LAB-09: Morphological Operations

Objective:

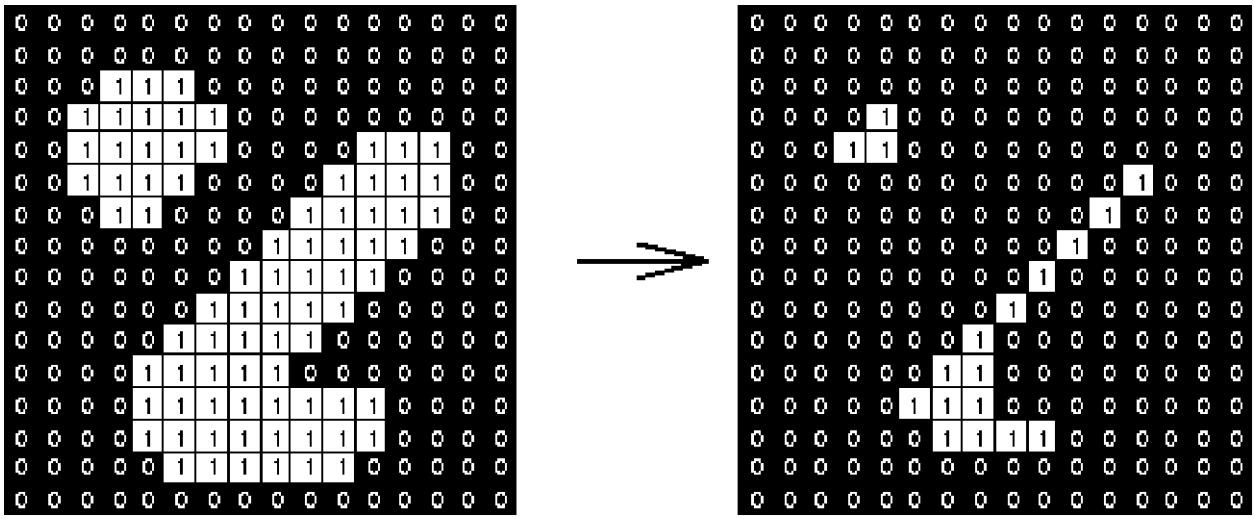
The objective of this lab is to apply morphological operations on both grayscale and binary images.

Theory:

Morphological image processing is quite like spatial filtering. The structuring element just like a spatial mask is moved across every pixel in the original image to produce an output pixel. The value of this new pixel depends on the operation performed. Two basic morphological operations are erosion and dilation.

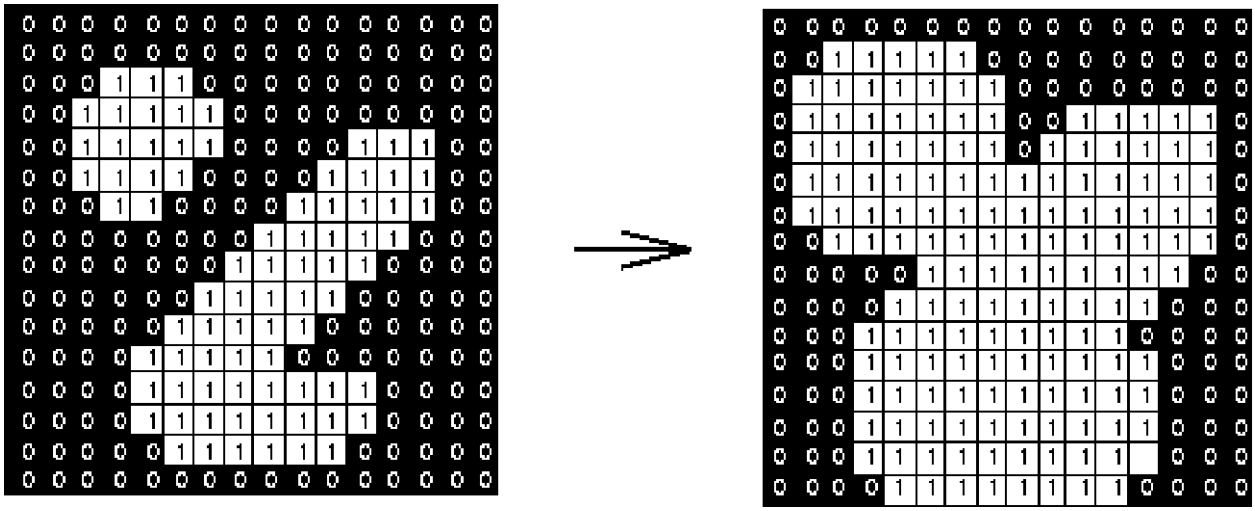
Erosion shrinks the size of foreground (1-valued) objects; smooths object boundaries and removes small objects. In erosion, for each foreground pixel (also called input pixel):

- Superimpose the structuring element on top of the input image so that the origin of the structuring element coincides with the input pixel position.
- If **for every** pixel in the structuring element, the corresponding pixel in the image underneath is a foreground pixel, then the input pixel is left as it is.
- If any of the corresponding pixels in the image are background, however, the input pixel is also set to background value



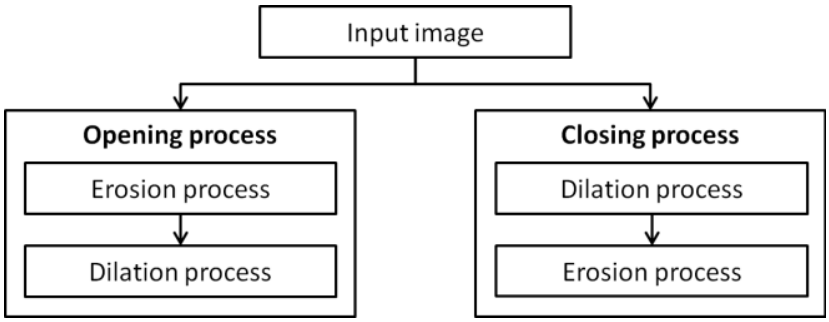
On the other hand, **dilation** expands the size of foreground (1-valued) objects; smooths object boundaries and closes holes and gaps. In dilation, for each foreground pixel (also called input pixel)

- Superimpose the structuring element on top of the input image so that the origin of the structuring element coincides with the input pixel position
- If **at least one** pixel in the structuring element coincides with a foreground pixel in the image underneath, then the input pixel is set to the foreground value
- If all the corresponding pixels in the image are background, however, the input pixel is left at the background value

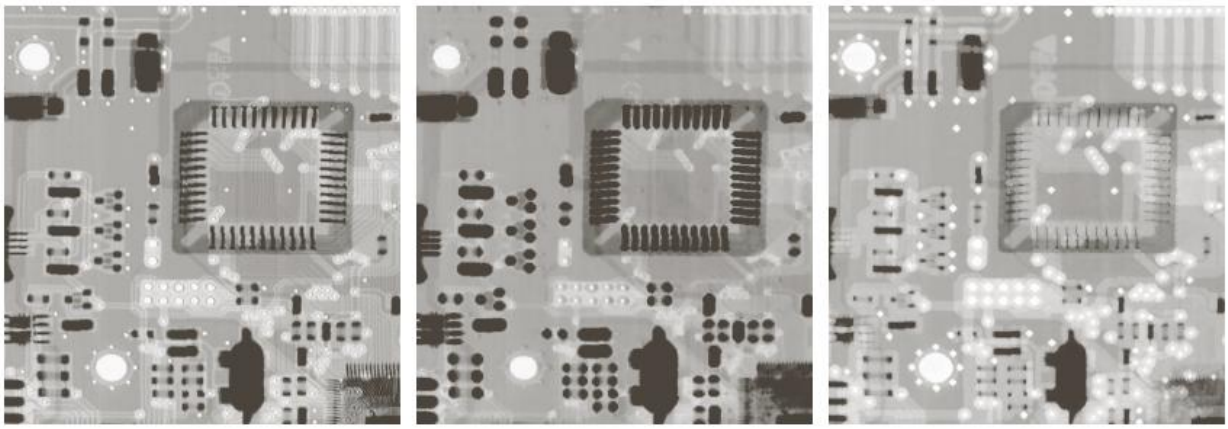


More interesting morphological operations can be performed by performing combinations of erosions and dilations. The most widely used of these compound operations are **opening** and **closing**.

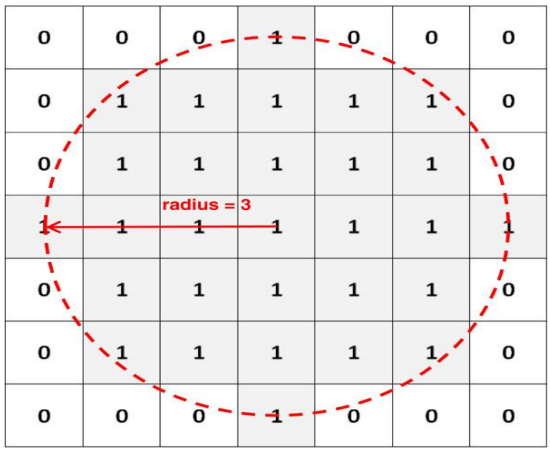
In **opening, erosion** is followed by **dilation.** On the other hand, in **closing, dilation** is followed by **erosion.**

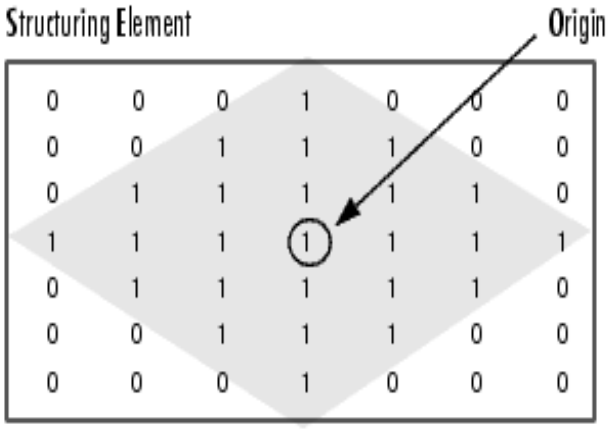


All these operations can be applied on grayscale images as well. Following image shows the application of morphological operation on a grayscale image.



Two different Structuring Elements are shown below. They are just two arrays of a fixed size that have 1s and 0s in a particular order. You can create the SEs yourself, however, it becomes difficult as their size increases.





The top-hat transform is defined as the difference between the original image and its opening. Similarly, **the bottom-hat transform** is defined as the difference between the closing of the original image and the original image. Top hat transformation is used when we extract bright objects from a darker background. Bottom hat transformation is used when we extract darker objects from bright backgrounds.

Some Useful Commands:

You can either construct the constructing elements yourself or you can use the following commands to create SEs:

- cv2.getStructuringElement(cv2.MORPH_RECT,(5,5))
- cv2.getStructuringElement(cv2.MORPH_ELLIPSE,(5,5))
- cv2.getStructuringElement(cv2.MORPH_CROSS,(5,5))

Lab Tasks:

Lab Task 1:

Erode the image "fp.tif" using a suitable structural element so that all the noise is removed from the image. Apply erosion on Fig01.tif with structuring elements of different sizes.

Lab Task 2:

Dilate the image "broken_text.tif" such that the breakages in the characters/alphabets no longer exist. Apply dilation on Fig01.tif with structuring elements of different sizes.

Lab Task 3:

Morphological operations can also be performed on grayscale images. For dilation, the maximum value is used that falls under the structuring element. For erosion, the minimum value is used that falls under the structuring element. Perform dilation and erosion on Fig01.tif.

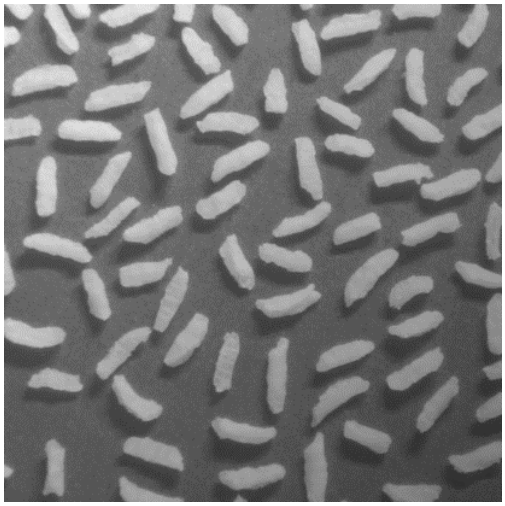
Lab Task 4:

Morphological operations can also be used to segment objects from an image. Using opening and a suitable structuring element (disc, diamond and rectangle), segment out each object from the "Objects.png" image. You would get 3 outputs each containing just one object.

Lab Task 5:

Apply top-hat transformation on the following image (rice.png) using given expression:

$$g_{top} = f - (f \circ b)$$



Conclusion:

This lab has given an introduction to morphological operations and has shown how an image can be preprocessed using morphological operations.