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Bioinformatics II

Assignment Sheet 6

If you have questions concerning the exercises, please write to our mailing list:
vl-bioinf@lists.iai.uni-bonn.de.

We strongly encourage you to continuously work on the assignments and contact us with questions. However, you will only have to hand in your results (for all sheets of the second project) on January 31.

Exercise 1 (Threshold-Based Image Segmentation, *25 Points*)

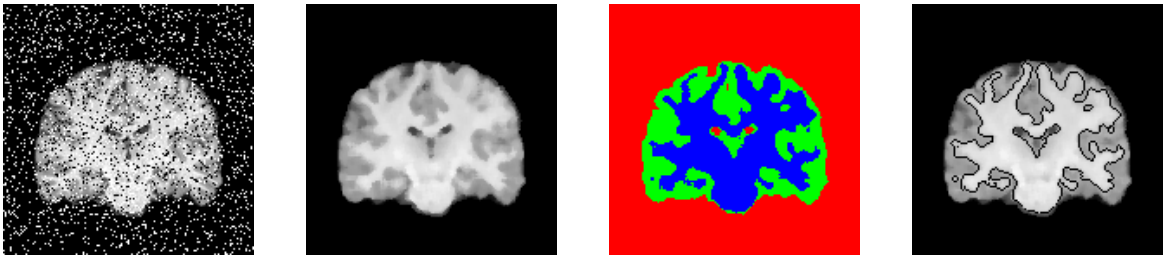

Figure 1: From left to right: The input image, after denoising, a threshold-based segmentation into background (red), gray matter (green), and white matter (blue), boundary between gray and white matter.

In the first part of the second project, you will learn how to perform some simple threshold-based image analysis in Python.

Hint: If you make proper use of Python packages, none of the tasks will require you to write large amounts of code. Routines for reading and writing images can be found in the Python module `scipy.misc`. Other useful routines for working with images are in `scipy.ndimage`. You may also find routines from `numpy` useful for parts of your analysis. We also recommend using `scikit-image` library for some of the image processing functions.

a) Read the grayscale image `brain.png`, which is provided on the lecture homepage. Reduce the salt and pepper noise in the image using a median filter.(3P)

b) Otsu thresholding is a histogram based method for image segmentation. Use it to find an intensity threshold to segment brain pixels from background. (2P) Use Otsu thresholding again to find the threshold only over the brain pixels to segment brain's gray matter from the white matter. (2P) Using the two thresholds create three binary masks `brain-bg.png`, `brain-gm.png`, `brain-wm.png`, which should be white in regions of background, gray matter, and white matter, respectively, and black elsewhere. (3P)

c) Plot a log-scaled histogram of the image, which should show how frequently different intensity values occur in the image. Mark the two intensity thresholds you found in task b). How do these thresholds divide the histogram? (4P)

d) Combine the three masks into a single color image so that background, gray matter, and white matter are mapped to red, green and blue, respectively. (2P)

e) Use erosion filter to produce a boundary between the gray and white matter. Put that boundary on the denoised input image. (3P)

f) Use bilinear interpolation to upsample the image by a factor of four along each axis. Apply the same thresholds as in b) to obtain a segmentation into background, gray matter, and white matter. Upsample the masks from b) in the same way and compare the upsampled masks to the masks from the upsampled image. Can you see a difference? Why? (4P) Repeat the same procedure using nearest neighbor interpolation. Can you see a difference now? (2P)

For all tasks, please submit the images and the corresponding Python code. Clearly mark what belongs to which subtask.

Good Luck!