Home Assignment 1

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The work was done in a team of two – by **Shahin Mammadov** and **Abumansur Sabyrrakhim**. The work distribution was following:

- **Shahin Mammadov**: in watershed algorithm implemented method for looking for new minimas, output image matrix and image flattening method.
- **Abumansur Sabyrrakhim**: in watershed algorithm implemented method for getting x and y pairs of the image and its neighbour, getNeighbours method and masking of pixels at current level
- The rest, such as sorting pixels, creating 256 gray values and etc., as well as experiments and report were done together.

Watershed Segmentation

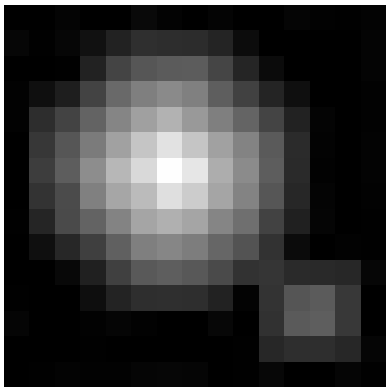
The watershed is a classical algorithm used for segmentation, that is, for separating different objects in an image.

Starting from user-defined markers, the watershed algorithm treats pixels values as a local topography (elevation). The algorithm floods basins from the markers until basins attributed to different markers meet on watershed lines. In many cases, markers are chosen as local minima of the image, from which basins are flooded.

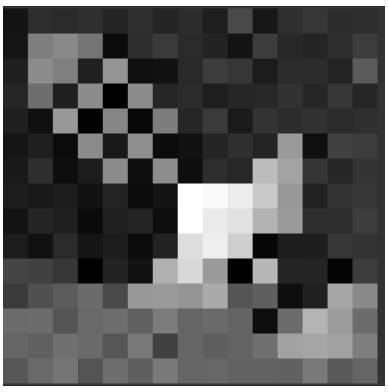
In the example below, two overlapping circles are to be separated. To do so, one computes an image that is the distance to the background. The maxima of this distance (i.e., the minima of the opposite of the distance) are chosen as markers and the flooding of basins from such markers separates the two circles along a watershed line. [1]

PROBLEM 1

Please generate output images for the inverse of the distance transform 'f1_dinv.txt' derived from a blob image.



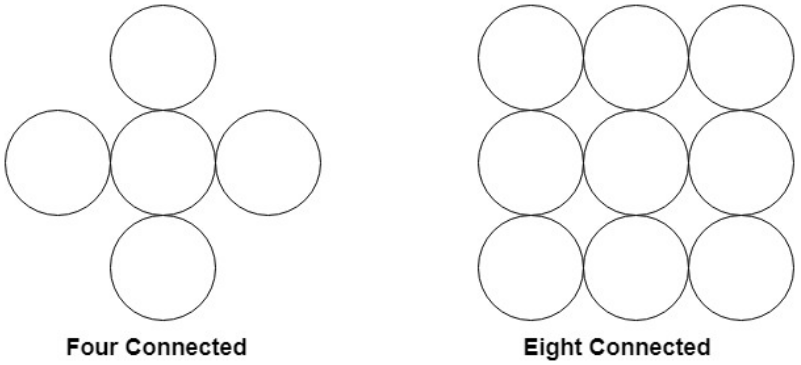
Distance transformation for f1



Watershed for f1 with 4 neighbours

PROBLEM 2

Please generate output images for the circle image (f2.txt). For this image, explain the differences between the 4- and 8-connected neighborhood implementations.



The visual comparison of 4- and 8- connected neighbourhood implementations

In particular, the more neighbors you have, the less regions appear in the resulting image. This is because the algorithm creates larger regions at the same time, starting from the initial regional minima. Each version of the 8-connected algorithm for each regional minimum uses a larger region to classify the minimum's neighbors, resulting in larger but fewer regions:

Watershed for f2 with 4 neighbours

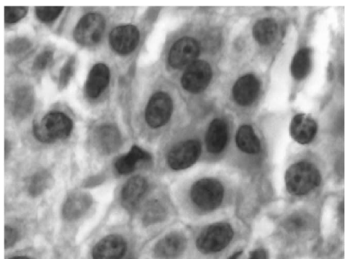
Watershed for f2 with 8 neighbours

PROBLEM 3

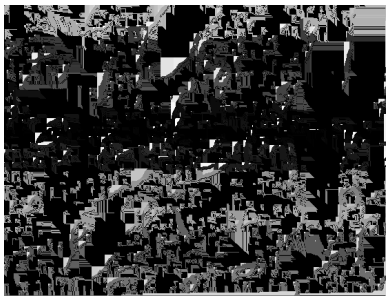
Please generate output images for three further images of your choice that shows multiple objects each to be segmented. Before applying the watershed transform, you must derive a suitable segmentation function through a method of your choice.

- Since for previous problems we were taking input in *.txt* format, for the 3rd problem, the code had to be adjusted, so that it converts *.png* format to grayscale.
- Since it was suggested us to use dilation and/or erosion, we tried filtering with erosion and dilation before applying watershed segmentation, to see and choose the best final results.
- We tested out both erosion and dilation on both 4- and 8- connected neighbourhood implementations.

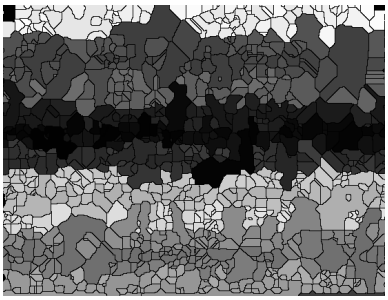
Experiment 1. The cell Nuclei



Input image of Experiment 1



Watershed after dilation with 4 neighbours

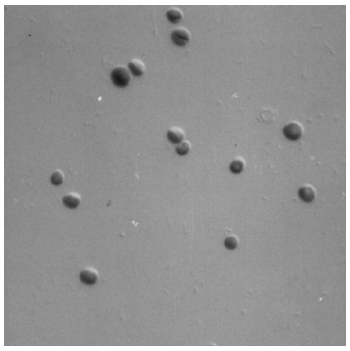


Watershed after dilation with 8 neighbours

Watershed after erosion with 4 neighbours

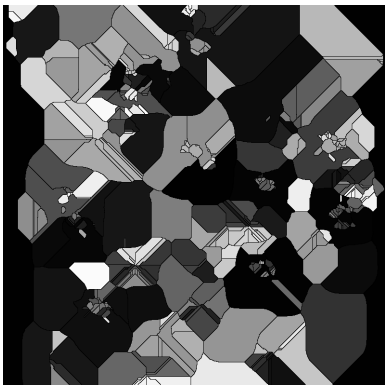
Watershed after erosion with 8 neighbours

Experiment 2. The cells



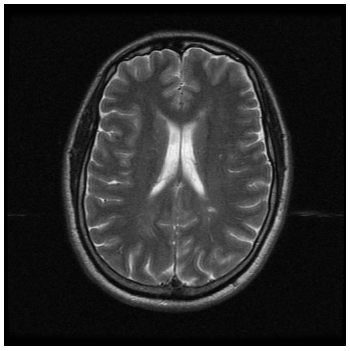
Input image of Experiment 2

Watershed after erosion with 4 neighbours



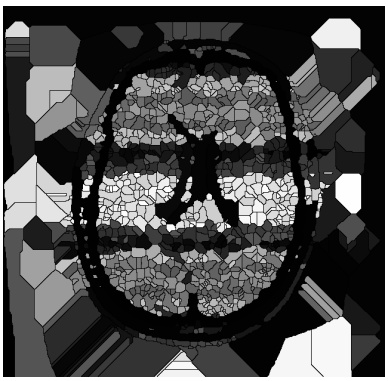
Watershed after erosion with 8 neighbours

Experiment 3. The Brain cut



Input image of Experiment 3

Watershed after erosion with 4 neighbours



Watershed after erosion with 8 neighbours

REFERENCES

[1] The Definition of Watershed Segmentation
https://scikit-image.org/docs/dev/auto_examples/segmentation/plot_watershed.html