

Morphological Operations

Intro

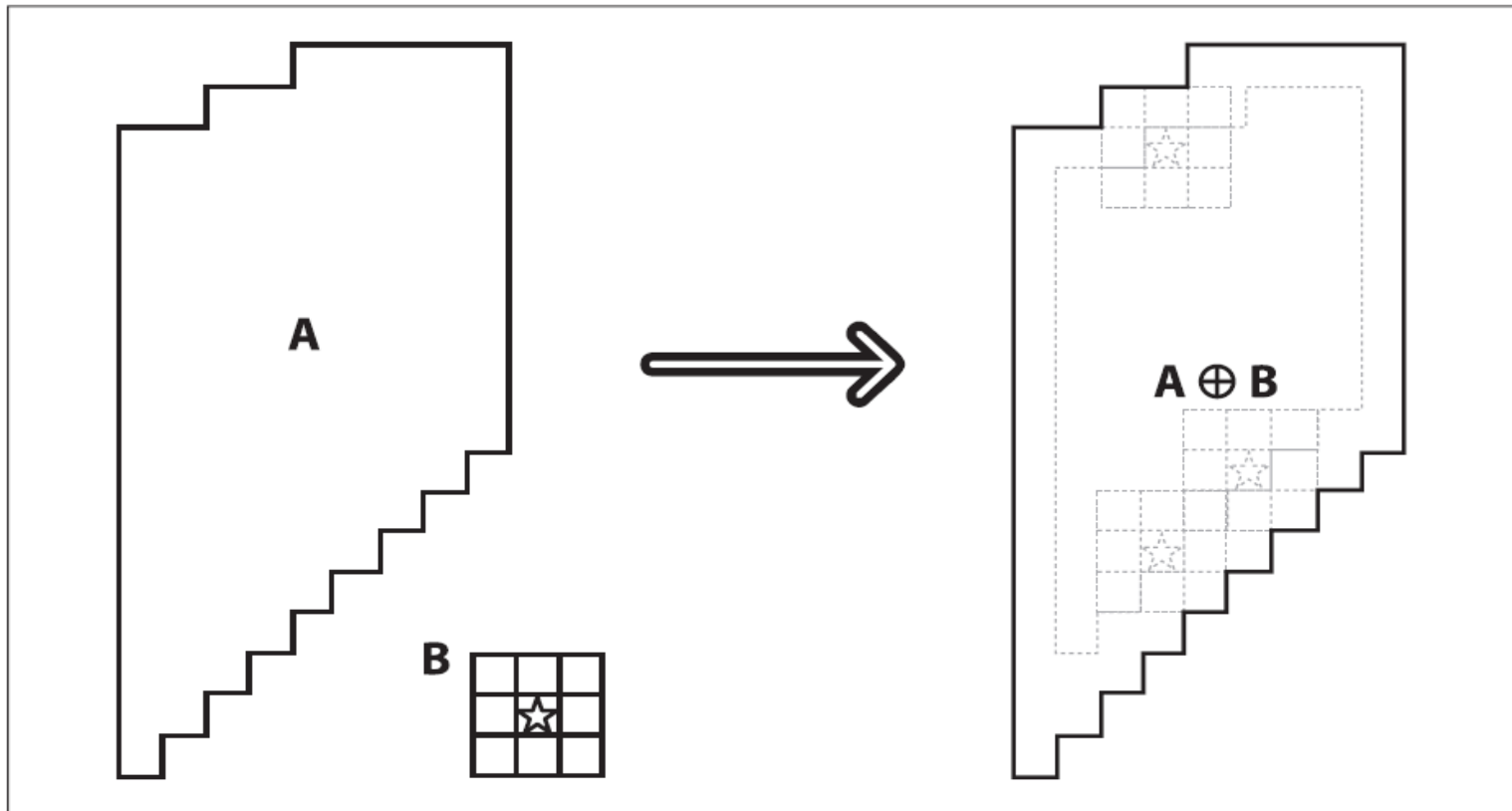
Mathematical morphology (MM) is a theory and technique for the analysis and processing of geometrical structures

The basic morphological transformations are called *dilation* and *Erosion*

Morphology can also be used to find intensity bumps or holes in an image and to find image gradients

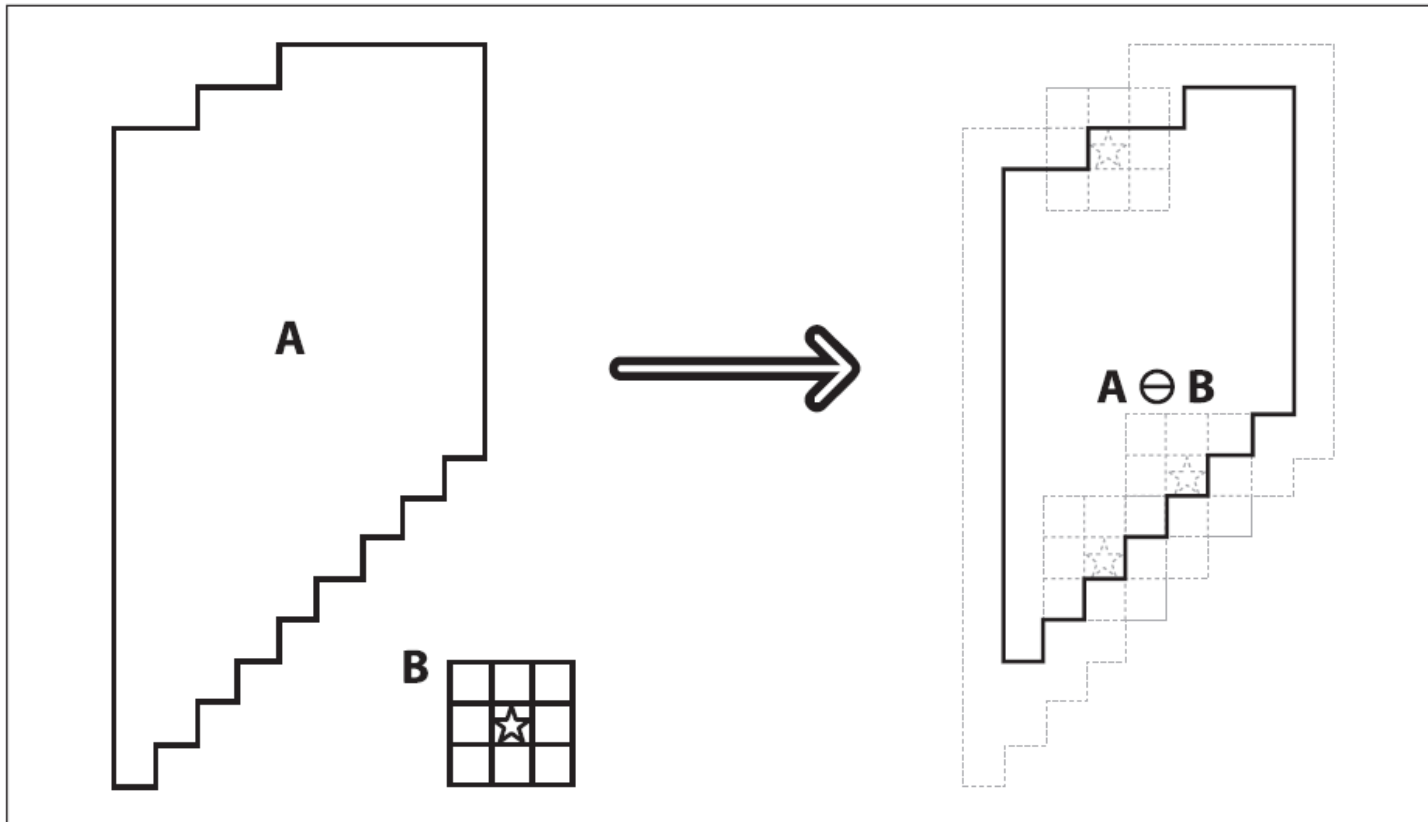
Dilation

Dilation is a convolution of some image (or region of an image), which we will call A , with some *kernel*, which we will call B . Most often, the kernel is a small solid square or disk. The kernel can be thought of as a template or mask, and its effect for dilation is that of a *local maximum* operator.



Erosion

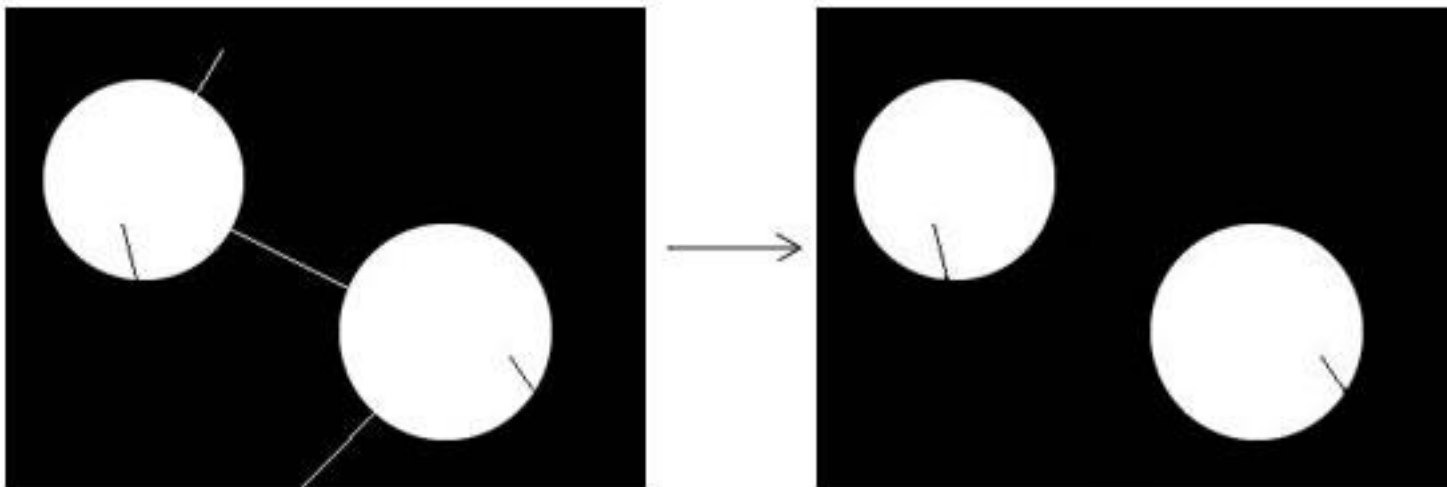
Erosion is the converse operation. The action of the erosion operator is equivalent to computing a *local minimum* over the area of the kernel.



Opening

In the case of opening, we erode first and then dilate

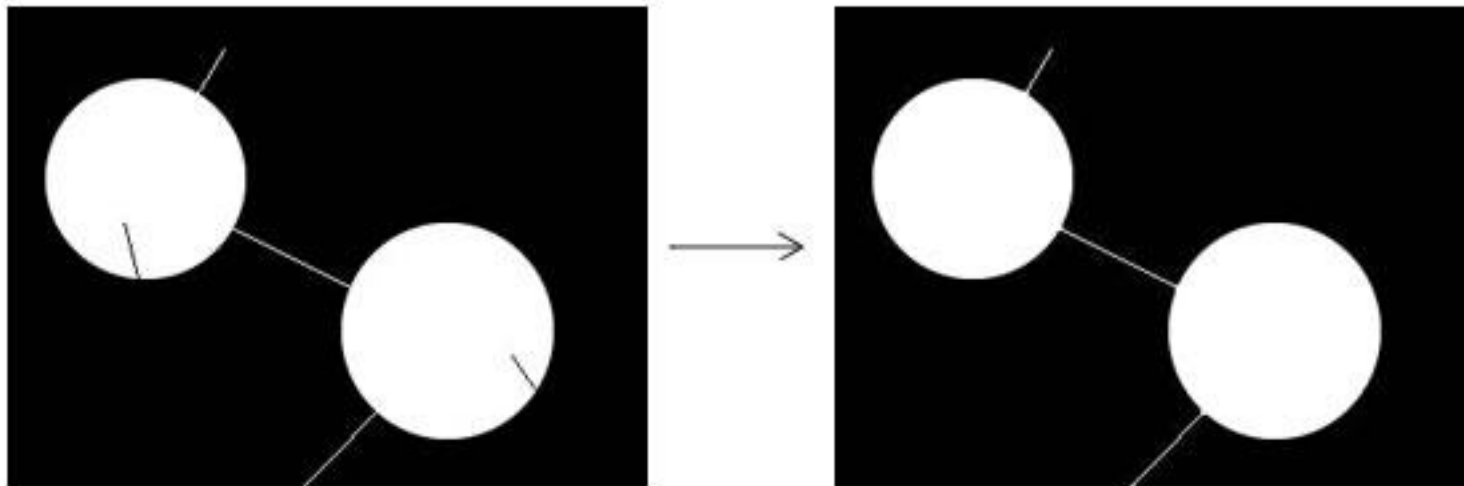
Opening generally smoothens the contour of an object, breaks narrow isthmuses, and eliminates thin protrusions



Morphological Opening

Closing

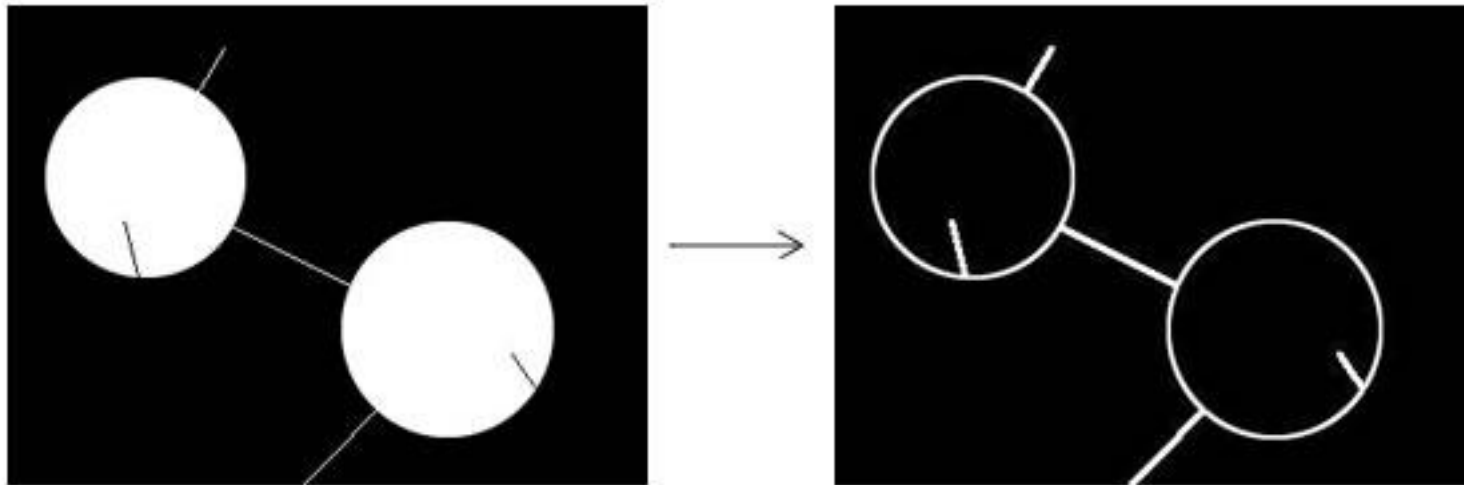
Closing an image is done by first dilating the image and then eroding it. The order is the reverse of opening. Closing fills up any narrow black regions in the image.



Morphological Closing

Morphological gradient

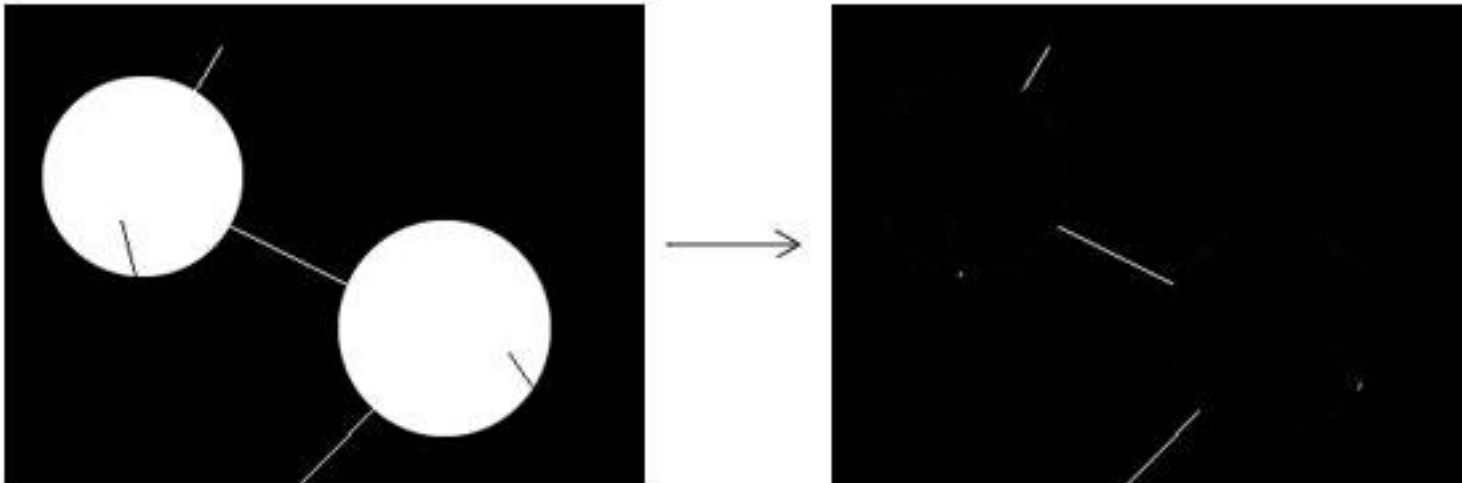
The morphological gradient is the difference between the dilation and the erosion of the image. Thus, you have three basic operations being used.



Morphological Gradient

TopHat

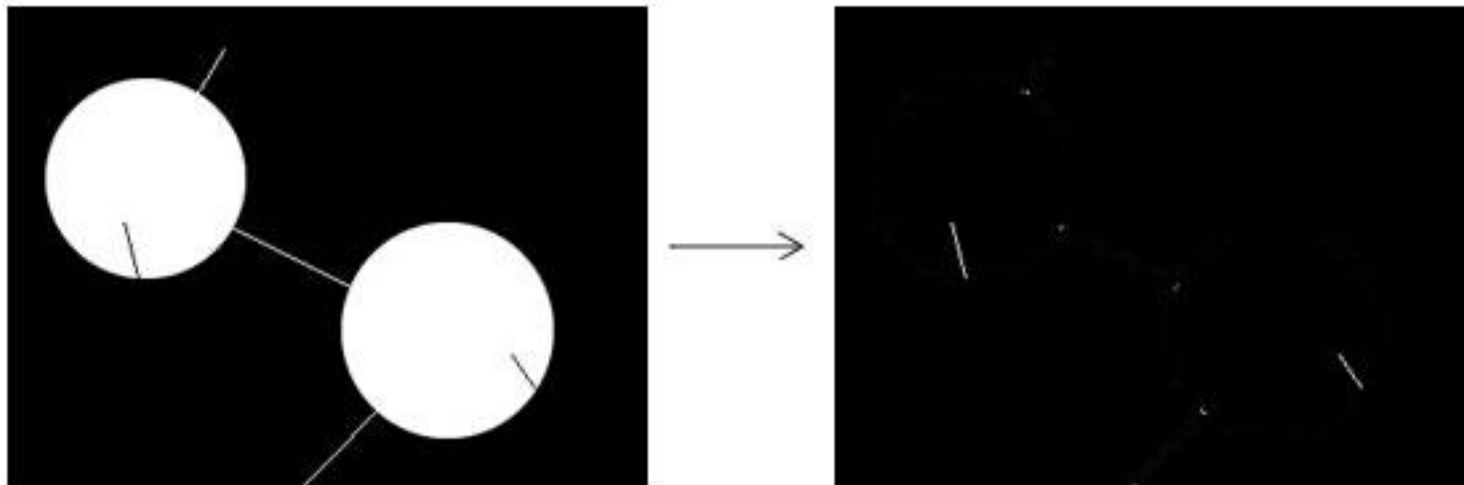
The top hat is the difference of the source image and the opening of the source image. It highlights the narrow pathways between different regions.



Morphological Top hat

BlackHat

The black hat is the difference between the closing of an image and the image itself. This highlights the narrow black regions in the image.



Morphological Black hat

Structuring Element

Its size and shape vary the results.

Most commonly used in 3x3 rectangular as shown in previous examples

Determining the size and shape of a structuring element is largely an empirical process.

For straight lines or sharp angles, a circular structuring element is an appropriate choice.

When extracting shapes from geographic aerial images of a city, a square or rectangular element will allow you to extract angular features from the image.

Different Shapes

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

Circular SE

1	1	1
1	1	1
1	1	1

Square SE

1	0	0
1	0	0
1	0	0

Vertical SE

Applications

- Flood-Fill
- Noise Removal
- Connected Component Extraction
- Skeletonisation
- Segmentation