

TDT4195 – IP assignment 3

Task 1

1.a)

Opening is erosion followed by dilation with the same structuring element. It is used to smooth out bumps in the foreground image.

Closing is the opposite of opening; dilation followed by erosion with the same structuring element. It is used to close small holes in the foreground image.

If we apply opening and closing multiple times consecutively, we end up with smoothed corners and rounded bumps/holes.

1.b)

We smooth an image before edge detection to remove outliers/noise, while leaving the general structure intact.

1.c)

Hysteresis thresholding works by using two thresholds: a low threshold T_L and a high threshold T_H . T_H should be 2-3 times larger than T_L .

Now, each pixel is assigned a label, based on its value:

- $T_H < \text{pixel value} \rightarrow$ **strong pixel**.
- $T_L < \text{pixel value} < T_H \rightarrow$ **weak pixel**.
- $\text{Pixel value} < T_L \rightarrow$ the pixel is suppressed.

Now, we check every weak pixel. If the weak pixel is connected to a strong pixel (8-connected neighbourhood pixels) we keep it. If not, we remove it.

1.d)

We use hysteresis thresholding because we separate between edges that we are certain of and edges that we are in doubt of. All certain edges (strong edges) are taken into account, while the ones we are in doubt of (weak edges) should only be taken into account if they are connected to strong edges.

If a weak edge is not connected to a strong edge, it is most likely just noise. If it is connected to a strong edge, however, it is most likely a part of that edge-body; the pixel may just be less visible due to lighting for example.

1.e)

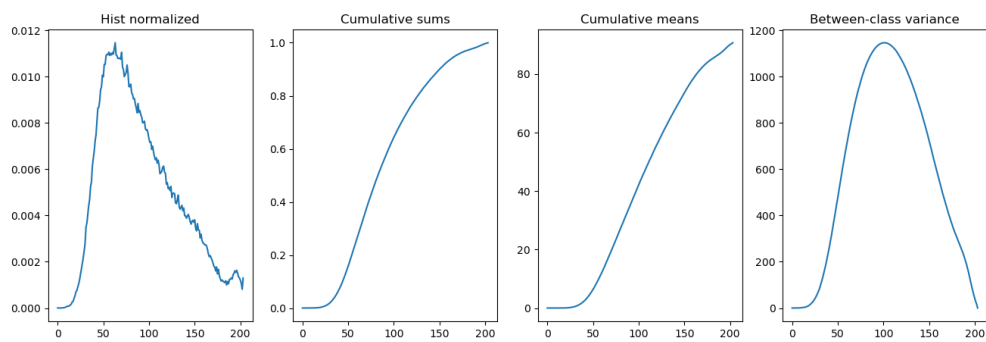
The structuring element says that if a pixel has a value of 1, the horizontal neighbourhood pixels should also become one. Thus, we grow only in the horizontal direction.

[0, 0, 0, 0, 0, 0] \rightarrow [0, 0, 0, 0, 0, 0]
[1, 0, 0, 0, 1, 0] \rightarrow [1, 1, 0, 1, 1, 1]
[0, 1, 1, 1, 0, 0] \rightarrow [1, 1, 1, 1, 1, 0]
[1, 0, 0, 0, 1, 0] \rightarrow [1, 1, 0, 1, 1, 1]
[0, 0, 1, 0, 0, 0] \rightarrow [0, 1, 1, 1, 0, 0]
[0, 0, 0, 0, 0, 0] \rightarrow [0, 0, 0, 0, 0, 0]

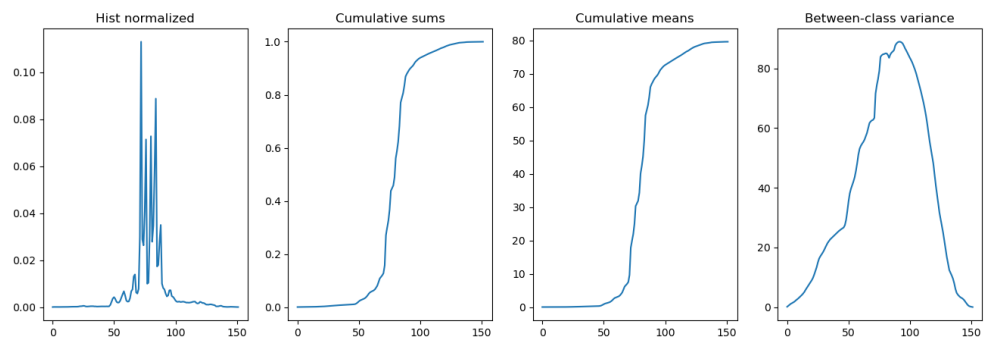
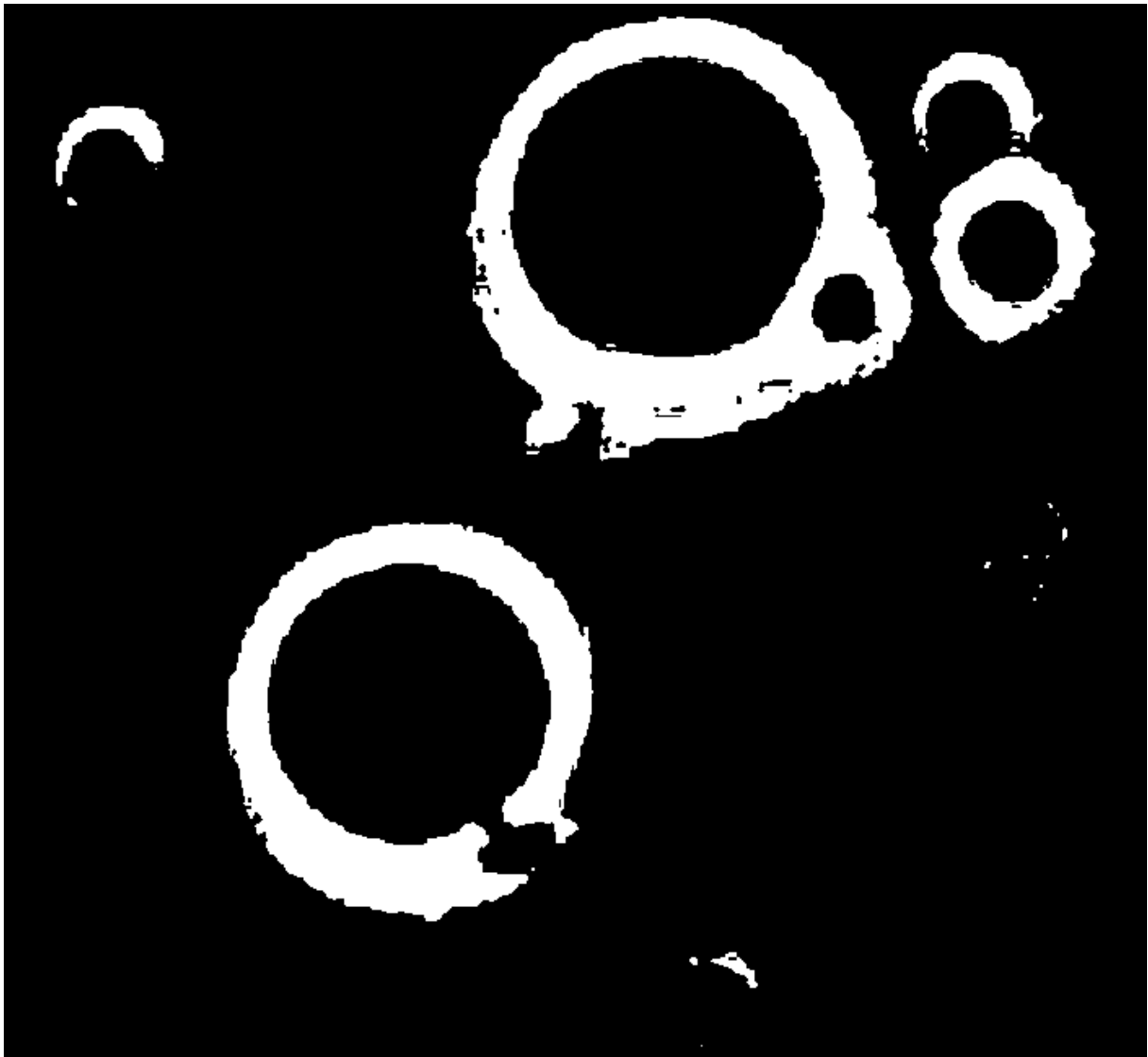
Task 2

2.a)

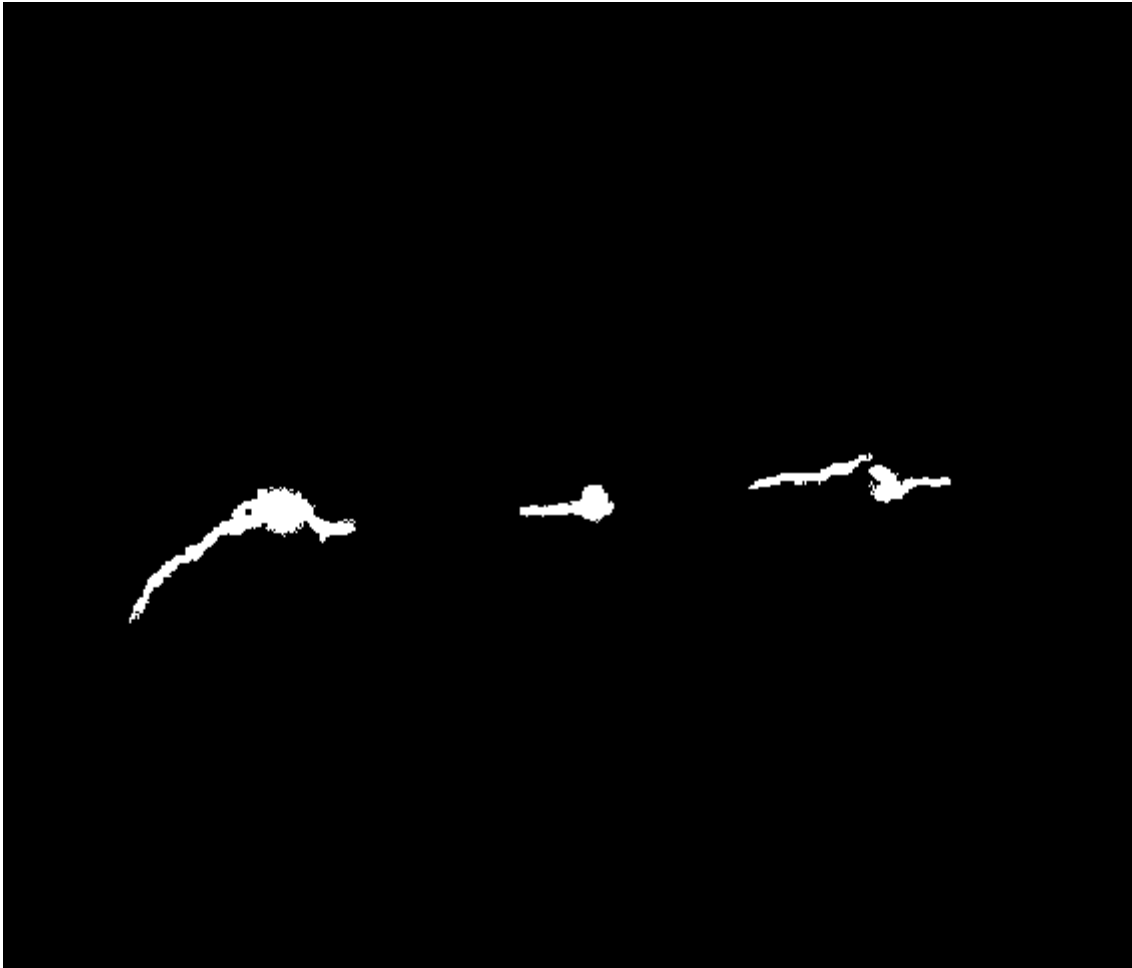
Found optimal threshold: 153.0



Found optimal threshold: 181.0



2.b)



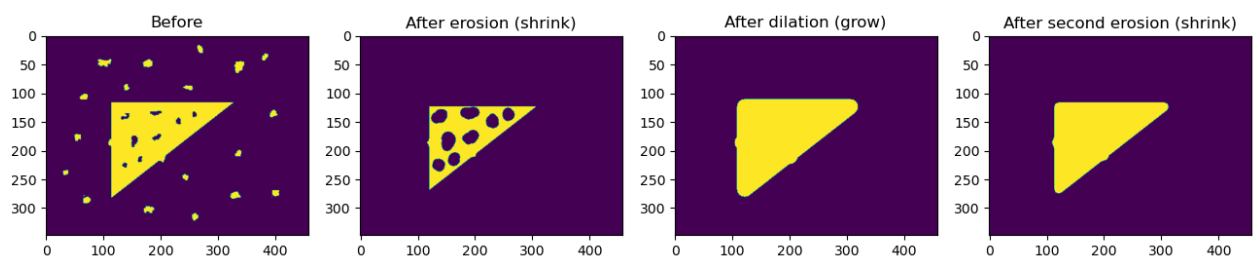
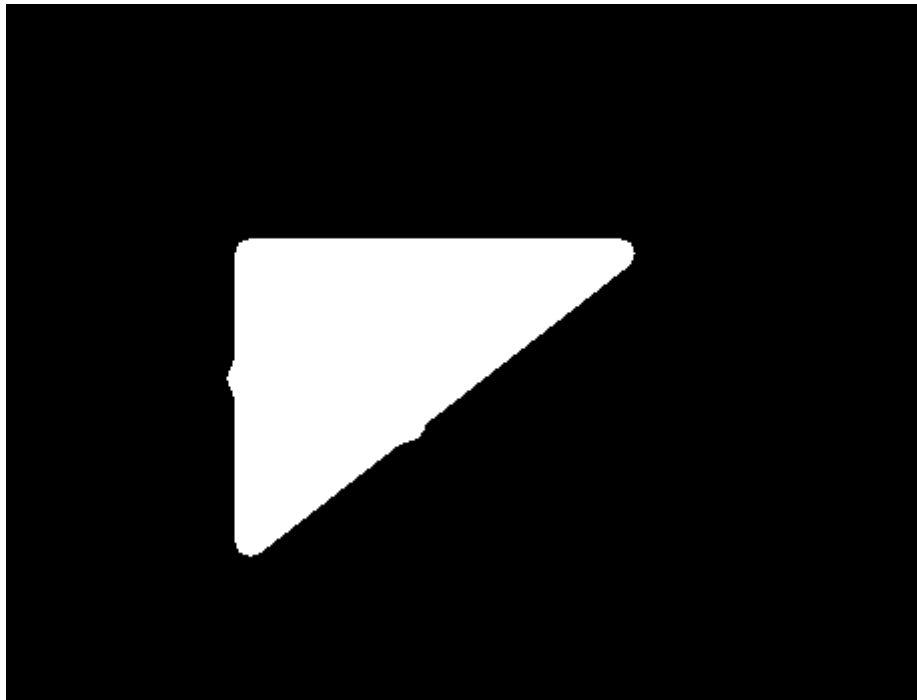
Task 3

3.a)

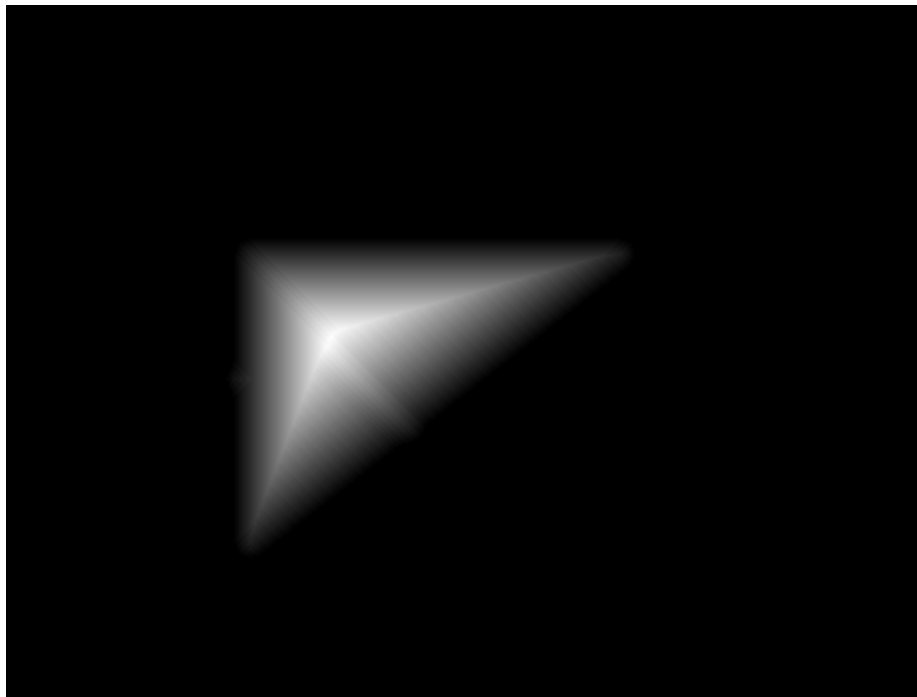
See the code for comments as well. We apply three steps in order to remove the noise.

- 1) Erosion to shrink/remove the outliers.
- 2) Dilation to grow/fill the holes in the triangle.
- 3) Erosion again since our first erosion has a radius of 7, while our dilation has a radius of 13. This second erosion grows with the radius of $13 - 7 = 6$, such that the triangle keeps its original width/height.

We could maybe apply closing/opening as well in order to remove the bumps on the triangle, but the result looks like figure 3b in the assignment description, so I am happy with the result.



3.b)



3.c)



3.d)

