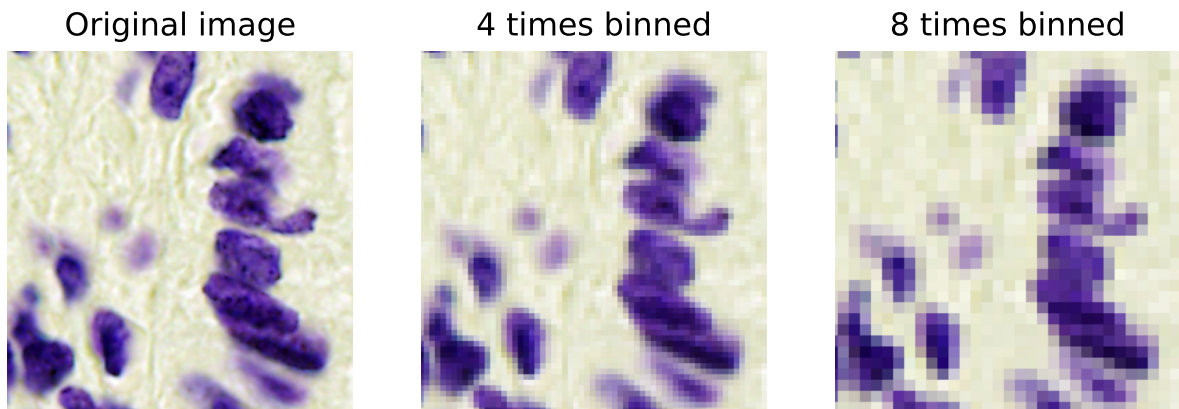
Question 5: Image arithmetic and logic

If you multiply an 8-bit grey-valued image by a scalar larger than one, or if you add two such images together, you can obtain intensities higher than the maximum value 255 for 8-bit images. What is often done to prevent these kind of problems?

Question 6: Neighborhood filters

What filter would be most appropriate to get rid of the noise in the following image with so-called pepper-and-salt noise? Chose out of following options, and explain why:

(a) A Gaussian filter with a large value of $\sigma = 10$
(b) A median filter (with a 3 by 3 kernel)
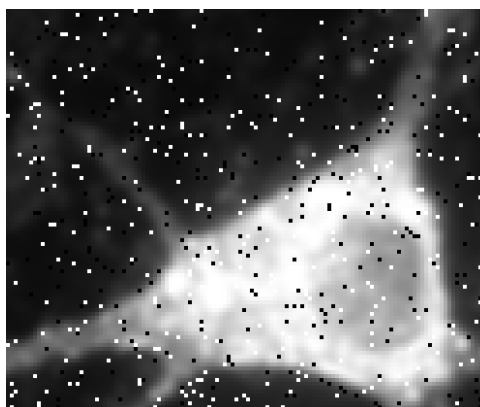(c) A high-pass filter

Figure 1: Image of neuron (Hippocampal region rat brain)

Question 7: Image Processing Pipeline

After segmentation often a post-processing step is performed. Splitting of foreground objects is often a challenge here. Can you describe a manner (a filter or combination of filters) in which you could possibly split the following two segmented objects?
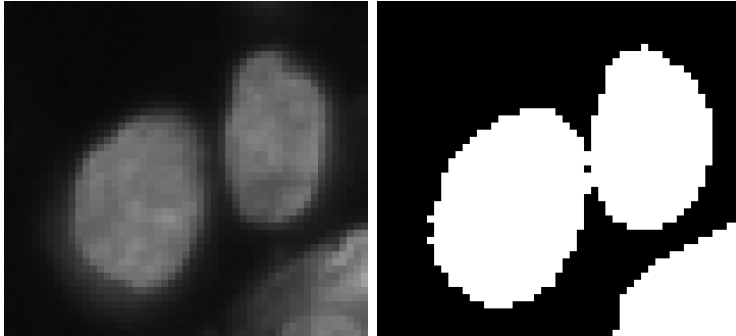
Question 8: Object features and classification

There are many possible morphological/shape features that we can derive from detected objects in an image:

- Area,
- Perimeter (length of the "border"),
- Circularity,
- Average diameter

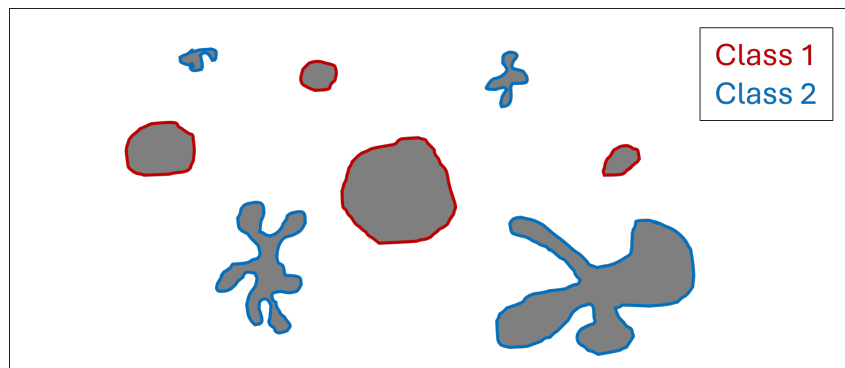If you want to distinguish the two classes of objects in below image, which of the above features would be the most appropriate?

Figure 2: Shape classification