Morphology and Morphological Image Processing

- For the extraction of feature we will focus on the following terminologies
- **Foreground**: white color → (region of interest), moving object
- **Background:** black color, not in interest for the development of specific application, non-moving objects are background

Morphology

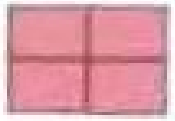
- **Morph**: forms or shapes
- **Ology**: to study something
- **Morphology**: is a branch of biology that deals with the form and structure of animals and plants
- **Image Morphology**: is a branch that deals with the form and structure of images
- Morphological Image processing is used to extract the image components for the representation and description of regions shape such as **boundaries, skeletons** and the **convex hull**

Morphology

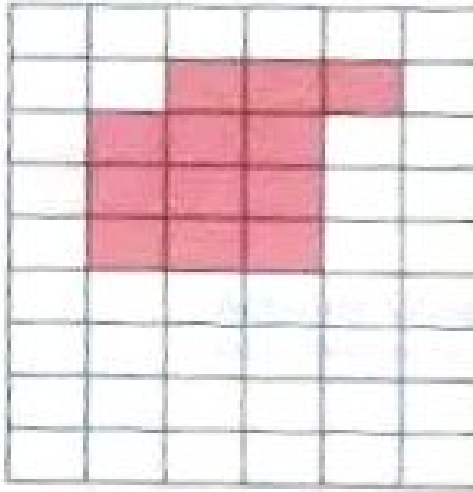
- **Morphological image processing** (or morphology) describes a range of image processing techniques that deal with the shape (or morphology) of features in an image
- Morphological operations are typically applied to remove imperfections introduced during segmentation, and so typically operate on bi-level(binary) images

Dilation and Erosion Structuring Elements

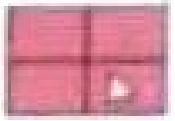
- Morphology deals with structuring elements
- Structuring Elements: Structuring elements are same as spatial filters (i.e. may have any shape, and size)



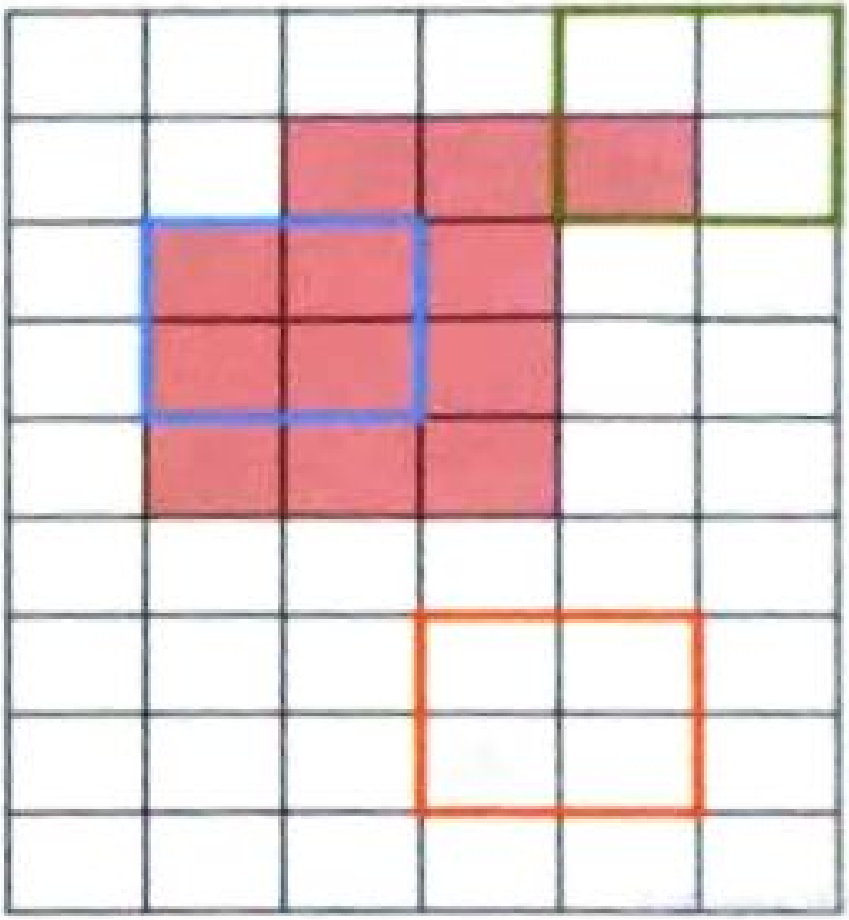
- **Fit**: All pixels in the structuring elements cover on pixels in the image
- **Hit**: Any pixel in the structuring element covers pixels in the image
- **Miss**: All are missed
- All morphological image processing operations are based on these simple ideas



Dilation and Erosion Structuring Elements



- FIT: All pixels in the structuring elements cover on pixels in the image
- HIT: Any pixel in the structuring element covers pixels in the image
- MISS: All are missed
- All morphological image processing operations are based on these simple ideas



Dilation and Erosion Structuring Elements

- Structuring elements can be any size and make any shape. Can have varied values of coefficients
- However, for simplicity we will use rectangular structuring elements with their origin at the middle pixel

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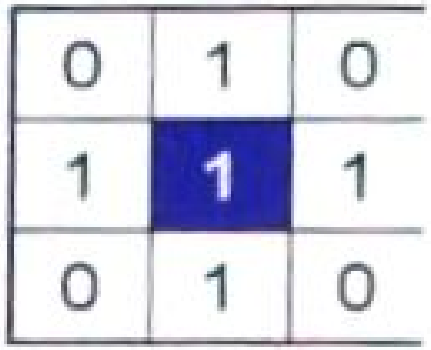
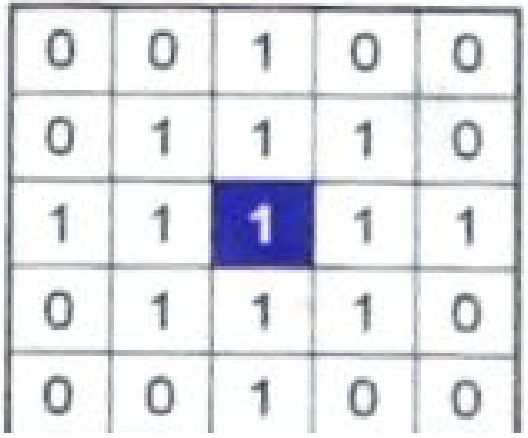




Example of Structuring Elements Application

1	1	1
1	1	1
1	1	1

0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	1	0	0	0	0	0	0
0	0	1	1	1	1	1	0	0	0	0
0	1	1	1	1	1	1	1	0	0	0
0	1	1	1	1	1	1	1	0	0	0
0	0	1	1	1	1	1	1	0	0	0
0	0	0	1	1	1	1	1	1	0	0
0	0	0	0	1	1	1	1	1	1	1
0	0	0	0	0	1	1	1	1	1	1
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0

Erosion and Dilation

- Fundamentally morphological image processing is same as spatial filtering
- The structuring element is moved across every pixel in the original image to give a pixel in a new processed image.
- The value of this new pixel depends on the operation performed.
- There are two basic morphological operations: **erosion** and **dilation** which are done using structuring elements process i.e. FIT, HIT, MISS
- Erode: If structuring element FITs then it is ERODE
- Dilate: if Structuring Element HIT then it is DILATE

Erosion

- Erosion of image ***t*** by structuring element ***s*** is given by $t \ominus s$
- The structuring element ***s*** is positioned with its origin at (x, y) and the new pixel value is determined using the rule:

$$g(x,y) = \begin{cases} 1 \text{ if } s \text{ fits } f \\ 0 \text{ otherwise} \end{cases}$$

Erosion-Example

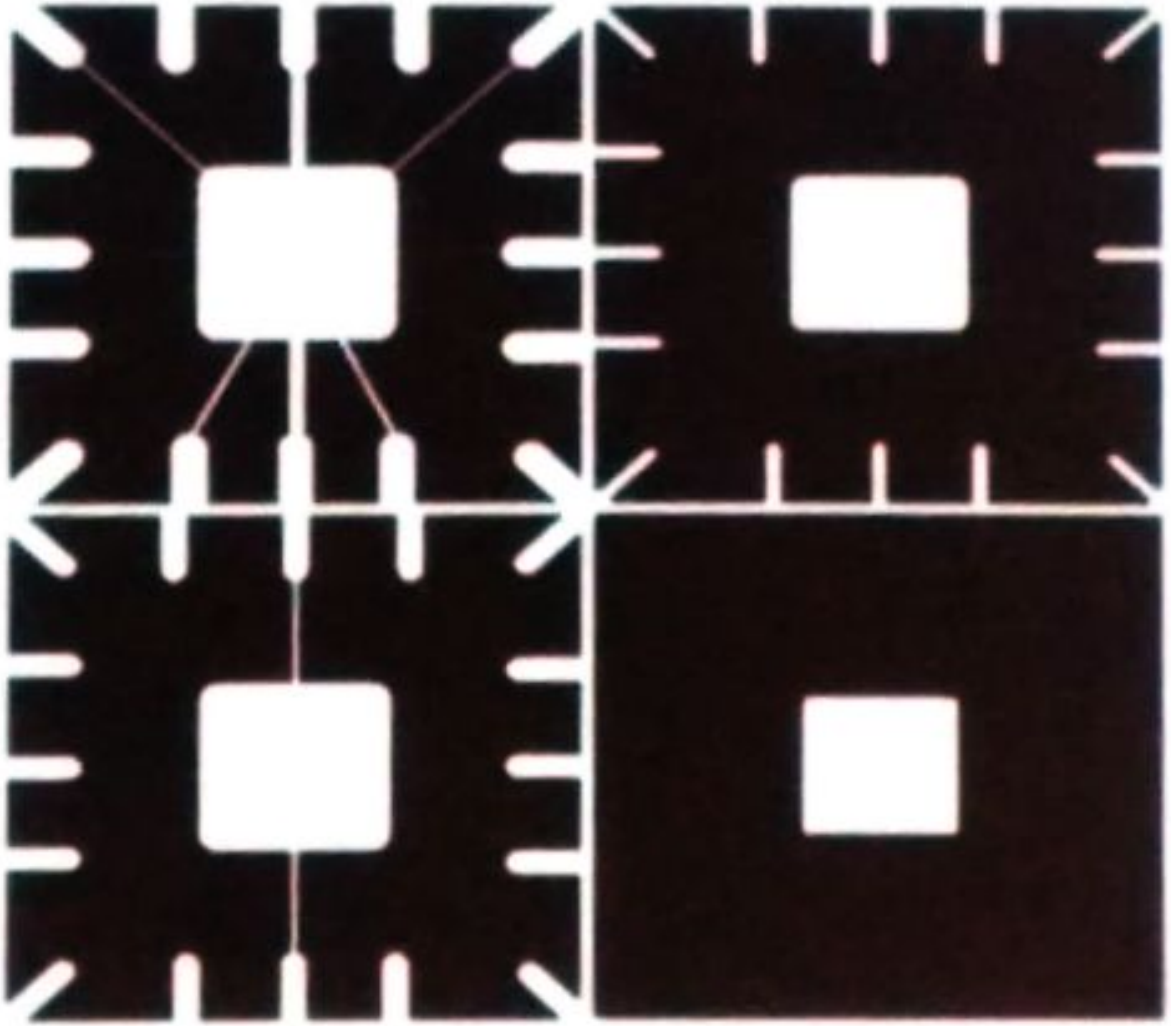
Original image

Erosion by 3*3 square structuring element

Erosion by 5*5 square structuring element

Input image → negative → morphological operations → Negative

Erosion-Example



Original image

After erosion with a disc of radius 10

After erosion with a disc of radius 5

After erosion with a disc of radius 20

Erosion

Erosion can Split apart joined parts

Erosion can strip away extrusions

Erosion Shrinks objects: Definitely, when it removes extrusions, the object becomes shrinks

Dilation

- Dilation of image ***t*** by structuring element ***s*** is given by $t \oplus s$
- The structuring element ***s*** is positioned with its origin at (x, y) and the new pixel value is determined using the rule:

$$g(x,y) = \begin{cases} 1 \text{ if } s \text{ hits } f \\ 0 \text{ otherwise} \end{cases}$$

Dilation-Example

Original image

Dilation by 3*3 square structuring element

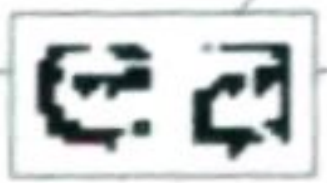
Dilation by 5*5 square structuring element

Input image → negative → morphological operations → Negative

Dilation-Example

Original image

Historically, certain computer programs were written using only two digits rather than four to define the applicable year. Accordingly, the company's software may recognize a date using "00" as 1900 rather than the year 2000.



After dilation

Historically, certain computer programs were written using only two digits rather than four to define the applicable year. Accordingly, the company's software may recognize a date using "00" as 1900 rather than the year 2000.

Broken characters are joined

0	1	0
1	1	1
0	1	0

Structuring element

Dilation-Example

Dilation can repair breaks

Dilation can repair intrusions

Dilation Enlarge objects

Compound Operations

- More interesting morphological operations can be performed by performing combinations of erosions and dilations.
- The most widely used of these compound operations are:
  1. Opening
  2. Closing

Opening

- Opening of image ***t*** by structuring element ***s*** denoted by
- **t ∘ s** is simply an erosion followed by a dilation

$$t \circ s = (t \ominus s) \oplus s$$

Original shape | After erosion | After dilation (opening)

- Note a disc shaped structuring element is used

Opening- Example

Original Image

Image After Opening