MORPHOLOGICAL OPERATIONS
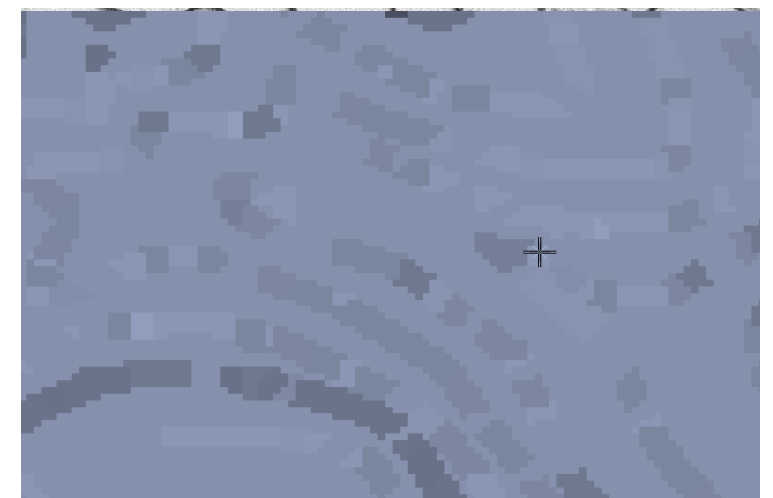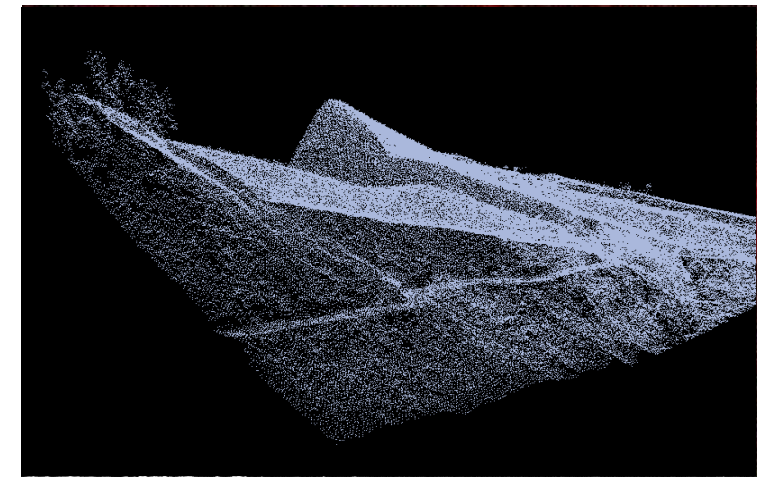
IMAGE AND VIDEO PROCESSING – MODULE 1

NINO PHILIP RAMONES | [GITHUB](#)

2020 - 05616

JULY 1, 2023

OBJECTIVES

- Perform morphological operations on different structuring elements to see how the resulting shape is formed based on the set origin and operation
- Apply morphological operations to clean thresholded and segmented images for feature extraction

KEY TAKEAWAYS

- Morphological operations are useful in cleaning a segmented image and eliminating unwanted details on the image prior to extracting the features of interest on every element on the image, while also preserving the shape and size of objects in the image
- Knowing what type of morphological operation to apply on the image is important depending on the characteristic of the segmented image

SOME PITFALLS

- Setting the origin on the image for the structuring element is important as shifting on the area being removed or retained differs based on the origin
- Performing morphological cleaning on an image might distort and remove some of the details of the cells prior to feature extraction and analysis
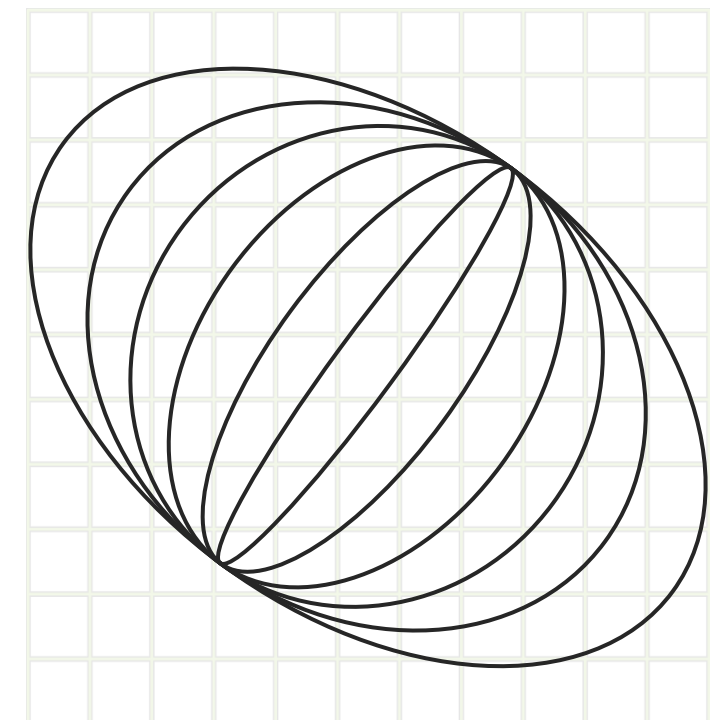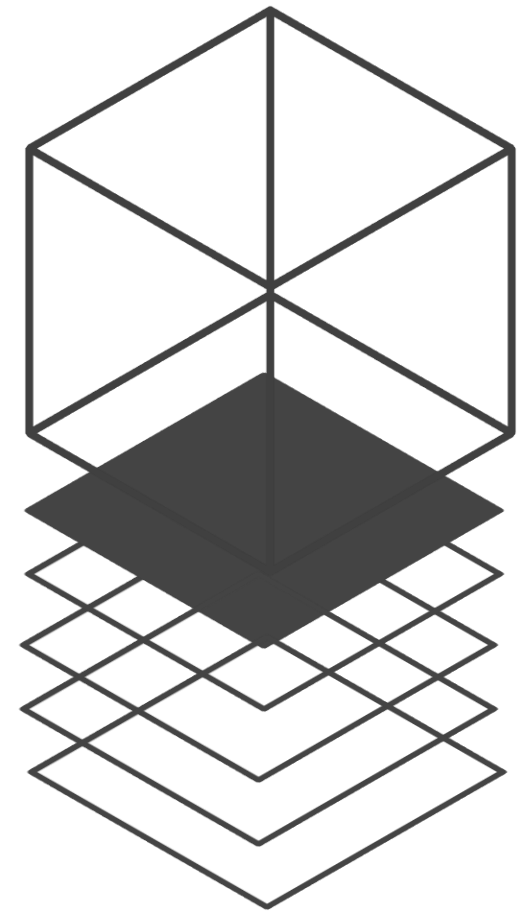
STRUCTURING ELEMENTS

In this activity, structuring elements of varying shapes and sizes were considered. In general, a **structuring element** is a shape used to interact with a given image where it is tested whether it fits or misses a portion of an original element or shape in the context. The following structuring elements were initialized to test our understanding on the different morphological operations --- using pen and paper!

A two-by-two square whose origin is on the upper left, a one by two rectangle with the left box as the origin, and a five-by-five square with the center as the origin were set as the structuring elements. Different shape forms were tested on these which will be shown on the succeeding slides.

Figure 1. Structuring elements used in the activity. Output can be viewed in this file link.
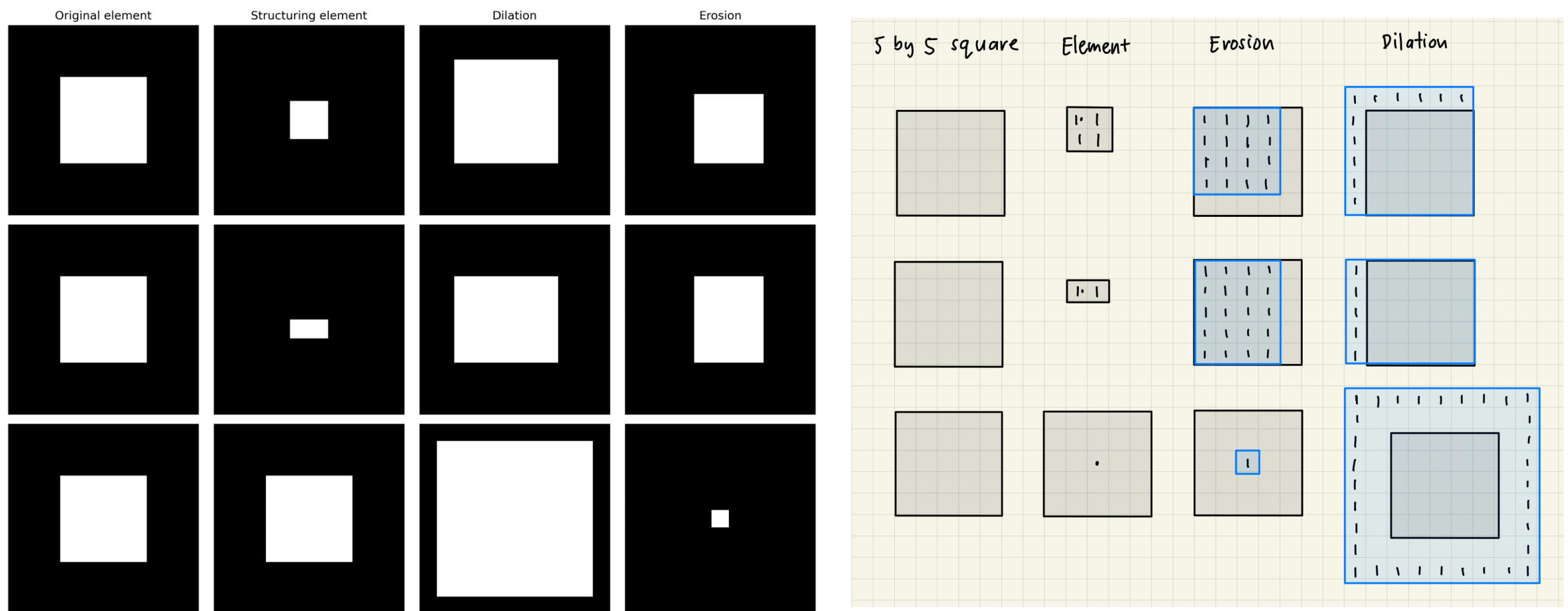
FIVE BY FIVE SQUARE

Figure 2. Dilation and erosion operators performed on a five-by-five square using three different structuring elements. The results from scratch (right) were compared to the results obtained after using **skimage.morphology** library in Python.
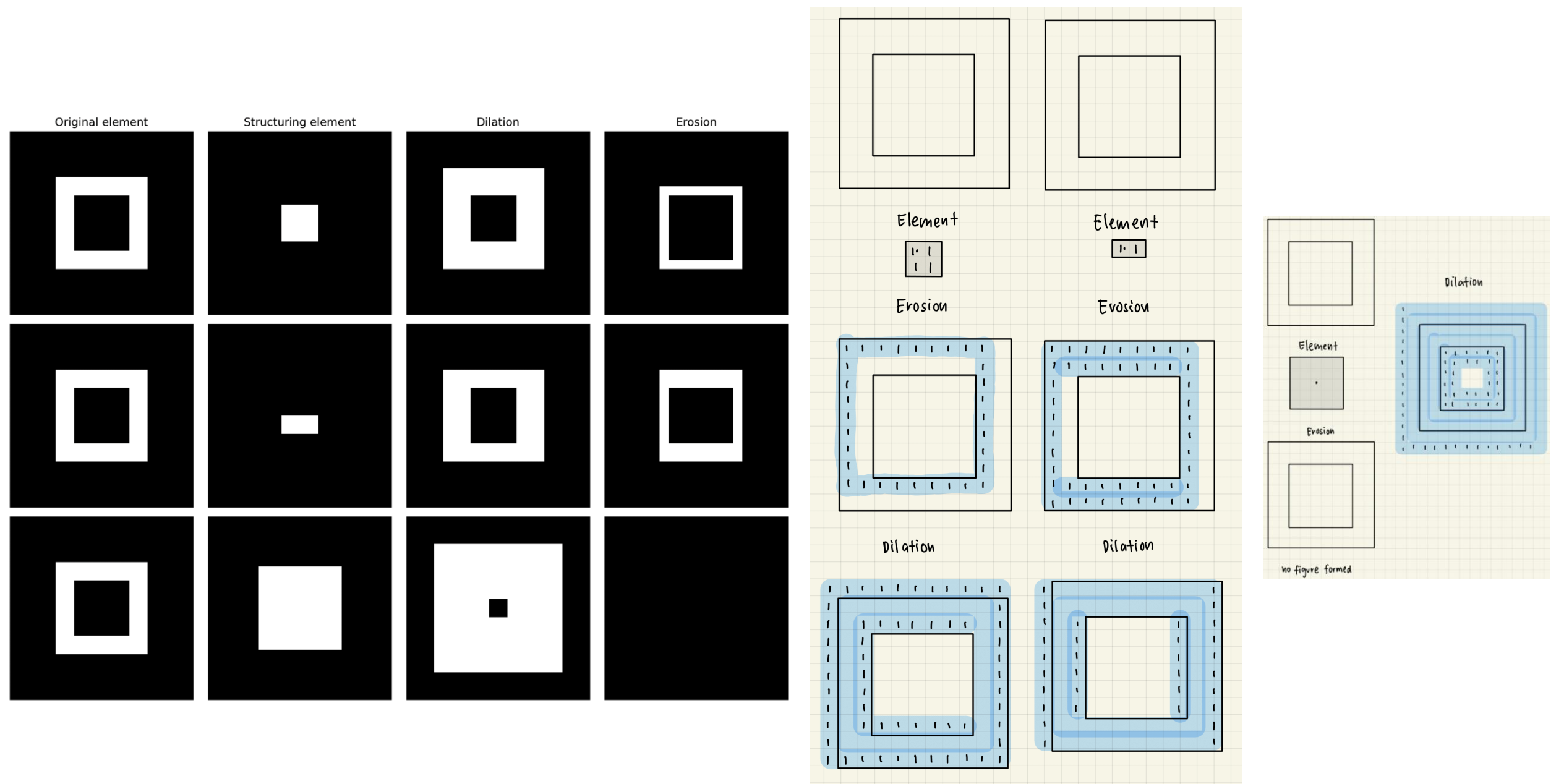
HOLLOW 10 X 10 SQUARE

Figure 3. Dilation and erosion operators performed on a hollow ten-by-ten square using three different structuring elements. The results from scratch (right) were compared to the results obtained after using **skimage.morphology** library in Python.
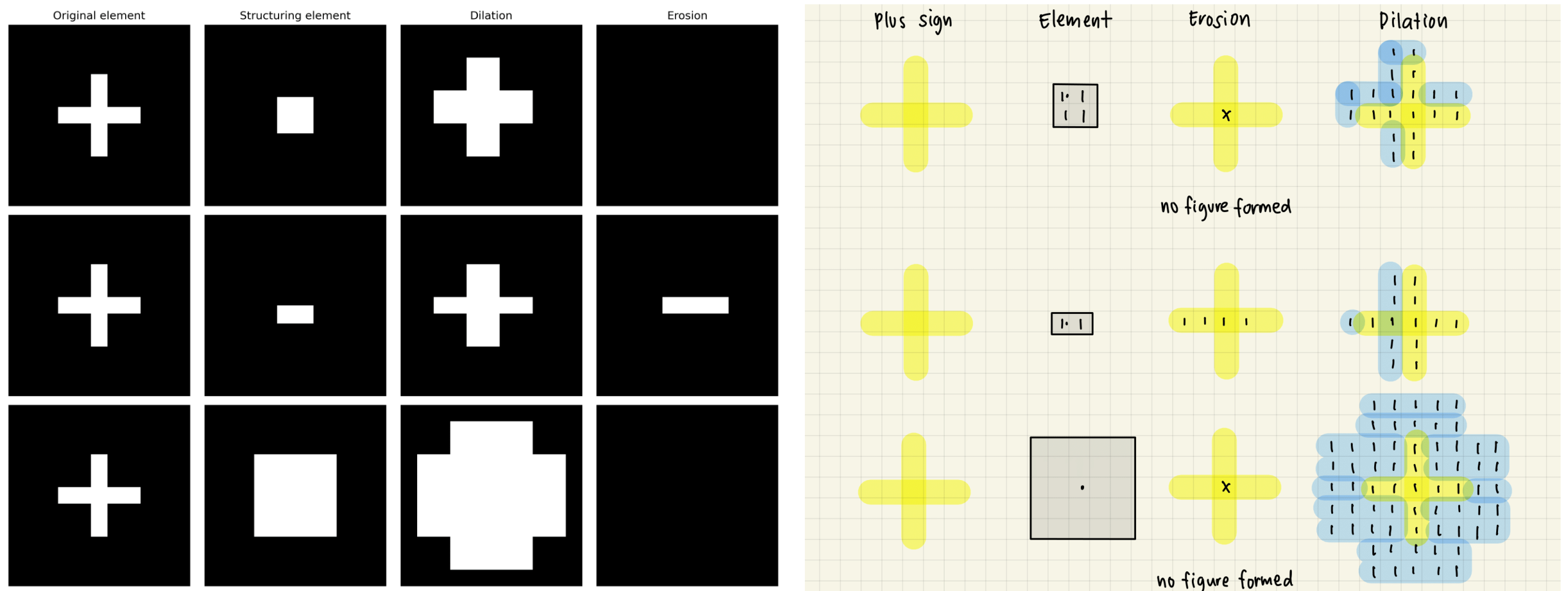
FIVE BY FIVE CROSS ACROSS AXIS

Figure 4. Dilation and erosion operators performed on a five-by-five cross or plus sign using three different structuring elements. The results from scratch (right) were compared to the results obtained after using **skimage.morphology** library in Python.
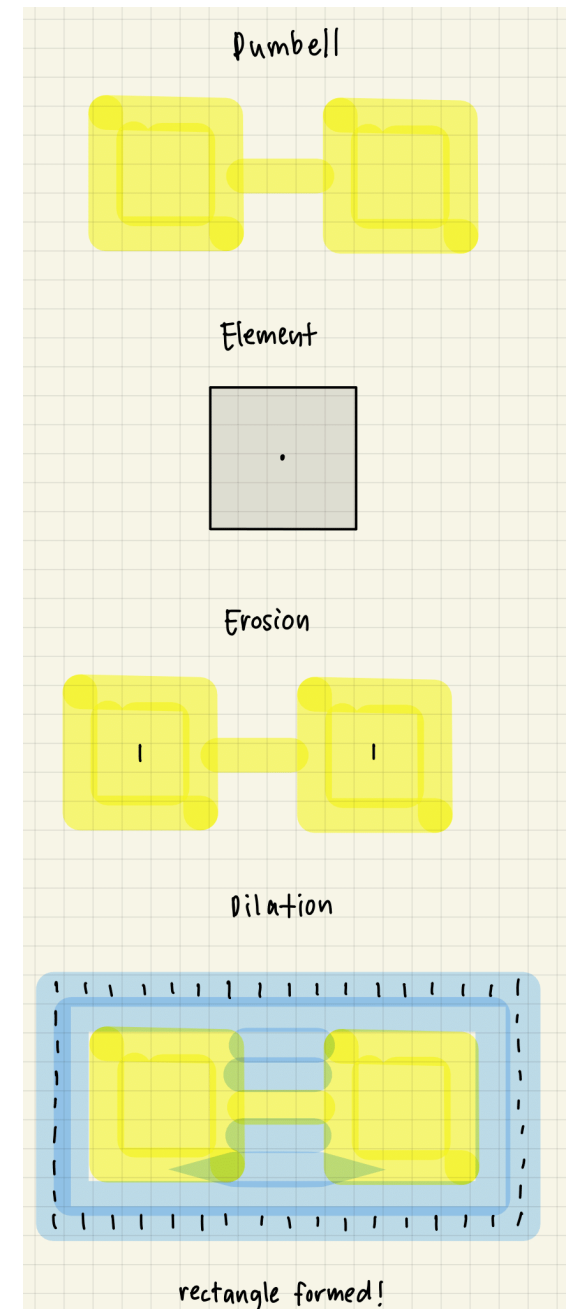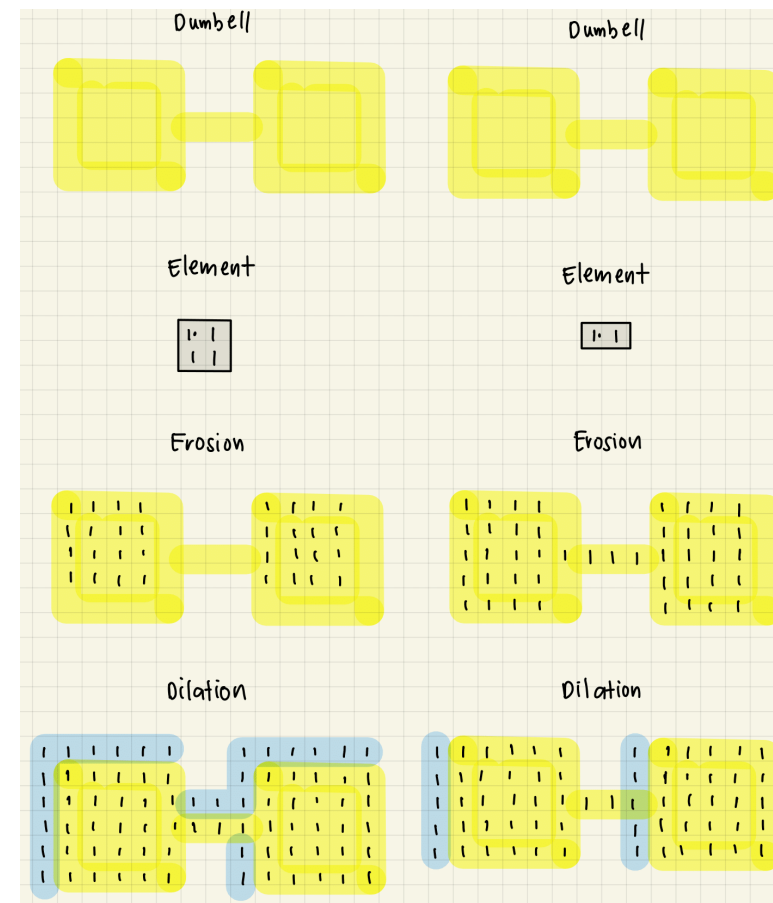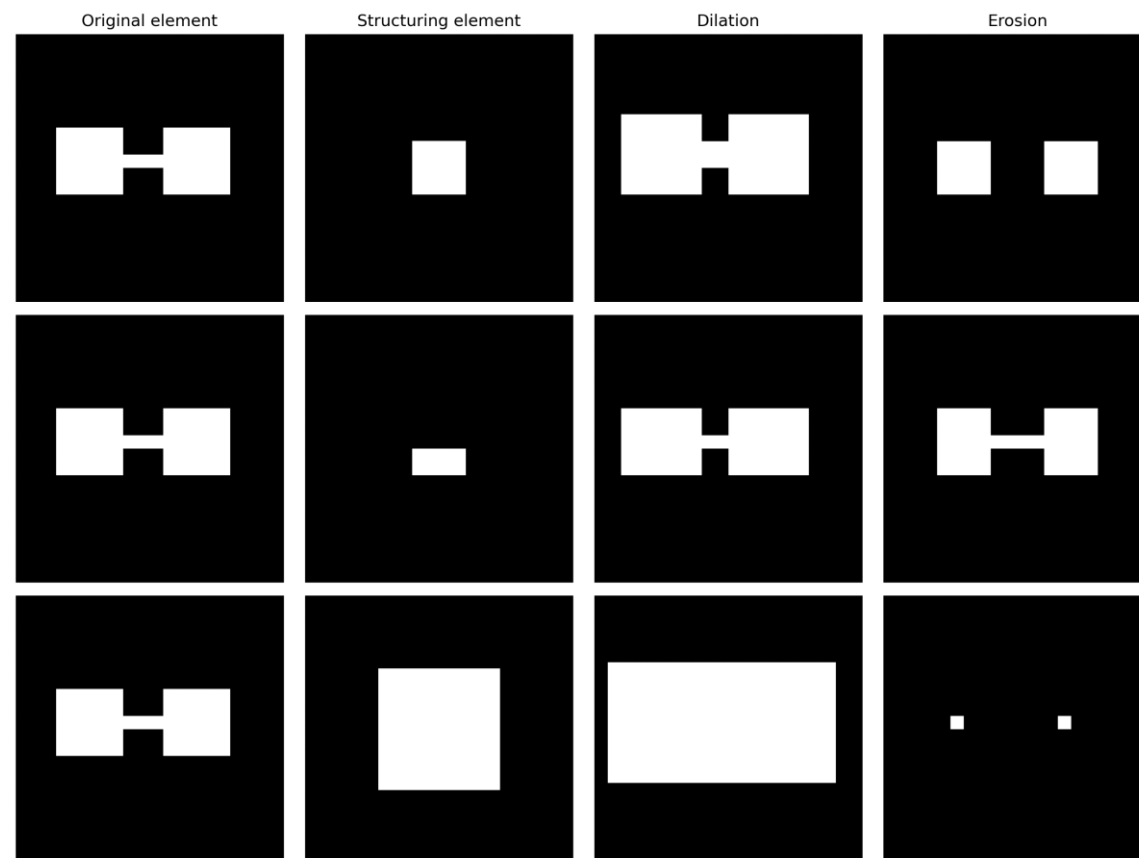
DUMBELL SHAPE

Figure 5. Dilation and erosion operators performed on a dumbbell-shaped element using three different structuring elements. The results from scratch (right) were compared to the results obtained after using **skimage.morphology** library in Python.

MORPHOLOGICAL CLEANING

Employing the same principle on segmenting images through **thresholding**, we performed **morphological cleaning** on the malaria samples to isolate unwanted details on the segmented image.
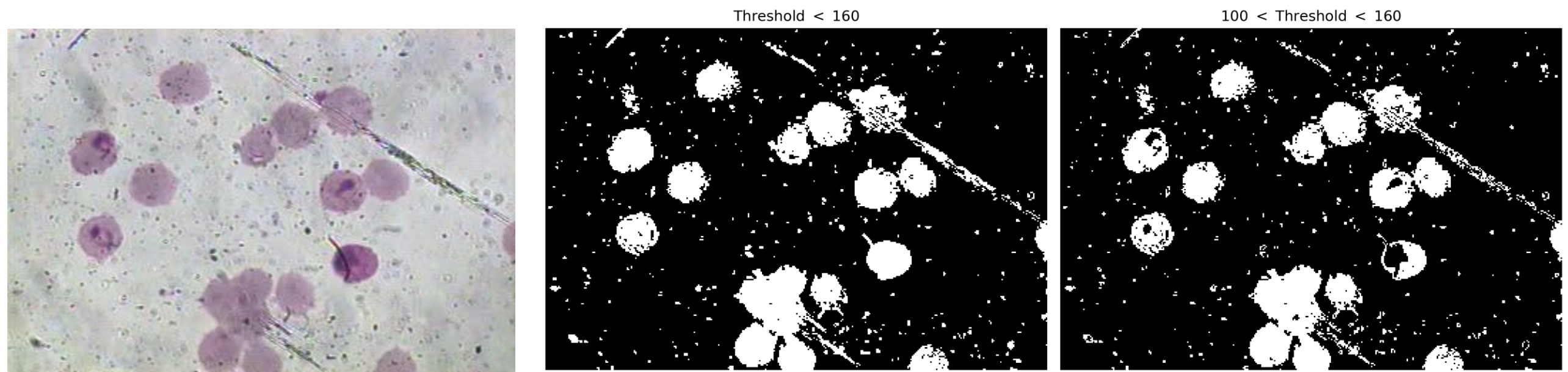

Figure 6. Thresholded image of the malaria cells for varying threshold or clipping values.

From the figure, the image was segmented by choosing a certain pixel value on the grayscale histogram of the original image, and **clipping values above it to zero** such that the resulting image only contains the regions of interest, i.e. the cells or blobs present. It can be noticed that the thresholded image contains a lot of dots that are unwanted for feature extraction since we only want to observe the cells itself. This is where the process of cleaning through morphological operations come into play!
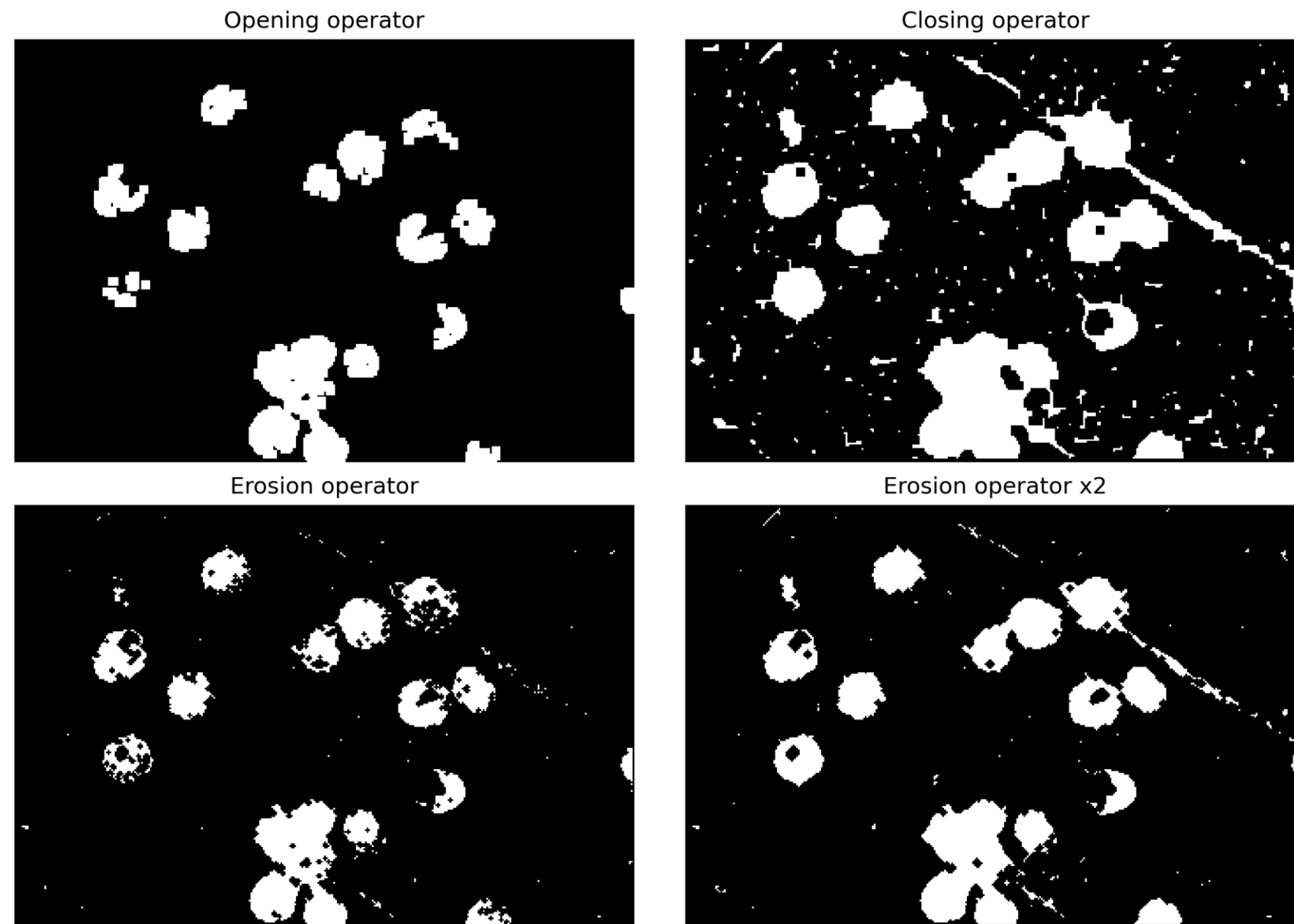
MORPHOLOGICAL CLEANING

Figure 7. Morphologically-cleaned image of the malaria cells after thresholding.

After thresholding the image, a series of different morphological operations were performed to experiment and see how the white dots gradually disappear resulting to a much cleaner and more detailed image.
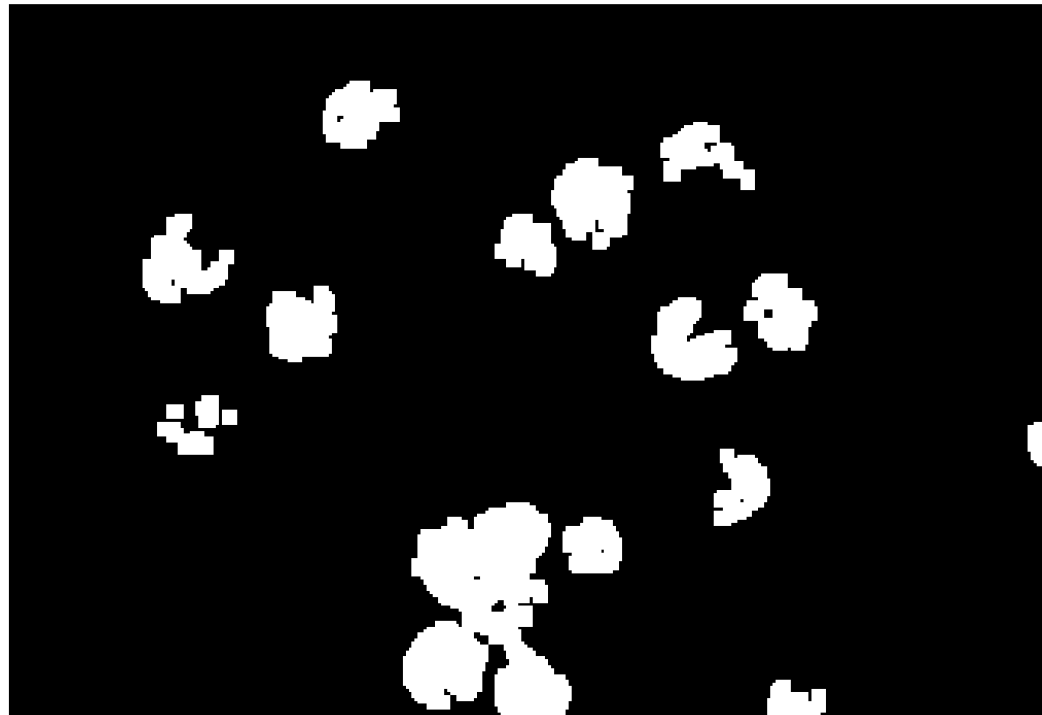
MORE ON OPERATIONS

Opening operator

Figure 8. Opening operator applied.

By inspection, the **opening operator** yielded an ideal image that can be used for **feature extraction** itself as it no longer contains the unwanted white spots previously. Although the shape of most cells were sort of **distorted and irregular** in general, the morphological cleaning was still able to do its job in **cleaning** the image! But what do these opening and closing operators really do?

Opening operator. This operation **erodes** an image and then **dilates** the eroded image while also using the same structuring element for both operations. This is useful for **removing small objects and thin lines** on an image while also preserving the shape and size of larger objects or blobs in the image.

Closing operator. This operation **dilates** an image and then **erodes** the dilated image while also using the same structuring element for both operations. This is useful for **filling small holes** on an image while also preserving the shape and size of larger objects or blobs in the image.

REFLECTION

I find the activity fun as I get to work and understand the principle behind morphological operations. The results that I obtained on the code and paper were similar, although a slight shifting on the axis was observed on the code results as I was not able to set the proper origin given in the activity. Nonetheless, I was still able to deliver what is expected on the activity and account for the pitfalls that I have encountered in my codes. Overall, I would give myself a score of **110/100** !

REFERENCES | [GITHUB](#)

1. M. Soriano, Applied Physics 157 – Morphological Operations, 2023.

2. [Types of Morphological Operations - MATLAB & Simulink (mathworks.com)](#)

3. [skimage.morphology — skimage 0.21.0 documentation (scikit-image.org)](#)