BE Morphology

Mathematical Morphology

ISAE - SUPAERO
Image Processing and Data Analysis

🏆
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Intro

📝 WHAT IS MORPHOLOGY ?

Mathematical Morphology (MM) is a theory and technique for the analysis and processing of geometrical structures, based on set theory, lattice theory, topology, and random functions. MM is most commonly applied to digital images, but it can be employed as well on graphs, surface meshes, solids, and many other spatial structures.

Topological and geometrical continuous-space concepts such as size, shape, convexity, connectivity, and geodesic distance, can be characterized by MM on both continuous and discrete spaces. MM is also the foundation of morphological image processing, which consists of a set of operators that transform images according to the above characterizations.

MM was originally developed for binary images, and was later extended to grayscale functions and images. The subsequent generalization to complete lattices is widely accepted today as MM's theoretical foundation.

Mathematical Morphology was born in 1964 from the collaborative work of Georges Matheron and Jean Serra, at the Ecole des Mines de Paris, France. Matheron supervised the PhD thesis of Serra, devoted to the quantification of mineral characteristics from thin cross sections, and this work resulted in a novel practical approach, as well as theoretical advancements in integral geometry and topology.

Erosion and Dilation

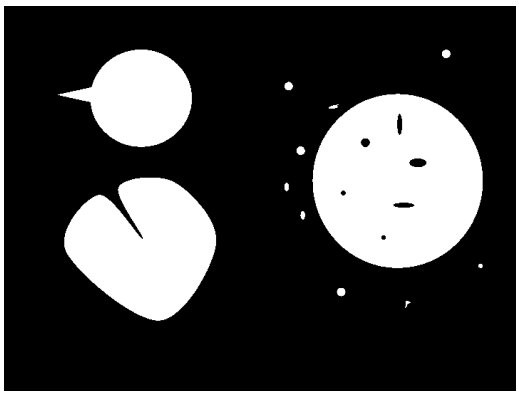
There are two basic operators in MM: **erosion** and **dilation**. Both are defined through a structuring element, which is similar to a neighborhood relationship.

❓ QUESTION

Define erosion and dilatation from an ensemblist point of view and a functional point of view.
Give some properties related to these operators.

❓ QUESTION

Operate on a binary image and a greyscale image with the commands `imerode` and `imdilate`.
What are the effects on binary and grayscale images? Justify.
Try with different structuring elements (different shapes, different sizes).



❓ QUESTION

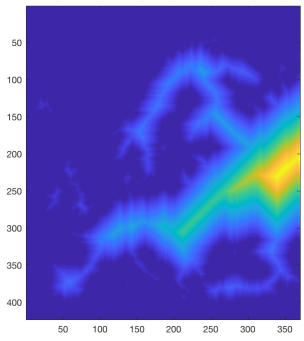
Define the following operators based on **erosion** and **dilation**:

- internal edges
- external edges
- morphological gradient

Apply them on a binary image.

? QUESTION

Write an algorithm that computes, on the map of Europe, the distance of each pixel w.r.t. the sea.



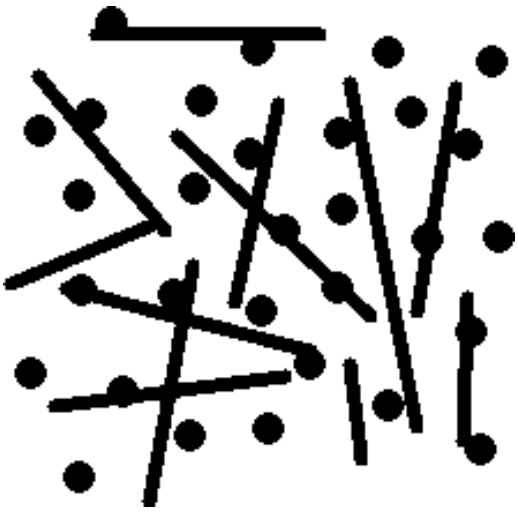
Morphological Filters

Filters

? QUESTION

Give the defintion of the two morphological filters called **opening** and **closing**.
What are their effects on a binary image ?

Filter out the lines from next image to count the number of circles.



Denoising

? QUESTION

Apply a salt-and-pepper noise to the Nebuleuse image.
Denoise the image with the appropriate morphological filter.

Top-Hat and Black-Hat Filters

? QUESTION

Give the definition of Top-Hat and Black-Hat filters.
Operate Top-Hat and Black-Hat on a greyscale image. What do you observe?

Skeletonization and Segmentation

Skeletonization is a process that reduce a 2D shapes into 1D shapes. It is defined by the center of maximal circles (a maximal circle cannot be included into another circle) into the 2D shape.
Different algorithms exist, such as ”Hilditch’s Algorithm for Skeletonization”.

Skeletonization Process

? QUESTION

Find the skeleton of the diplodocus.

Tip : Try the function `bwmorph`

```
skeleton = bwmorph(img,'skel',Inf);
```

Segmentation

? QUESTION

Based on skeletonization, operate a segmentation of the blood cells image below.