Assignment 5: Segmentation
Vision and Image Processing

Serge Belongie, Hang Yin

This is the last mandatory assignment on the course Vision and Image Processing. The goal is to implement some basic Segmentation algorithms and discuss their results.

This assignment must be solved in groups. We expect that you will form small groups of 2 to 4 students that will work on this assignment. You have to pass this and the other mandatory assignments in order to pass the course.

The deadline for this assignment is Friday 17/1, 2025 at 20:00. You must submit your solution electronically via the Absalon home page. For general information on relevant software, requirement to the form of your solution including the maximal page limit, how to upload on Absalon etc, please see the first assignment.

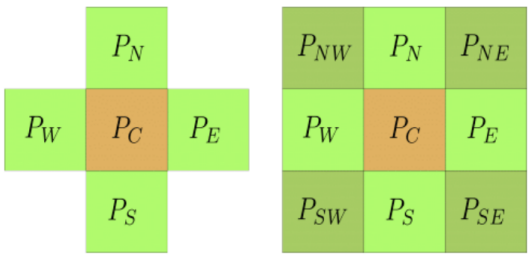
Segmentation

The goal of this assignment is to implement two basic segmentation algorithms and a simple post processing one.

1. The k-means algorithm for grey-scale images, first with $k = 2$, then with larger ks, via Lloyd's algorithm. Handling scalar values should be easy!

2. The Otsu's thresholding algorithm (for a single threshold) following the description provided on the slides or the paper of N. Otsu which you can find in Absalon.

3. A cleaning/denoising algorithm, briefly described in the slides for removing small holes in the segmentations. At each *interior pixel* compute how many of its neighbours are of a given label. If enough of them "vote" for a given label, this pixel (in the cleaned segmentation) is given the majority value. The threshold on the number of votes is a parameter of the algorithm. It could be: all neighbours, or 2/3 of them etc.



4 and 8 pixels neighbourhood systems.

You will allow for either 4-pixels or 8-pixels neighbourhoods. It should be possible to iterate this algorithm a certain amount of time, and this should be a parameter in your implementation.

You will use several images provided to you on Absalon in the `Images_Data` folder, and you are welcome to use other grey-scale images of your choice, or a colour one that you convert to grey-scale.

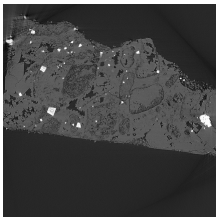
- Create and run your implementations of k-means and Otsu on Absalon's images and one or more of your choice.
- Comment on their similarity, dissimilarities?
- Run several iterations of the segmentation denoising algorithm with varying voting thresholds values. Comment on the results.
- Run a k-means segmentation with $k > 2$. Can it help with the page image?
- Can you imagine a way to generalise the segmentation denoising algorithm to more than 2 segments? Comment on it.
- You may want to try some of the algorithms available in `scikit-learn`, such as the Chan-Vese segmentation.

Data

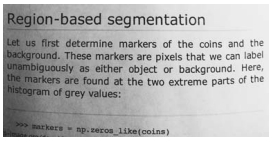
Here are the 4 images provided to you for this assignment. Image 3, a micro-tomographic slice of a rock sample, has been strongly reduced in size (the original is 2560x2560 pixels).

Cameraman

Coins



rock sample slice



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Again, fill free to use other images of your choice (not too many...-:))