

Morphological Operations

Activity 8 Short Report

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Tasks

❖ Basic Morphological Operations

- Erosion of pixels
- Dilation of pixels

Basic Morphological Operations

Given some shape A and a structuring element B , **erosion** aims to reduce A by the shape of B . Mathematically speaking, this operation is denoted by:

$$A \ominus B = \{z \mid (B)_z \subseteq A\} \quad (1)$$

Equation 1 says that erosion is the set of all points z such that B translated by z is contained in A ^[1].

[1] – Soriano, M. (2019). A8 – Morphological Operations [lecture handouts]

Basic Morphological Operations

To visualize this, say we have our structure element as in Fig. 1 with its origin marked by the black dot. We run this along our shape, making sure that the structure element is within the shape, and then we map the origin along all pixels it traverses. Those mapped dots constitute our eroded shape.

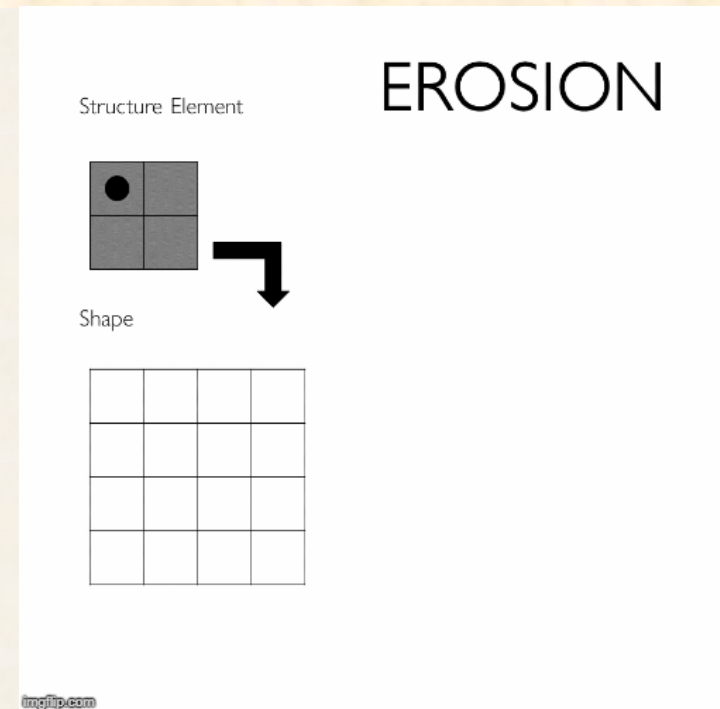


Figure 1. Erosion operation

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Given some shape A and a structuring element B , **dilation** aims to expand A in the shape of B . Mathematically speaking, this operation is denoted by:

$$A \oplus B = \{ z \mid (\hat{B})_z \cap A \neq \emptyset \} \quad (2)$$

Equation 2 says that dilation involves all z 's that are translation of a reflected B that when intersected with A is not the empty set^[1].

[1] – Soriano, M. (2019). A8 – Morphological Operations [lecture handouts]

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To visualize this, say we have our structure element as in Fig. 2 with its origin marked by the black dot. We run the black dot along our shape (with the SE), and then retain all outlying pixels that are not originally in the shape. These constitute our dilated shape.

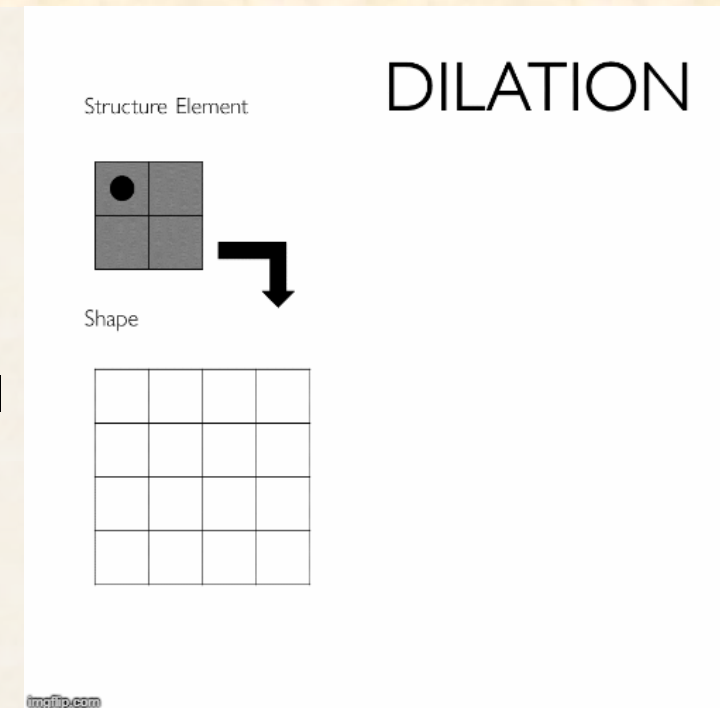


Figure 2. Dilation operation

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Preliminaries

Four shapes (5x5 square, triangle, 10x10 hollow square, plus sign), and five structure elements (2x2, 2x1, 1x2 ones, 3-pixel long cross, diagonal) were drawn on a graphing paper. Resulting images from erosion and dilation were predicted. The drawings are shown in the next few slides.

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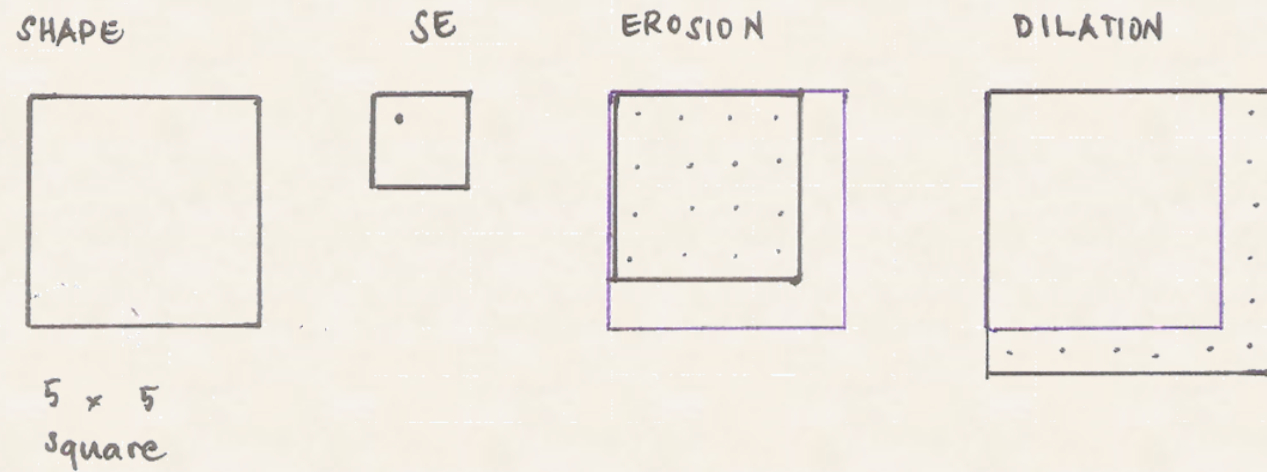


Figure 3. Predicted erosion and dilation for 5x5 square. Blue ink denotes the original shape, dots in erosion constitute eroded shape, dots in dilation constitute the additional pixels to be added to the dilated shape.

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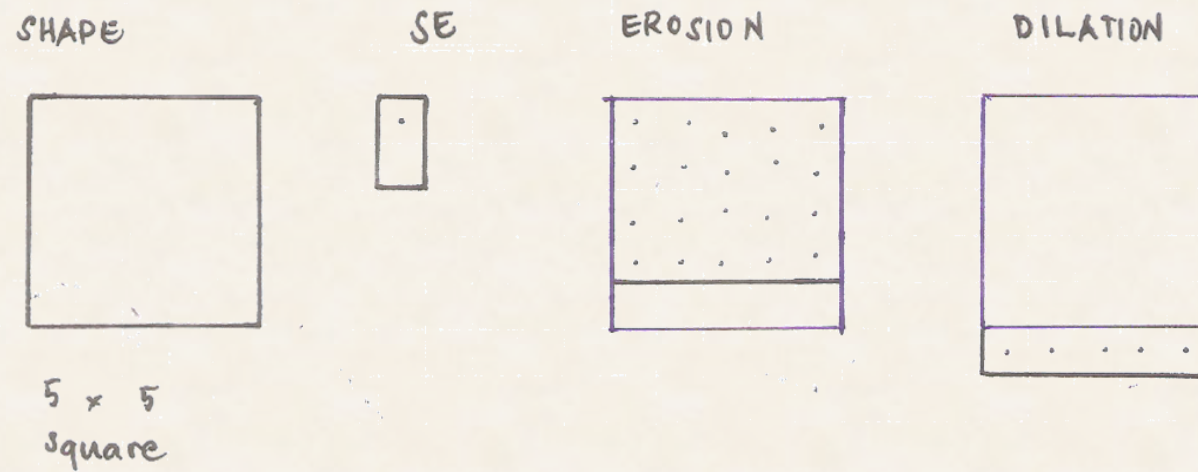


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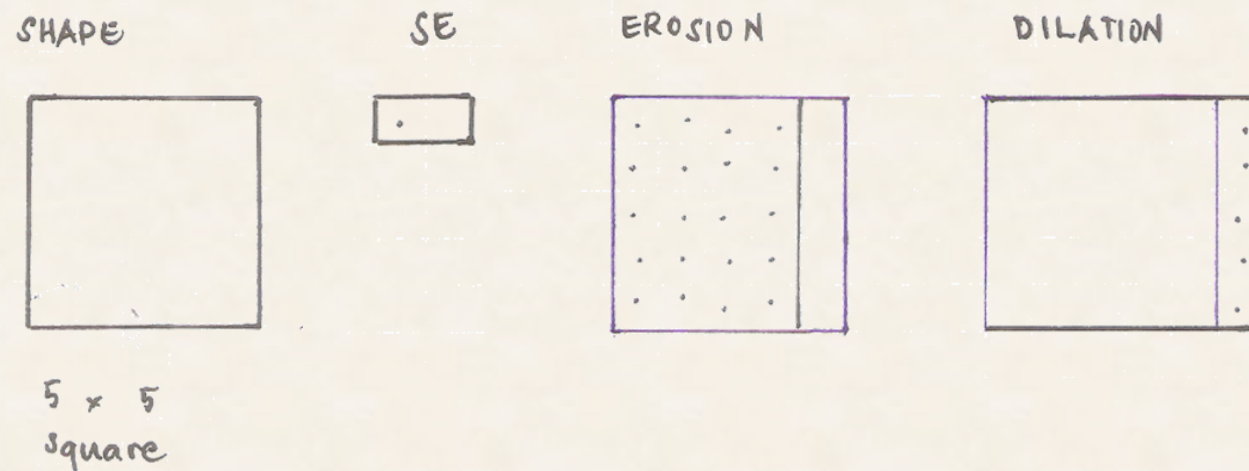


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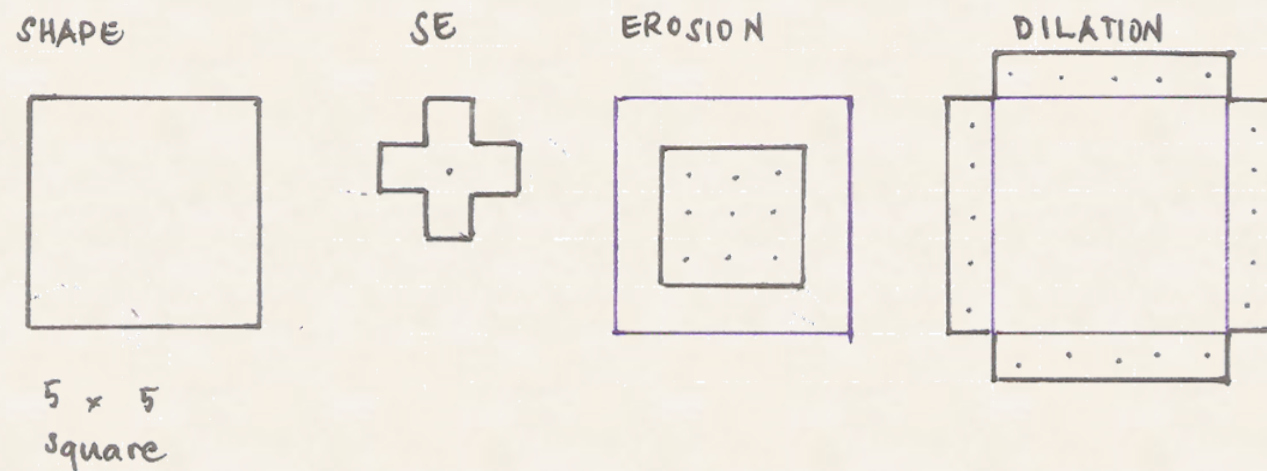


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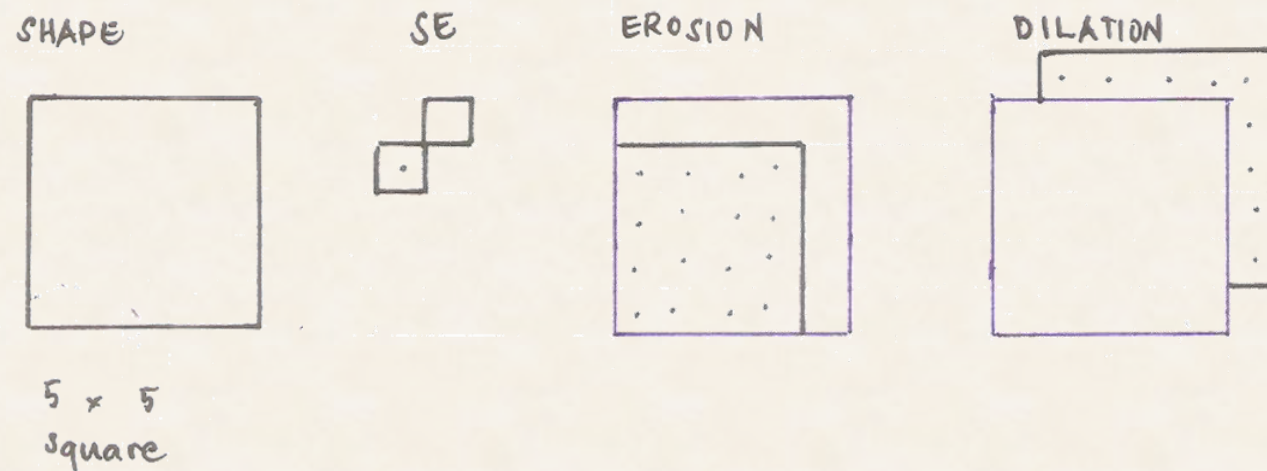


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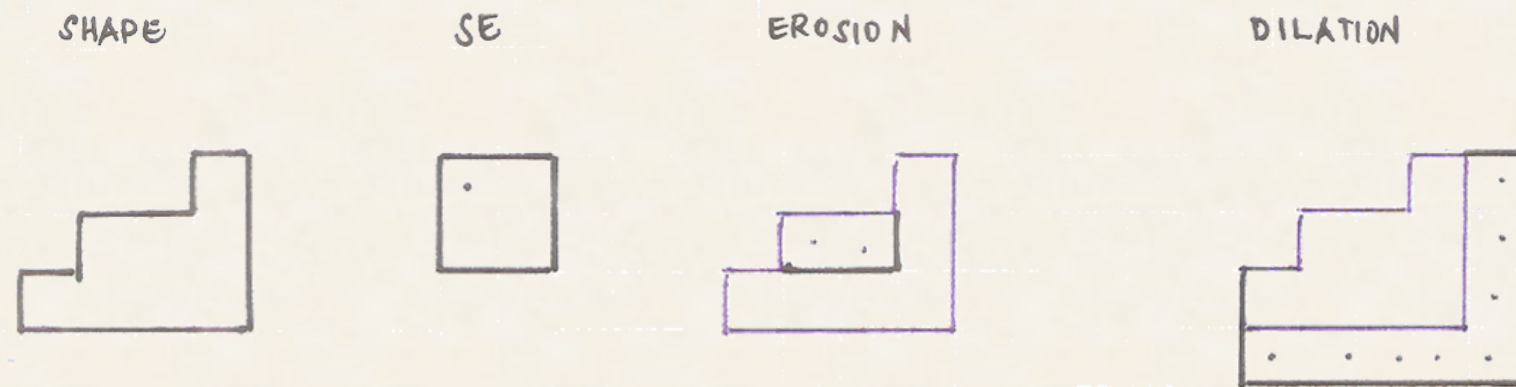


Figure 4. Predicted erosion and dilation for triangle (4-box base, 3-box height). Blue ink denotes the original shape, dots in erosion constitute eroded shape, dots in dilation constitute the additional pixels to be added to the dilated shape.

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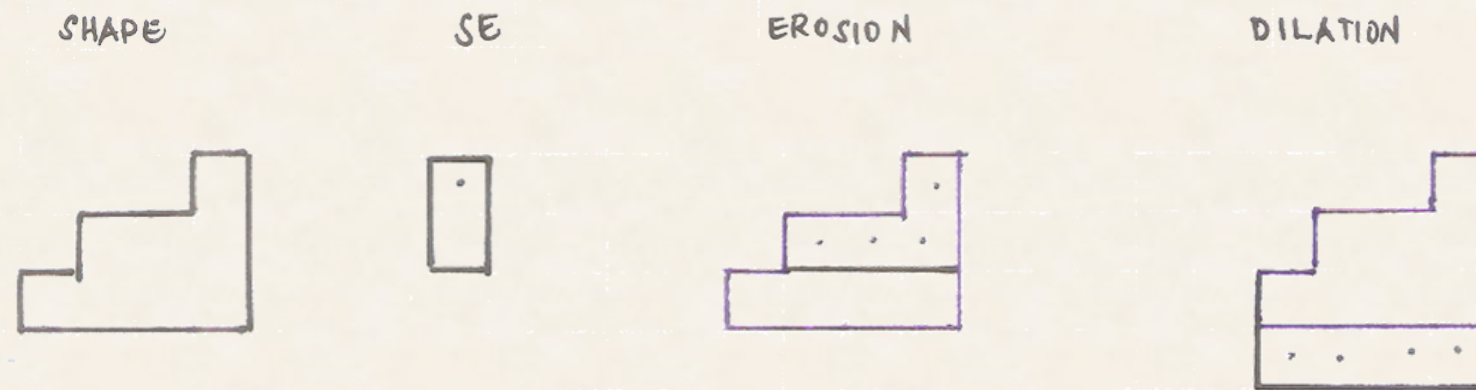


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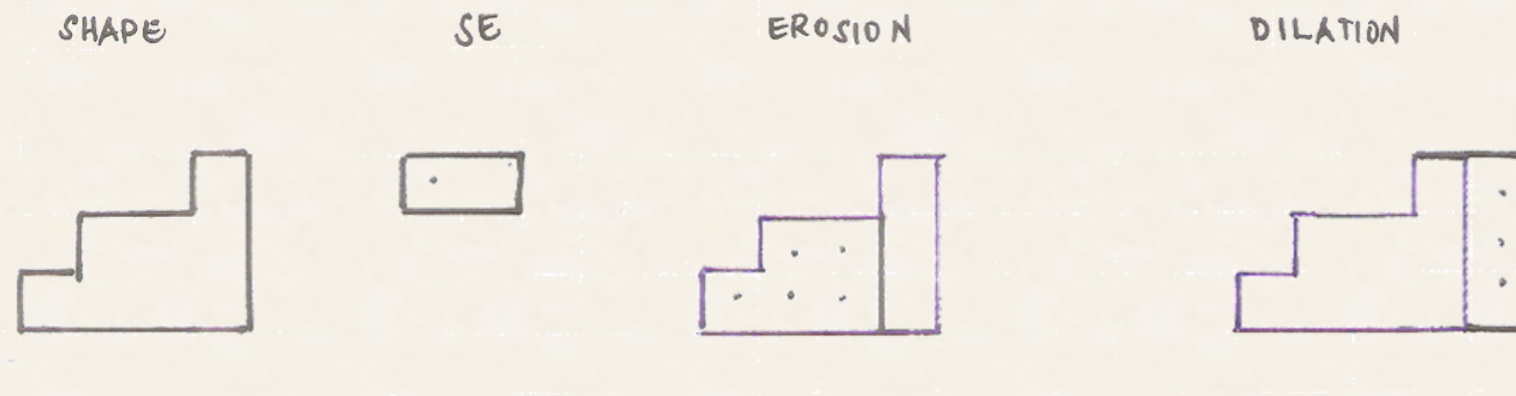


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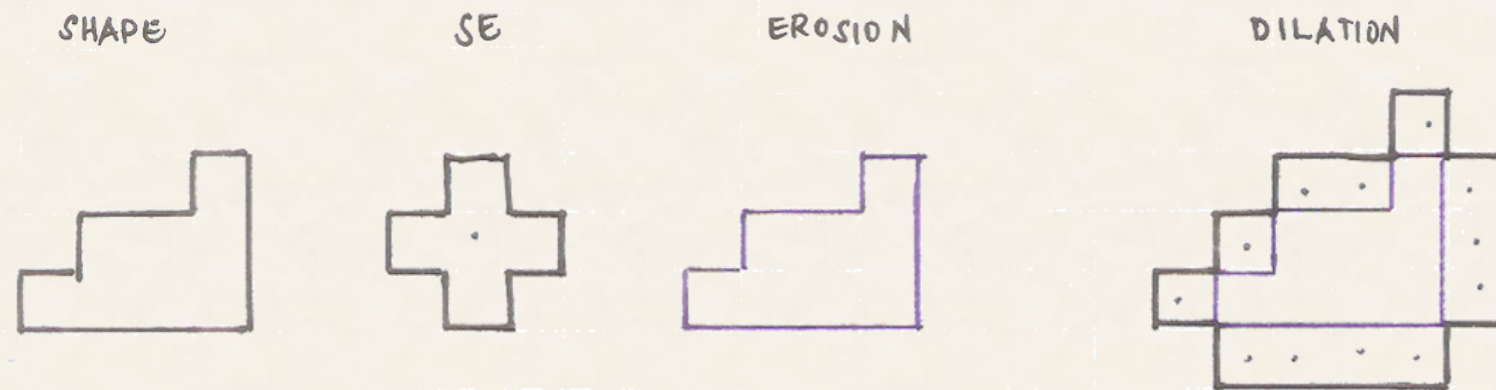


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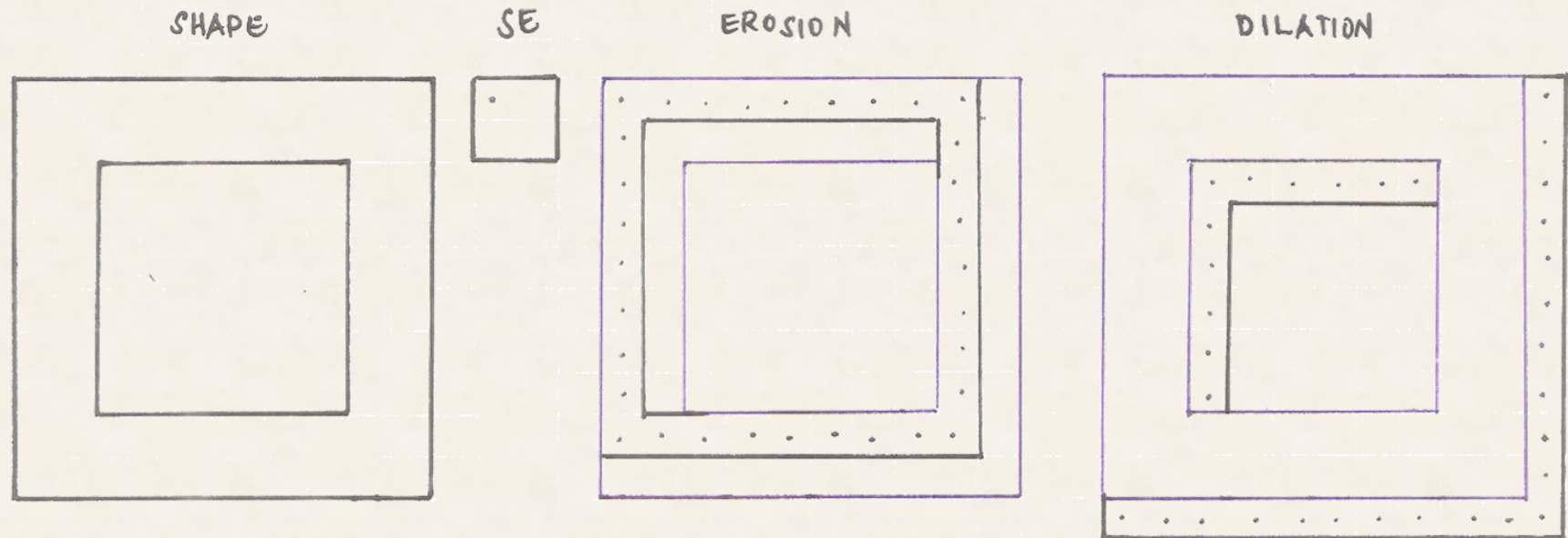


Figure 5. Predicted erosion and dilation for 10x10 hollow square. Blue ink denotes the original shape, dots in erosion constitute eroded shape, dots in dilation constitute the additional pixels to be added to the dilated shape.

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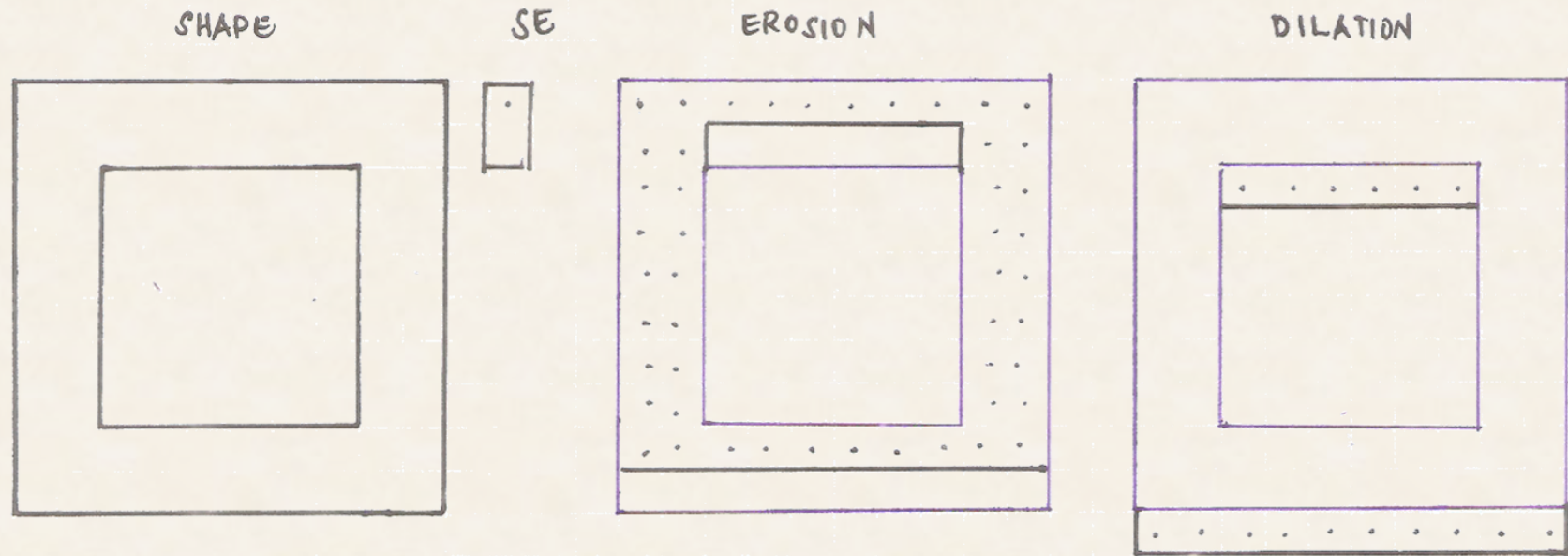


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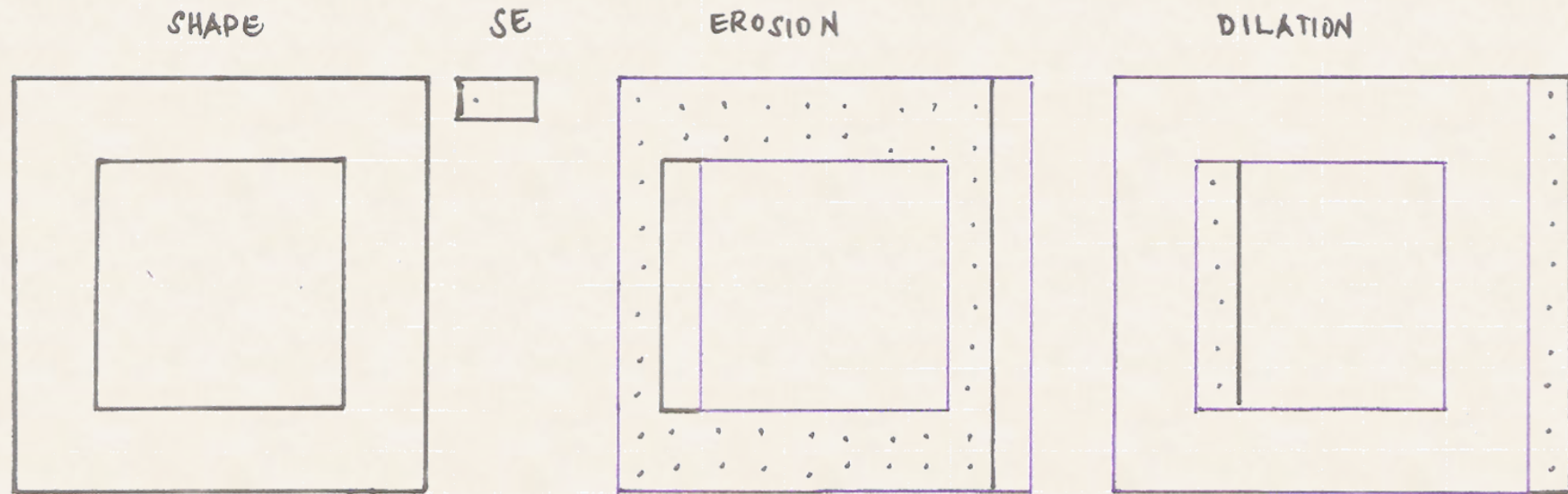


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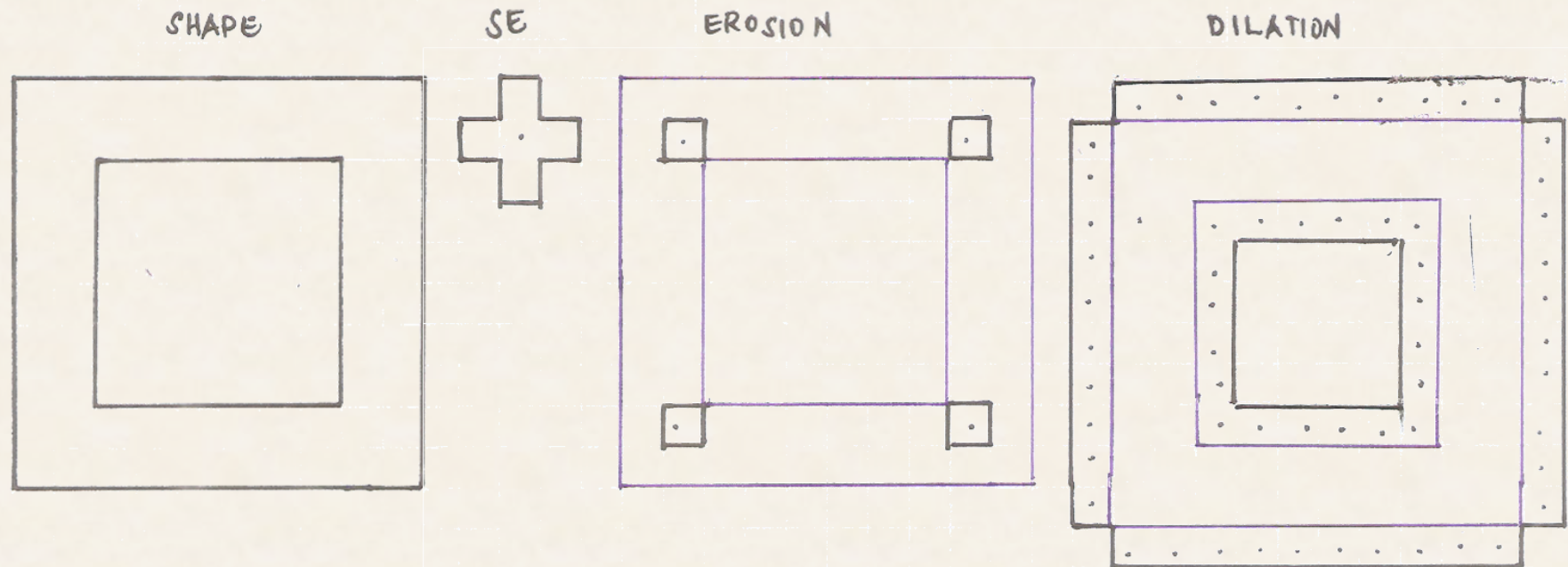


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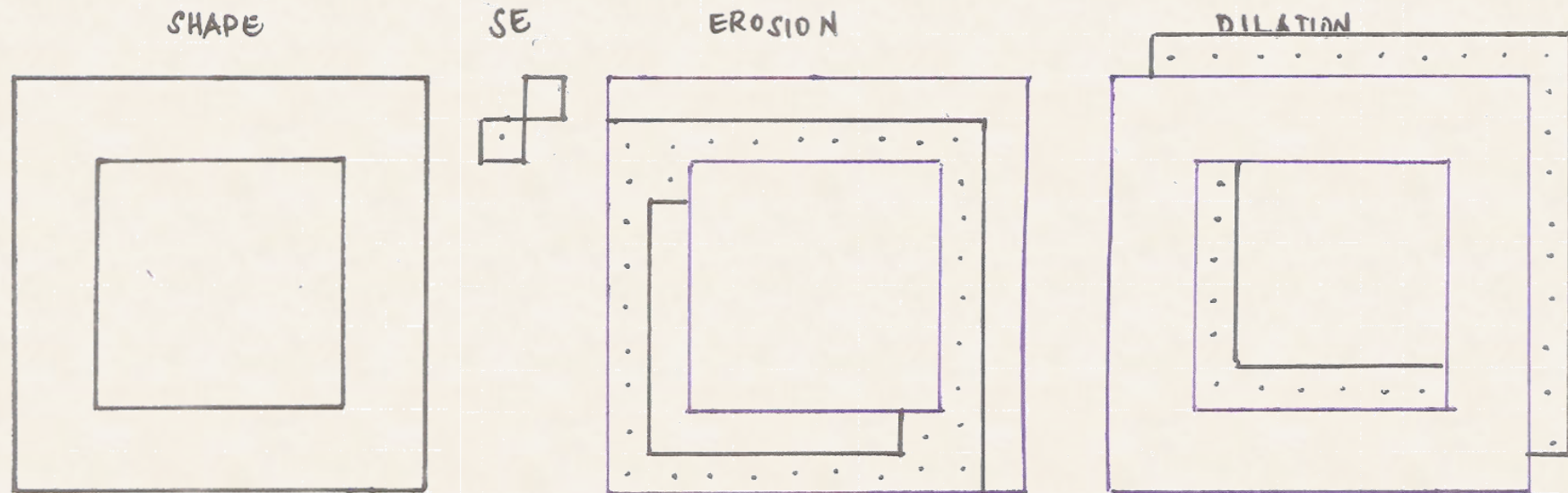


Figure 5. Predicted erosion and dilation for 10x10 hollow square. Blue ink denotes the original shape, dots in erosion constitute eroded shape, dots in dilation constitute the additional pixels to be added to the dilated shape.

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Figure 6. Predicted erosion and dilation for 5-box long plus sign. Blue ink denotes the original shape, dots in erosion constitute eroded shape, dots in dilation constitute the additional pixels to be added to the dilated shape.

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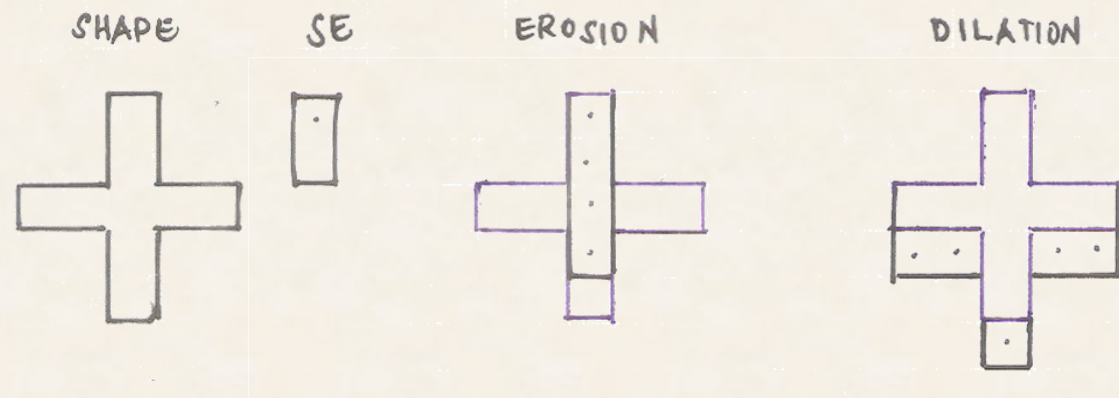


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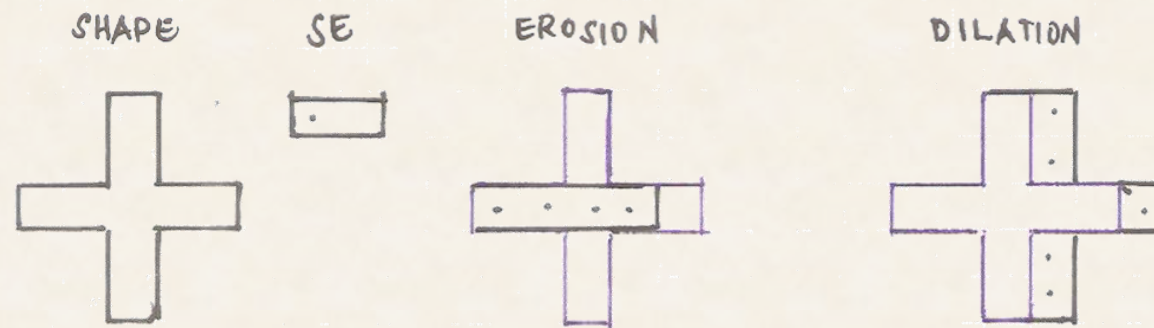


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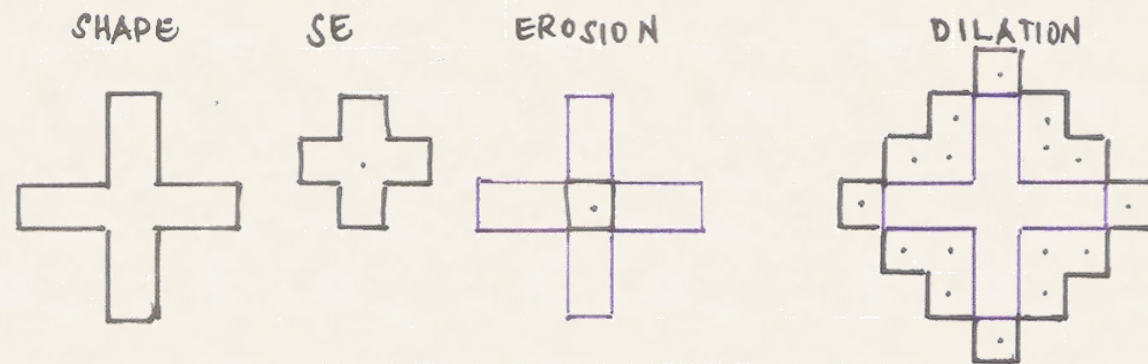


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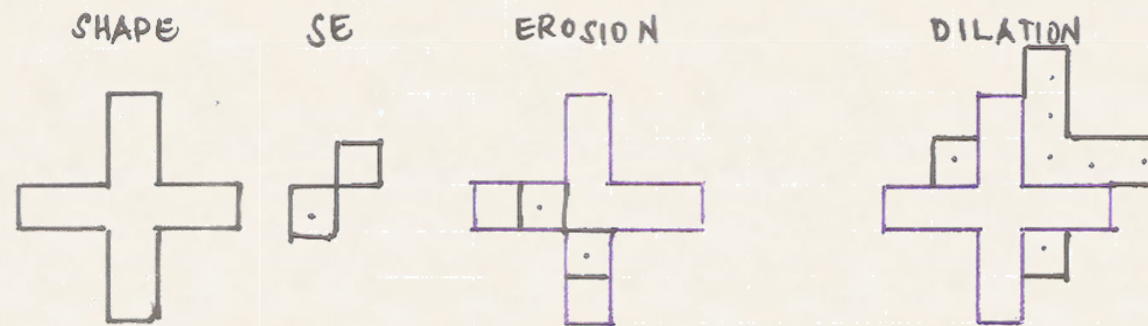


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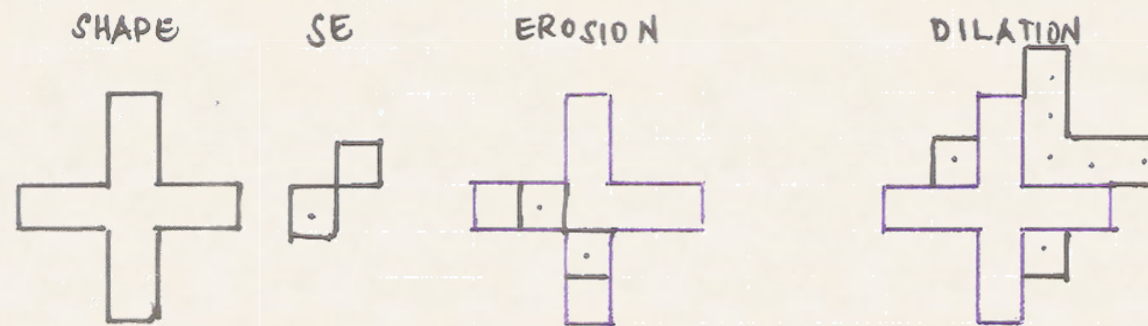


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Simulation

These drawings were then created in Matlab as binary images. To verify if I predicted the results correctly, erosion and dilation was also done in Matlab. In the following slides, I will be comparing the results.

Basic Morphological Operations

Simulation



Figure 7. Morphological operations on: (L to R) 5x5 square, triangle, 10x10 hollow square, 5-pixel long plus sign.

Evaluation

I rate myself 10/10 for this activity for producing all required outputs.