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Activity 8: Morphological Operations

Goal

To perform erosion and dilation to certain shapes

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Morphological Operations

Erosion

$A \ominus B = \{z | (B)_z \subseteq A \}.$

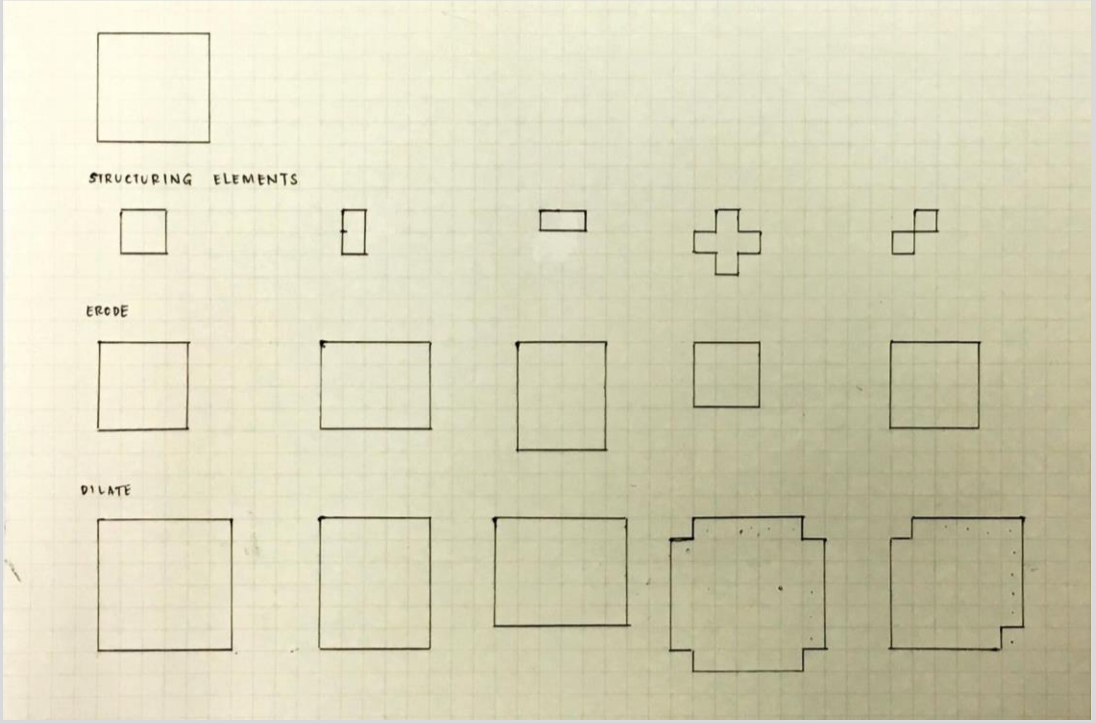
Erosion removes pixels on the boundaries of the shape. From the given equation, we see that the erosion of A by B is just the set of z such that B that is being translated by z is part of A. The effect of this is to reduce the image depending on the shape of B.

Dilation

$A \oplus B = \{ z | (\hat{B})_z \cap A \neq \emptyset \}$

Dilation adds pixels on the boundaries of the image. From the equation, the reflected B’s, which are z’s, are involved such that when intersected with A, we consider this set to be a non-empty set. The effect is to expand A depending on the shape of B.

Predict-Observe-Explain: 5x5 square



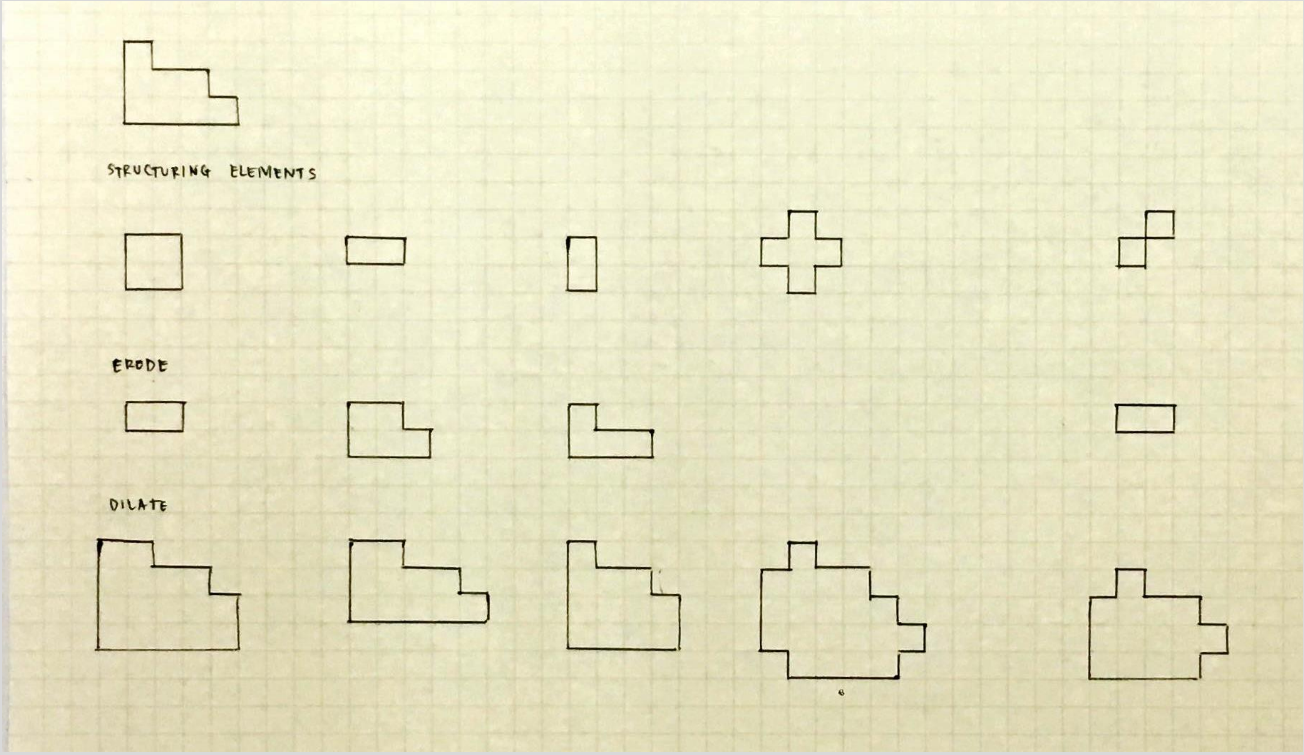
Erosion

The first part of the experiment is to predict, observe and explain. Given that we have 5 structuring elements (first row), the erosion can be observed on the second row. The initial image were shrunk. What happens is that when there is a structuring element found on the initial image, the origin will be included in the eroded image. Note that the final shape is not affected by the origin. Notice in row 2, columns 1 and 5 is just the same. For column 5, only 2 pixels were used. This can indicate good optimization in morphological operations.

Dilation

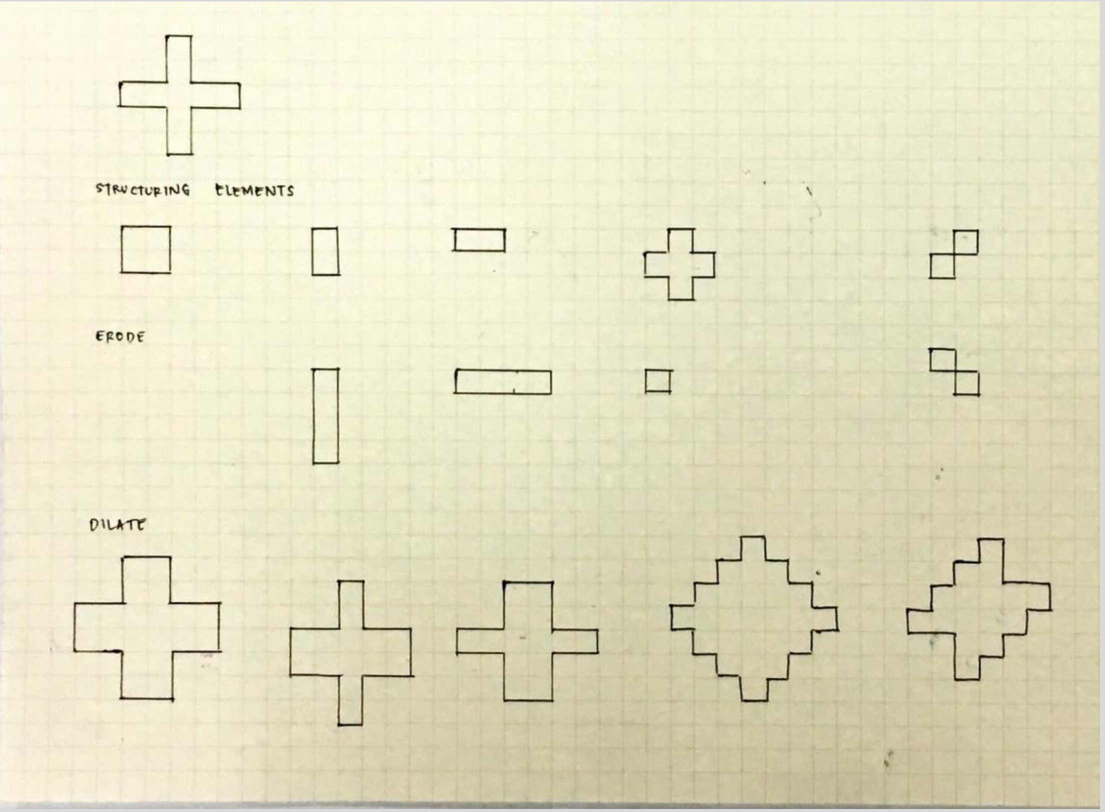
Here, our final image includes the initial image. We try to enlarge the image by adding pixels based on the structuring elements. We want each pixel in the initial image to be an origin of the element. Therefore, we add pixels when they lack.

Predict-Observe-Explain: triangle



The same goes for the eroded and dilated images of triangle. Although, for the eroded image in column 4, there is not existing image since we cannot see a cross structuring element inside the shape. It is impossible to diminish the initial image.

Predict-Observe-Explain: plus sign



The erosion and dilation for cross is also straightforward. Again, in row 2, column 1, the final image is not existing since a cross is not visible in a box.

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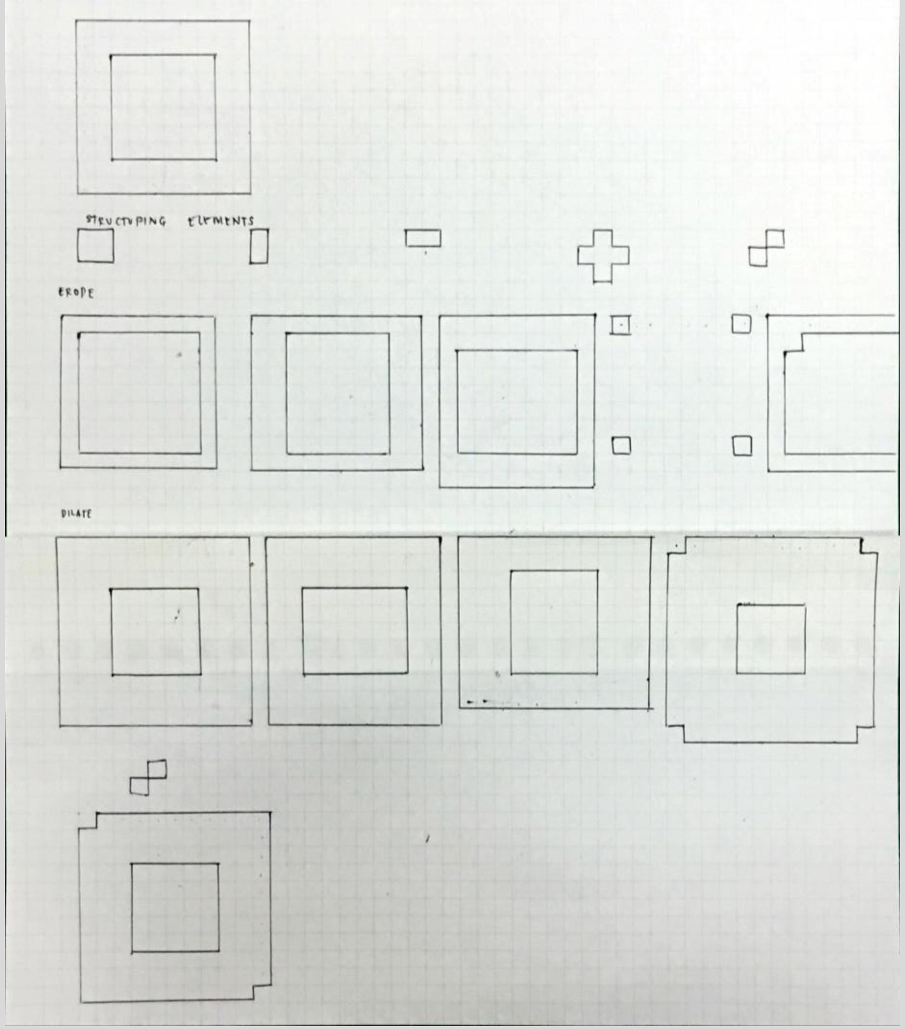
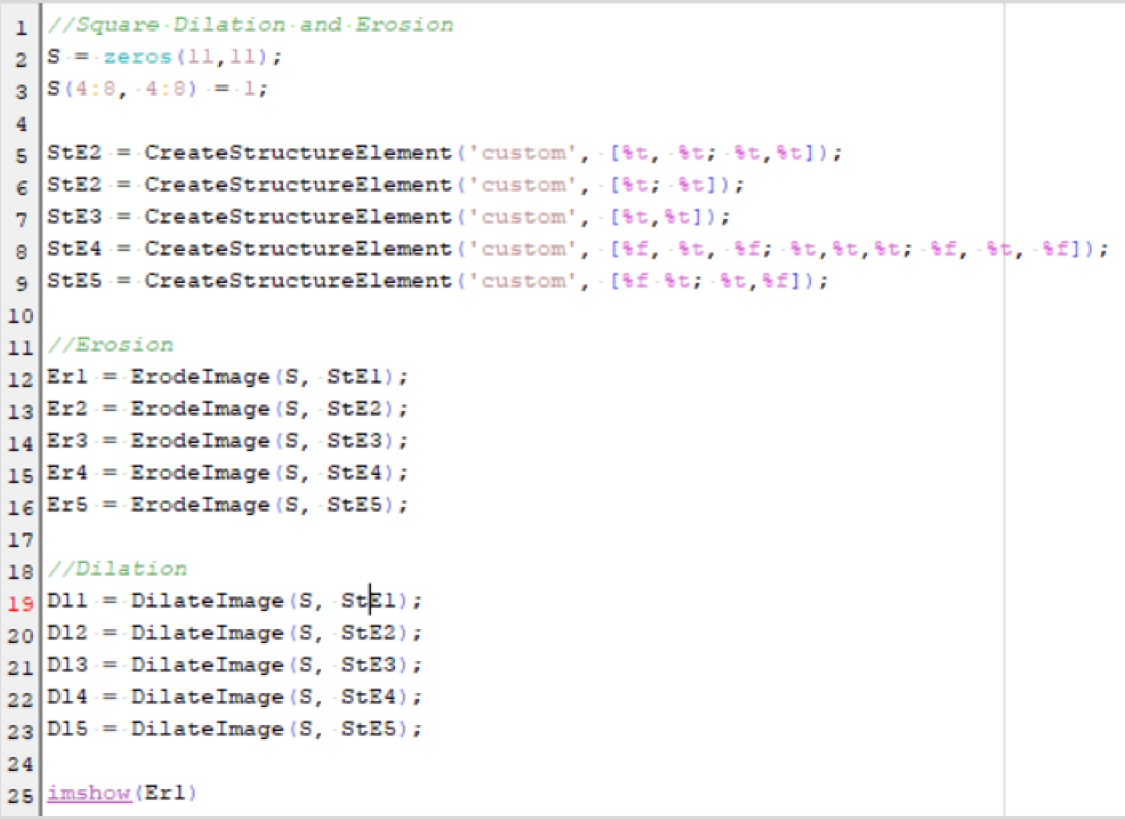
Predict-Observe-Explain: hollow 10x10 square

For the hollow shape, the process is a bit tricky. Since we assumed for the box shape that column 1 and 5 would be the same, we would assume the same for the hollow shape. However, this is a different case since two pixels in the corners are still included. Generally, erosion operation will increase the size of the hole.

For dilation, the size of the hole decreases based on the structuring element.





```
//Square Dilation and Erosion
S = zeros(11,11);
S(4:8, 4:8) = 1;

StE2 = CreateStructureElement('custom', [%t, %t; %t,%t]);
StE2 = CreateStructureElement('custom', [%t; %t]);
StE3 = CreateStructureElement('custom', [%t,%t]);
StE4 = CreateStructureElement('custom', [%f, %t, %f; %t,%t,%t; %f, %t, %f]);
StE5 = CreateStructureElement('custom', [%f %t; %t,%f]);

//Erosion
Er1 = ErodeImage(S, StE1);
Er2 = ErodeImage(S, StE2);
Er3 = ErodeImage(S, StE3);
Er4 = ErodeImage(S, StE4);
Er5 = ErodeImage(S, StE5);

//Dilation
Dl1 = DilateImage(S, StE1);
Dl2 = DilateImage(S, StE2);
Dl3 = DilateImage(S, StE3);
Dl4 = DilateImage(S, StE4);
Dl5 = DilateImage(S, StE5);

imshow(Er1)
```

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Scilab Implementation

Thanks to atomsInstall("IDP"), I was able to run this code in SanD's computer. It was very convenient to code this as there are existing packages already. This is the sample code for showing an eroded square image using a 2x2 element. The functions were not colored because I took a screenshot in my laptop but the code was run in SanD's computer where IDP package was installed.

CreateStructureElement()

There are 5 structuring elements for this activity. This function returns a new object of class.

ErodeImage()

Another function is ErodeImage() which I used for predicting the eroded final image . Thanks to IDP for having this. In python, cv2.erode() can be used.

DilateImage()

Another convenient function is DilateImage() which dilates the image depending on the created structure element. For python users, cv2.dilate() can be used.

Results (via Scilab)

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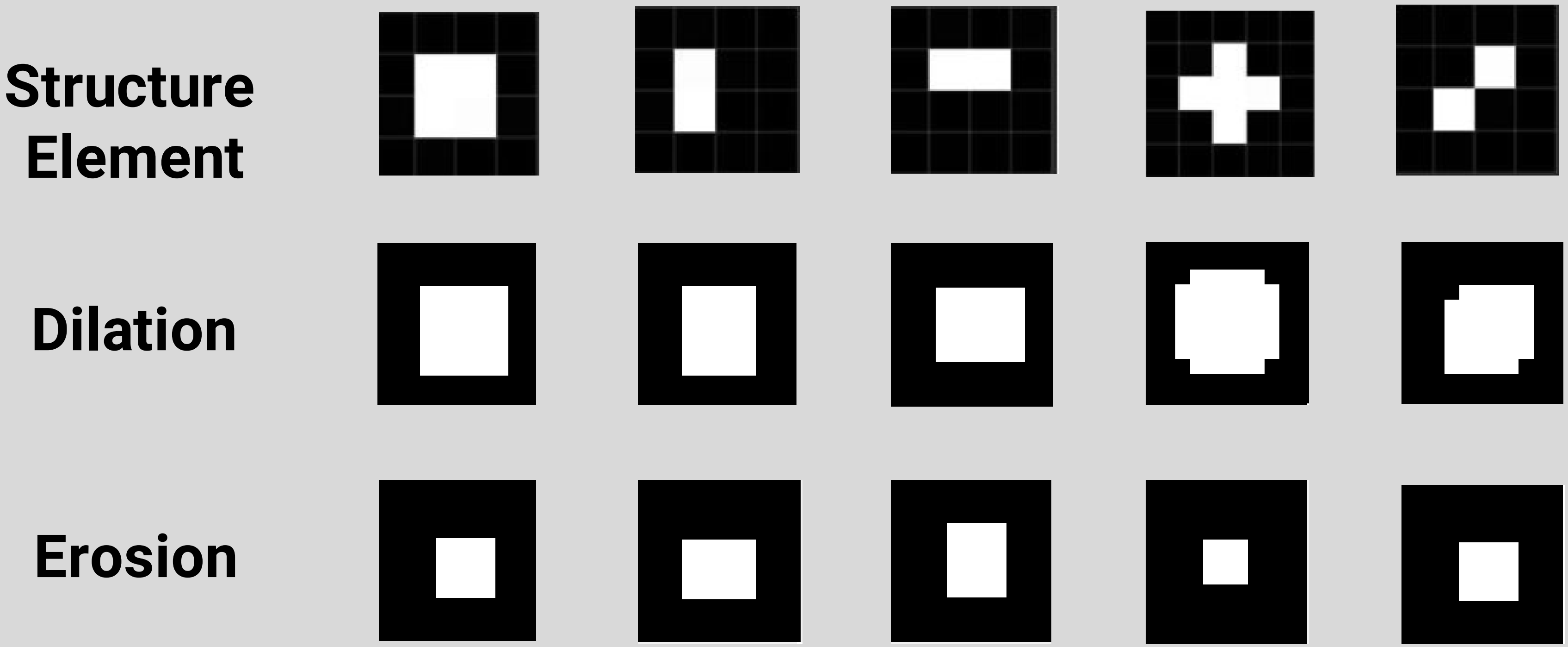
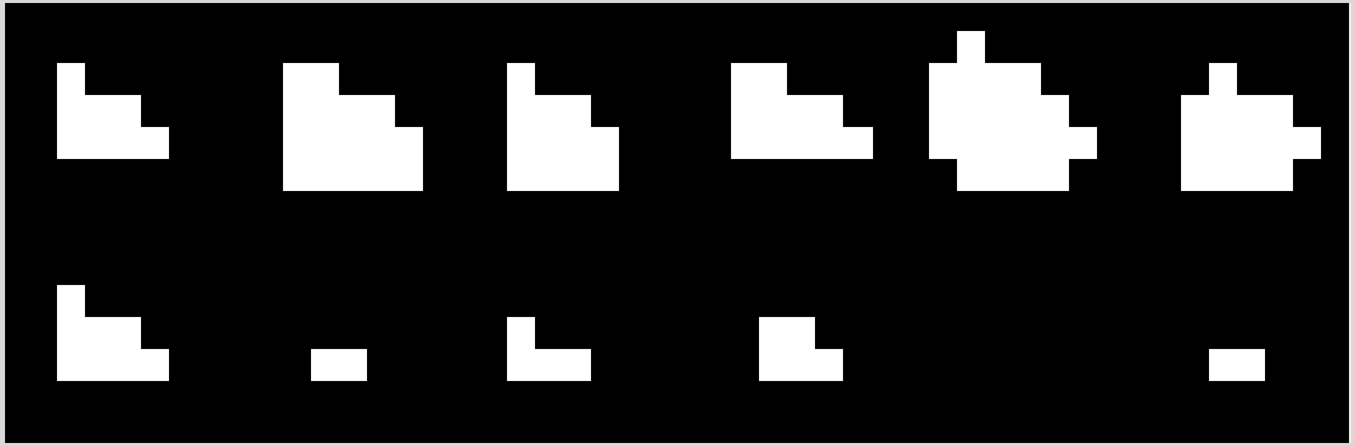
The code was first tested with the square image. So far, the predicted shapes were right.



Results (via Scilab)



Dilation

Erosion

Then by changing variables, the results for the ‘triangle’ shape were obtained. For row 2, column 2, it showed a different one from what I’ve predicted. The limited knowledge about erosion in irregular shaped can be taken into account. I miscalculated the number of pixels.

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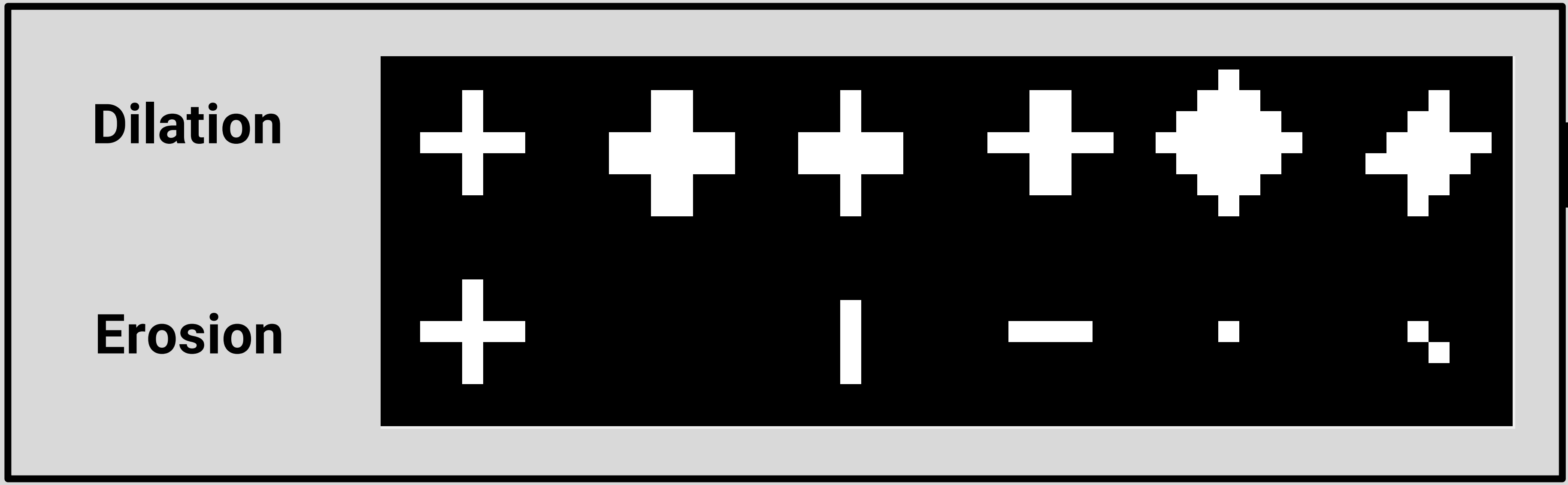
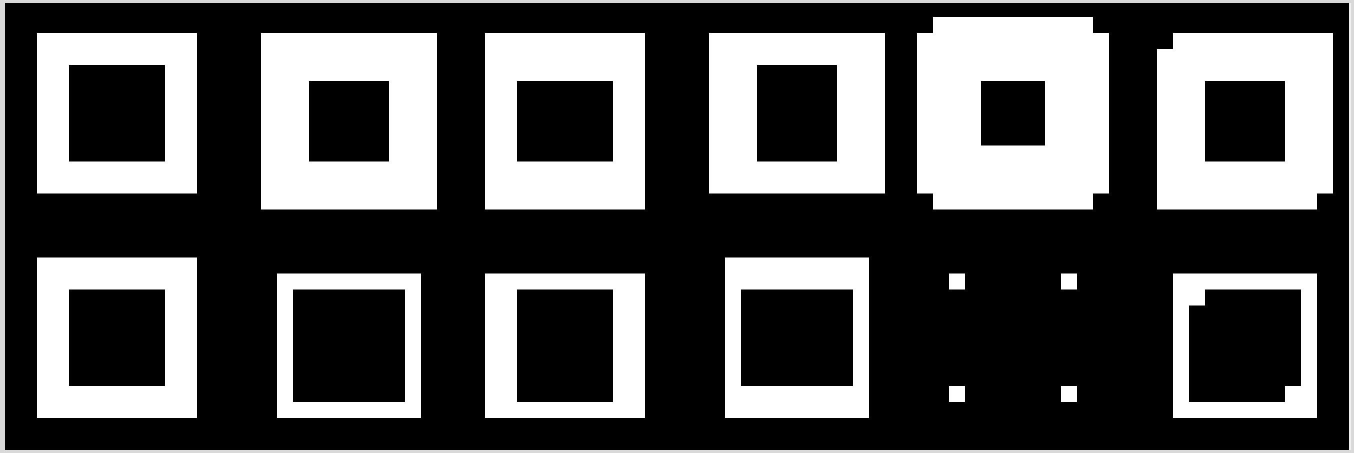
Results (via Scilab)



The same process was done for the cross shape. The prediction in which the 2x2 structuring element will not produce image was right. The rest were the same as my prediction.

Results (via Scilab)



Dilation

Erosion

The same goes with the hollow shape. So far, the results I got from the code was in line with my prediction.

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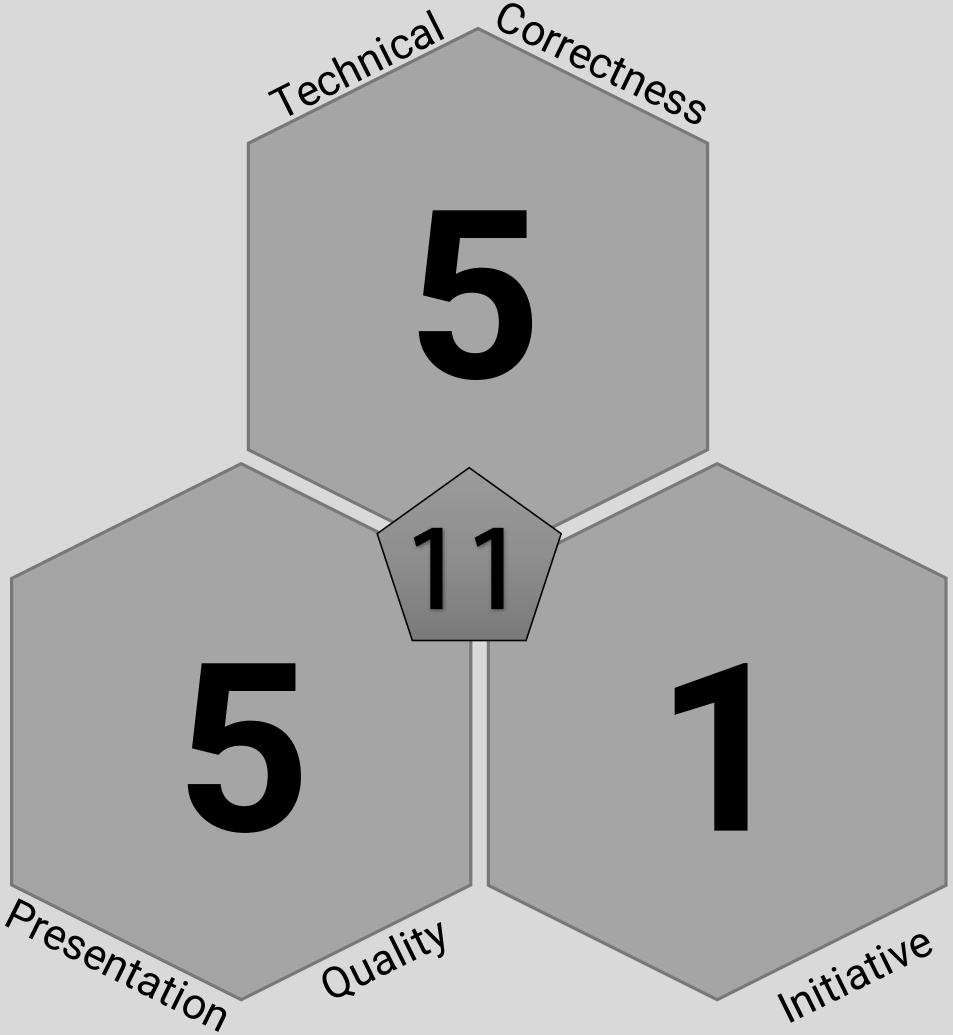
Summary

The coding part was the easiest (thank you IDP package). It was a very long activity but something that would push your brain think harder. It is like a mind-boggling twister. Although, I did enjoy trying to predict the shapes because I feel like I'm trying to beat AI. But in the end, AI still wins. I got one mistake in predicting the shapes especially for the 'triangle' shape. It was a bit hard to detect the final for irregular shapes. It was the most challenging shape for me.

Self-Evaluation



Technical Correctness

5

Presentation Quality

5

Initiative

1

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References

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