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EECS 332, Fall 2018
MP2 Report

About My Code:

My code for MP2 can be found in this folder, in the python file, `MP2.py`. The file is callable from the command line with the command `$ MP2.py PATH_TO_IMAGE`.

After running, it will write a result image named "`PATH_TO_IMAGE_result `" of the classified images to the folder named "results." When called from the command line, MP2.py will print relevant information like the number of insertions or deletion made from each morphological function (e.g. the number of deletions made for erosion or the number of insertions made for dilation.)

I wrote my code in Python 3.7, and it assumes python packages `numpy`, `imageio`, `copy`, `matplotlib`, and `sys` are installed.

Results:

I ran my code on the two given image files, "gun.bmp" and "palm.bmp". In short, my program produced the correct result for each.

To implement all the functions, I first wrote a helper function named `getCellLabel()`. This function is where the most significant portion of all of the morphological functions were implemented. The helper function takes in as inputs, the 2-d matrix of values representing an image, the current row and column desired to be classified, the structuring element, the origin of the structuring element, and the whether to perform a dilation classification or an erosion classification. The function then masks the SE on top of the given A[row][col] centered at the origin. Then, it constructs the mask from the 2-D matrix. This mask is the exact shape and size of the SE, where each element represents the value of the corresponding cell in the image. If a cell is out-of-bounds, it receives a value of -1. Now, the function has two matrices of the exact shape and size: the SE and the mask of the SE from the image matrix.

Then the function classifies the label of the desired cell based off whether to do erosion or dilation. If the function tag is "d" for dilation, the helper function will return 1 if there is a single match between the mask and the SE, otherwise it will return 0. Likewise, if the function tag is "e" for erosion, the helper function will return 1 if there is a perfect matching between the mask and the SE, otherwise it will return 0.

For each dilation and erosion, then, each function will iterate through the 2-d matrix representing the image. For each cell, it will call the helper function with the appropriate function tag to get the cell the desired label. It will then maintain a new matrix of labels, adding each classified cell to the new matrix. When the scan is done, it will then return the new matrix of correctly classified cells.

For opening, the function calls dilation on the image returned by erosion. For closing, likewise, the function calls erosion on the image returned by dilation. Finally, for boundary, the function subtracts the erosion image from the initial 2-d matrix image.

All images for a given input can be reviewed in the "results" will be sent to the "results" folder in the directory of this report. Additionally, if run from the command line, MP2.py will print out the number of total changes made for each morphological function. Below are results for the two inputs, "gun.bmp" and "palm.bmp" for two different structuring elements. In each SE, the cell highlighted in this color denotes the origin.

Results Analysis for gun.bmp and palm.bmp

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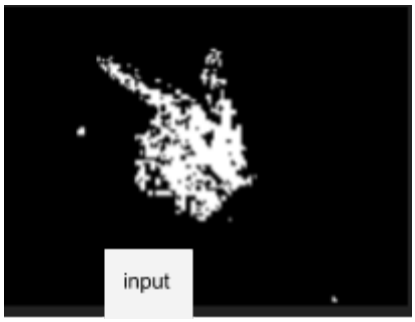
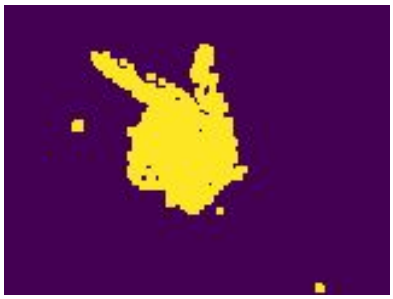
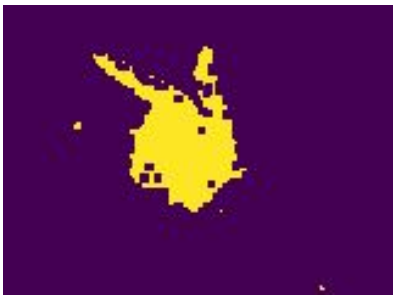
gun.bmp

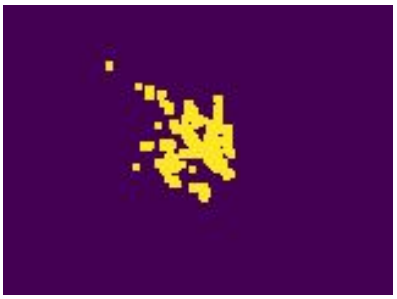


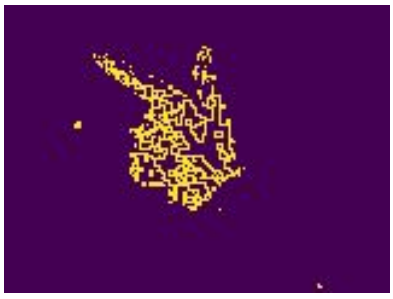
Erosion	Dilation	Closing





Opening	Boundary	Structuring Element



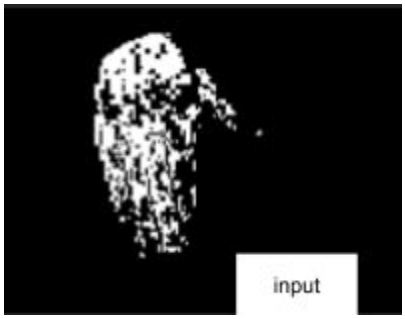


$$\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

Command Line Output:

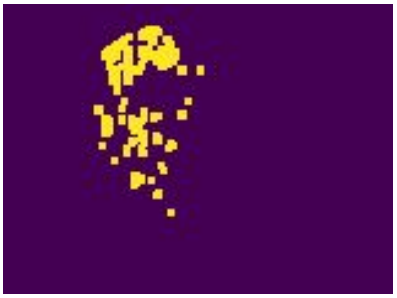
```
---------------------------------------------------------------------------------------------
Running erosion, dilation, opening, closing, and boundry on gun.bmp.
---------------------------------------------------------------------------------------------
During erosion : 947 total changes were made.
During dilation: 927 total changes were made.
During opening : 1379 total changes were made.
During closing : 1455 total changes were made.
During boundary: 393 total changes were made.
---------------------------------------------------------------------------------------------
```

palm.bmp



Erosion	Dilation	Closing

Opening	Boundary	Structuring Element

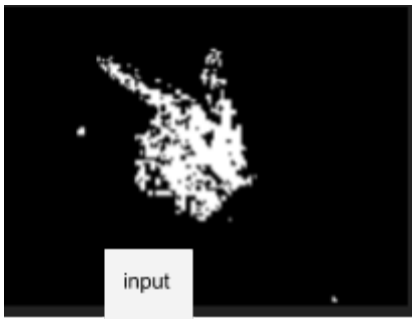


$$\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

Command Line Output:

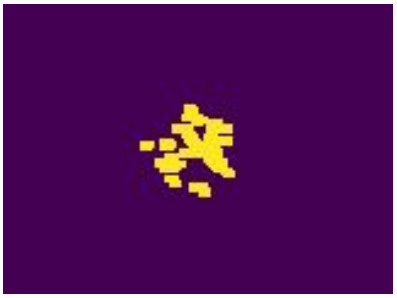
```
---------------------------------------------------------------------------------------------------
Running erosion, dilation, opening, closing, and boundary on palm.bmp.
---------------------------------------------------------------------------------------------------
During erosion : 1309 total changes were made.
During dilation: 1369 total changes were made.
During opening : 1844 total changes were made.
During closing : 2083 total changes were made.
During boundary: 322 total changes were made.
---------------------------------------------------------------------------------------------------
```

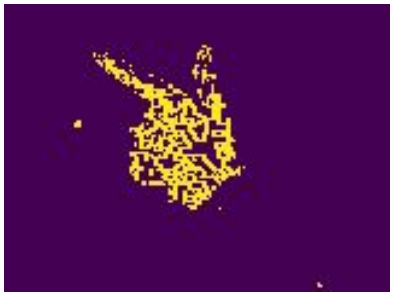
gun.bmp

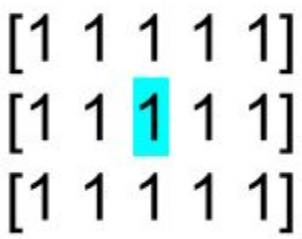


Erosion	Dilation	Closing

Opening	Boundary	Structuring Element



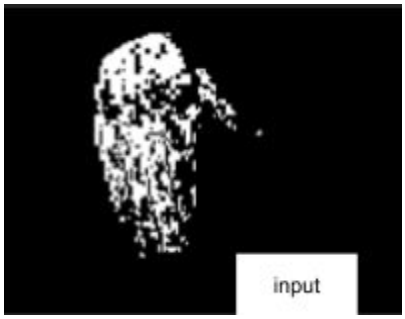




Command Line Output:

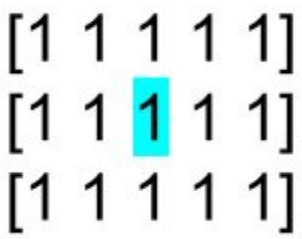
```
---------------------------------------------------------------------------------------------------
Running erosion, dilation, opening, closing, and boundary on gun.bmp.
---------------------------------------------------------------------------------------------------
During erosion : 1135 total changes were made.
During dilation: 1176 total changes were made.
During opening : 1536 total changes were made.
During closing : 1803 total changes were made.
During boundary: 205 total changes were made.
---------------------------------------------------------------------------------------------------
```

palm.bmp



Erosion	Dilation	Closing

Opening	Boundary	Structuring Element



Command Line Output:

```
---------------------------------------------------------------------------------------------------
Running erosion, dilation, opening, closing, and boundary on palm.bmp.
---------------------------------------------------------------------------------------------------
During erosion : 1512 total changes were made.
During dilation: 1732 total changes were made.
During opening : 1826 total changes were made.
During closing : 2532 total changes were made.
During boundary: 119 total changes were made.
---------------------------------------------------------------------------------------------------
```