

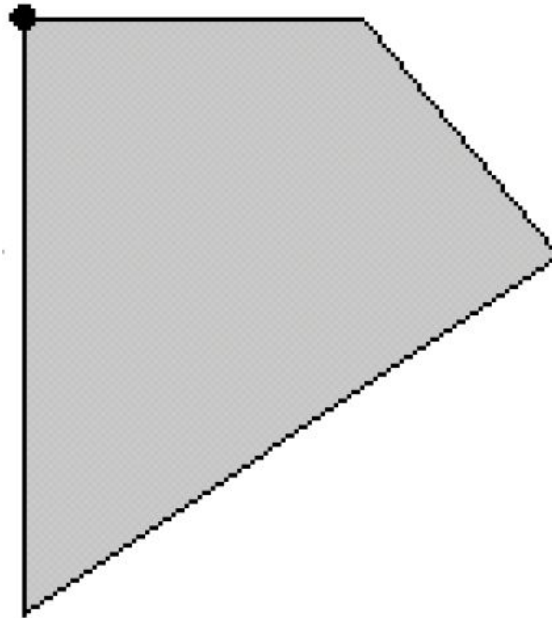
# Chapter 9

# Morphological Image Processing

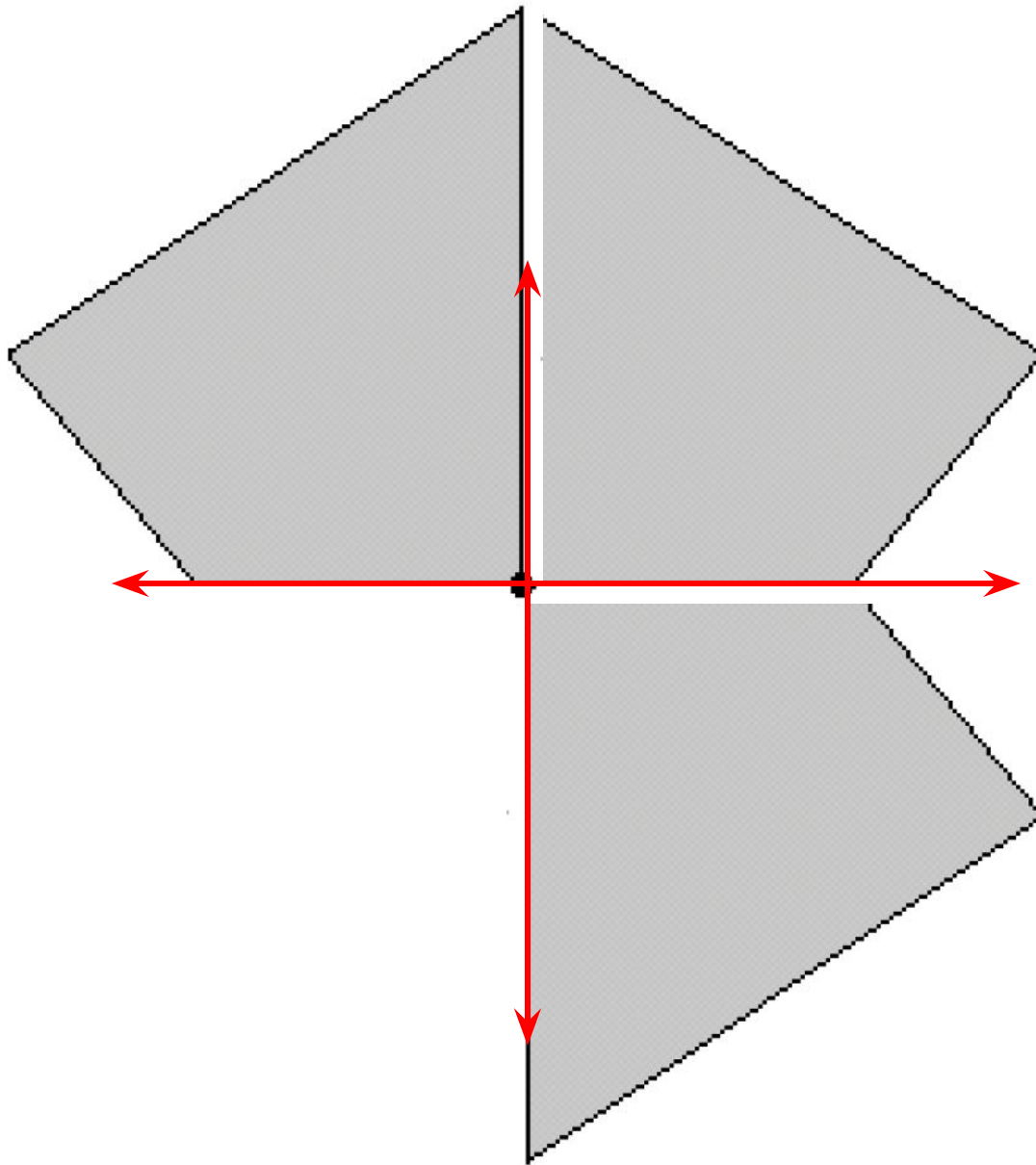
By. Mohamed S. Bayomi

# Mirroring of an object

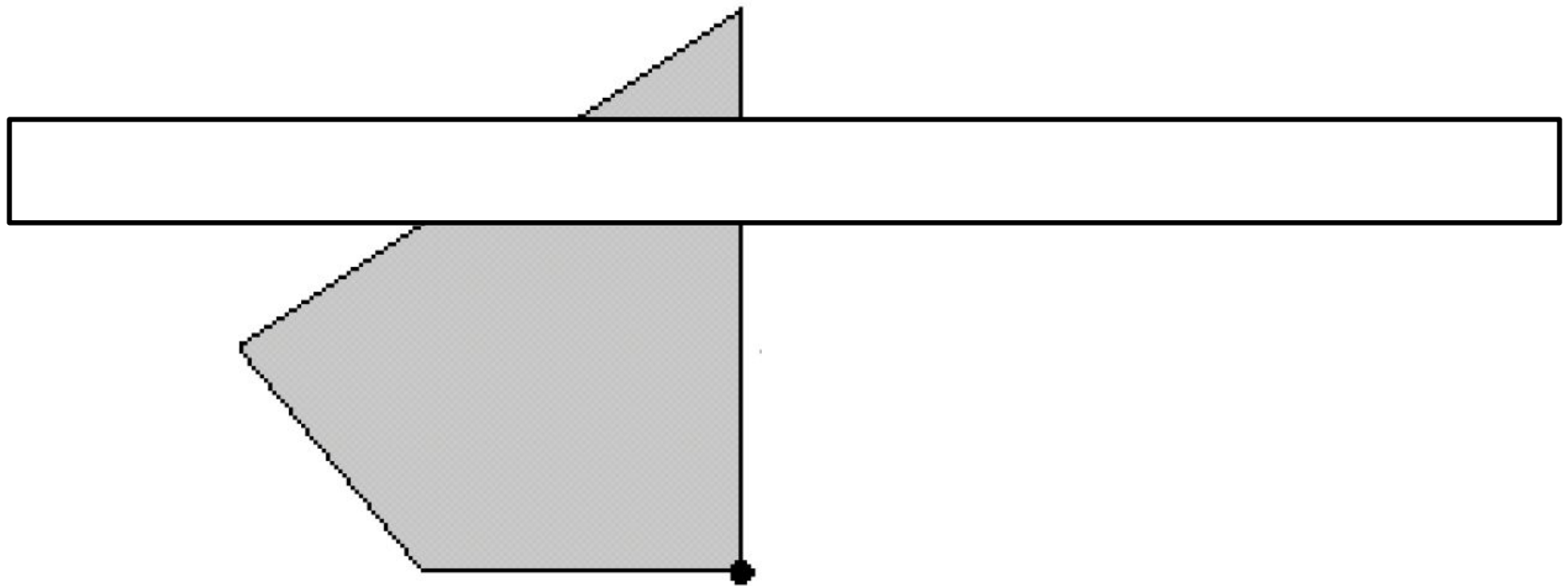
In asymmetric structure elements we don't use the original structure element we mirror it around it's origin.



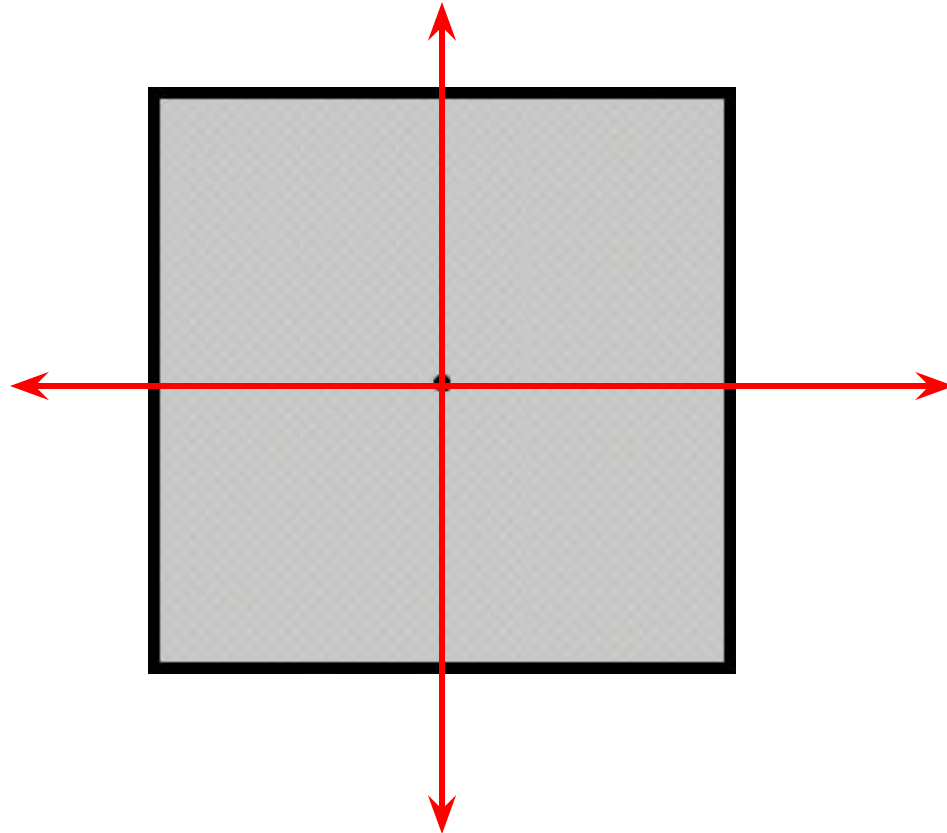
# Mirroring of an object



# Mirroring of an object



# Mirroring of an object

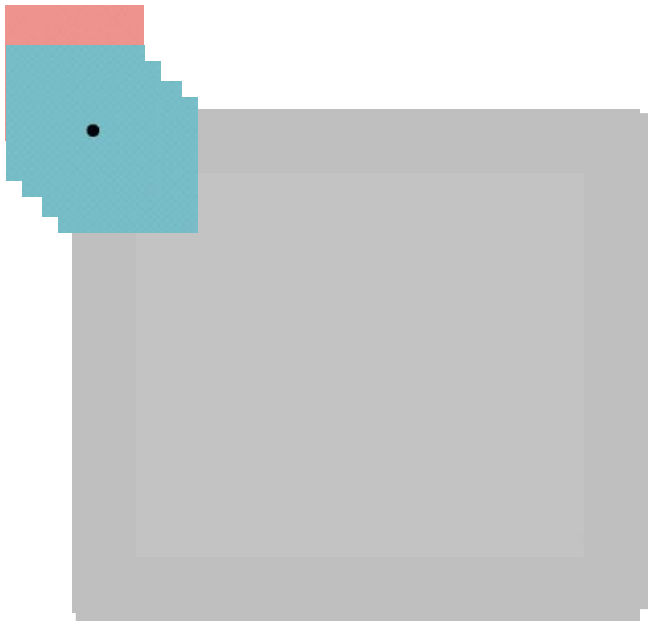


# We have 2 main morphological operations

## Dilation

The rule is:

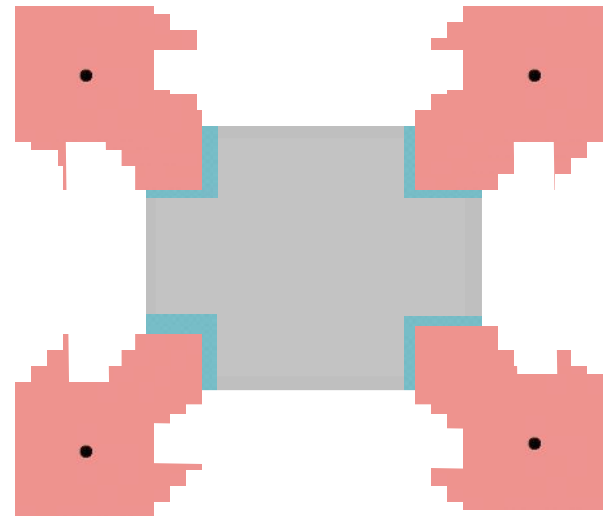
if the structure element has at least one pixel of binary 1, the origin will be 1



## Erosion

The rule is:

if the structure element has at least one pixel of binary 0, the origin will be 0. The structure element should be totally contained inside the body to give 1 at the origin.

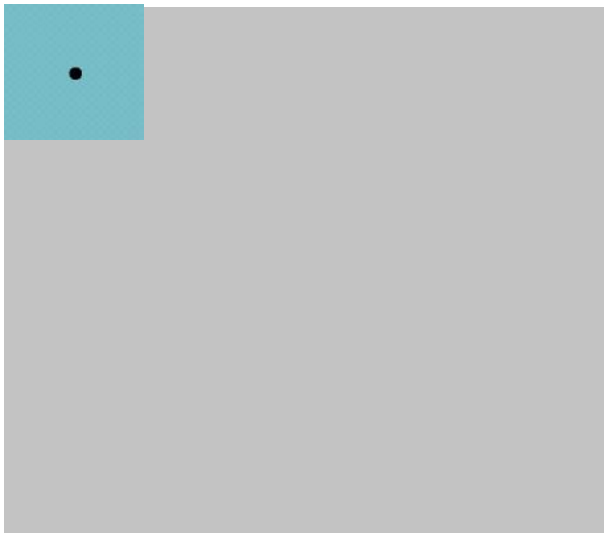


For simplicity we imagine a moving origin on the boundary of the body and the whole structure element to be changed

## Dilation

The rule is:

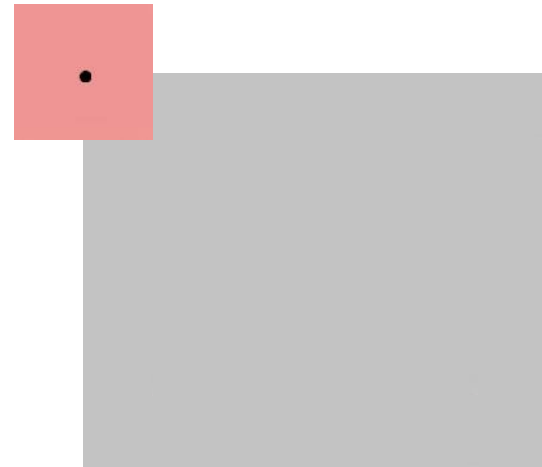
The origin moves on boundary and the structure element draw ones.





## Erosion

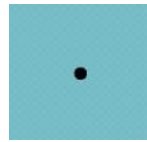
The rule is:

The origin moves on boundary and the structure element draw zeros.

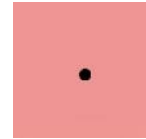


Dilating point  structure element  
Eroding a body with an structure element of the same shape  
 point

# Dilation



# Erosion

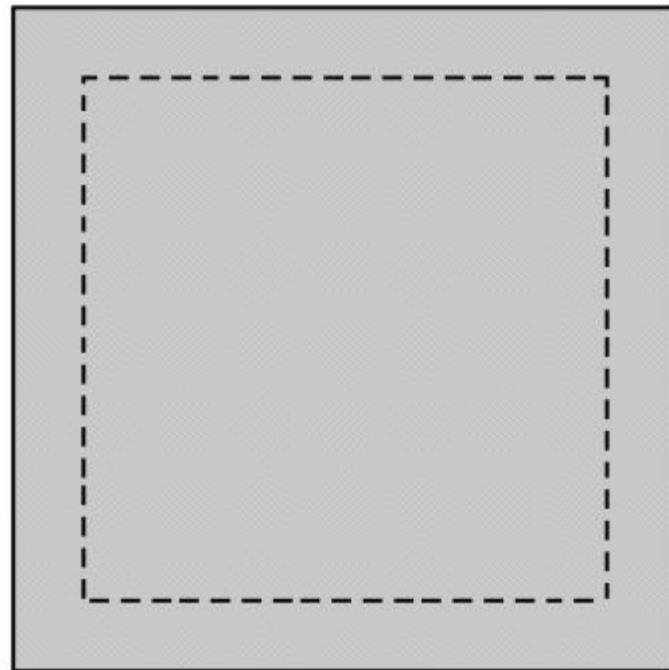




# Dilate

$$A \oplus B$$

## Object



$d/8$

$d$

$d/8$

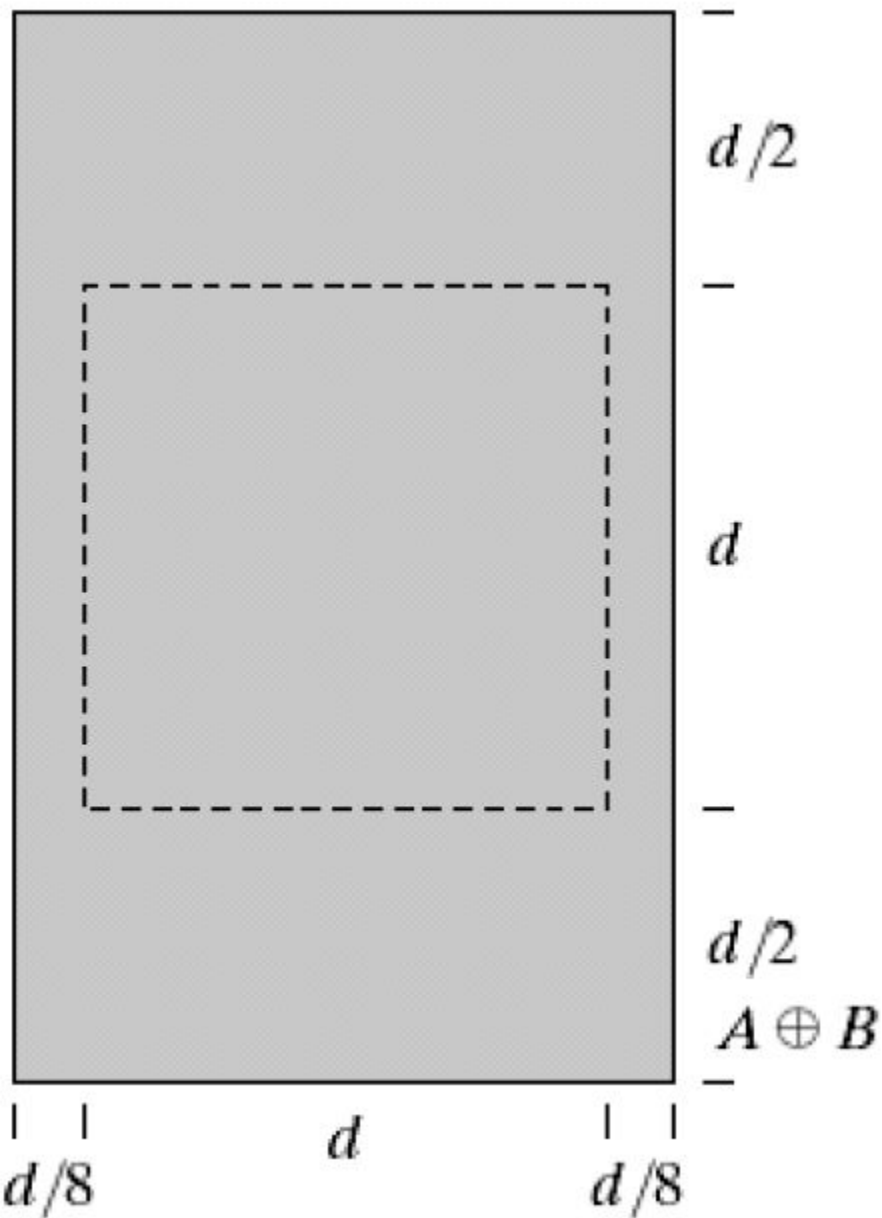
## Structure



$A \oplus B$  g of Symmetric object,  
: same object.

# Dilate

$$A \oplus B$$



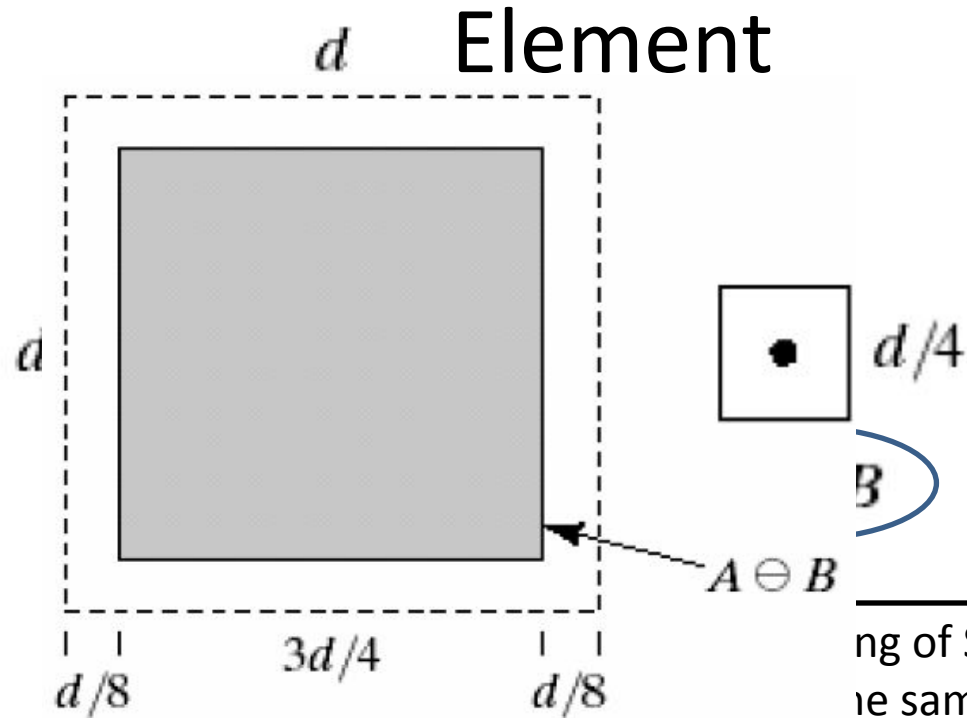
)  
of Symmetric object,  
ame object.

# Erode

$$A \ominus B$$

Object

Structure



ing of Symmetric object,  
ie same object.

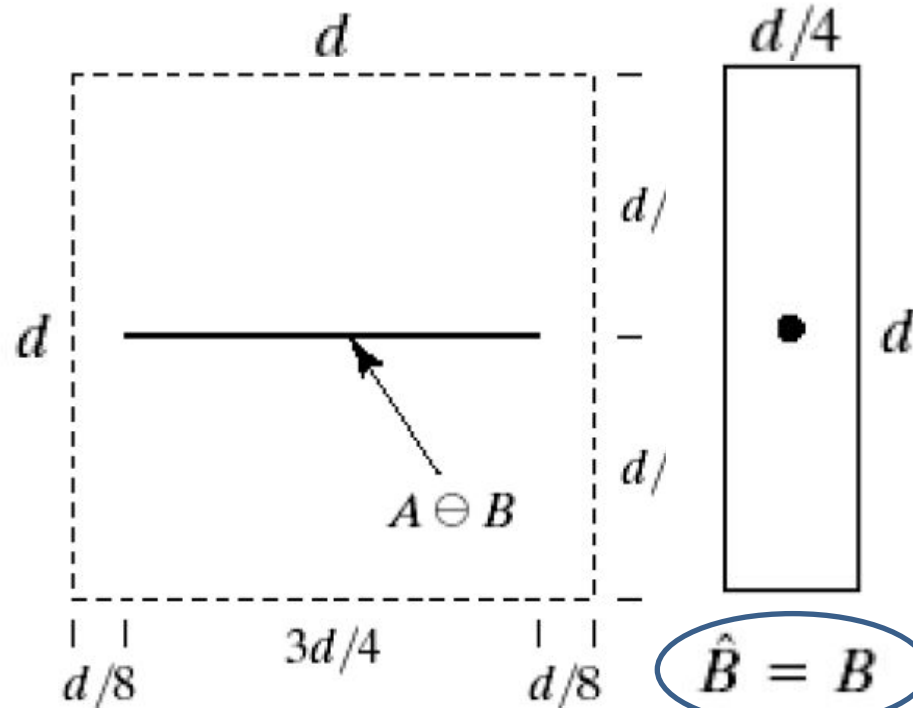
Erode

$$A \ominus B$$

Structure

Object

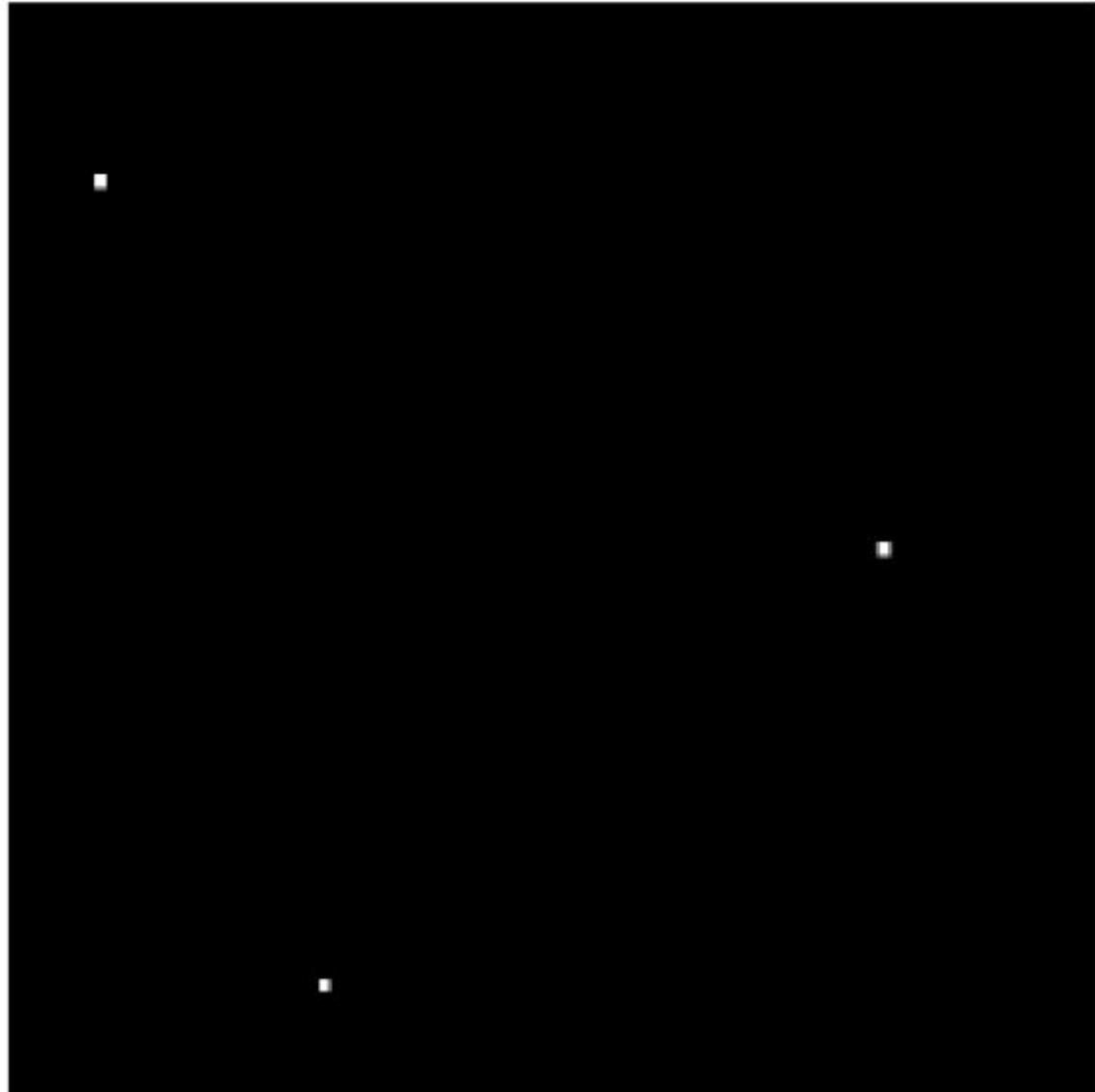
Element



Mirroring of Symmetric object,  
gives the same object.

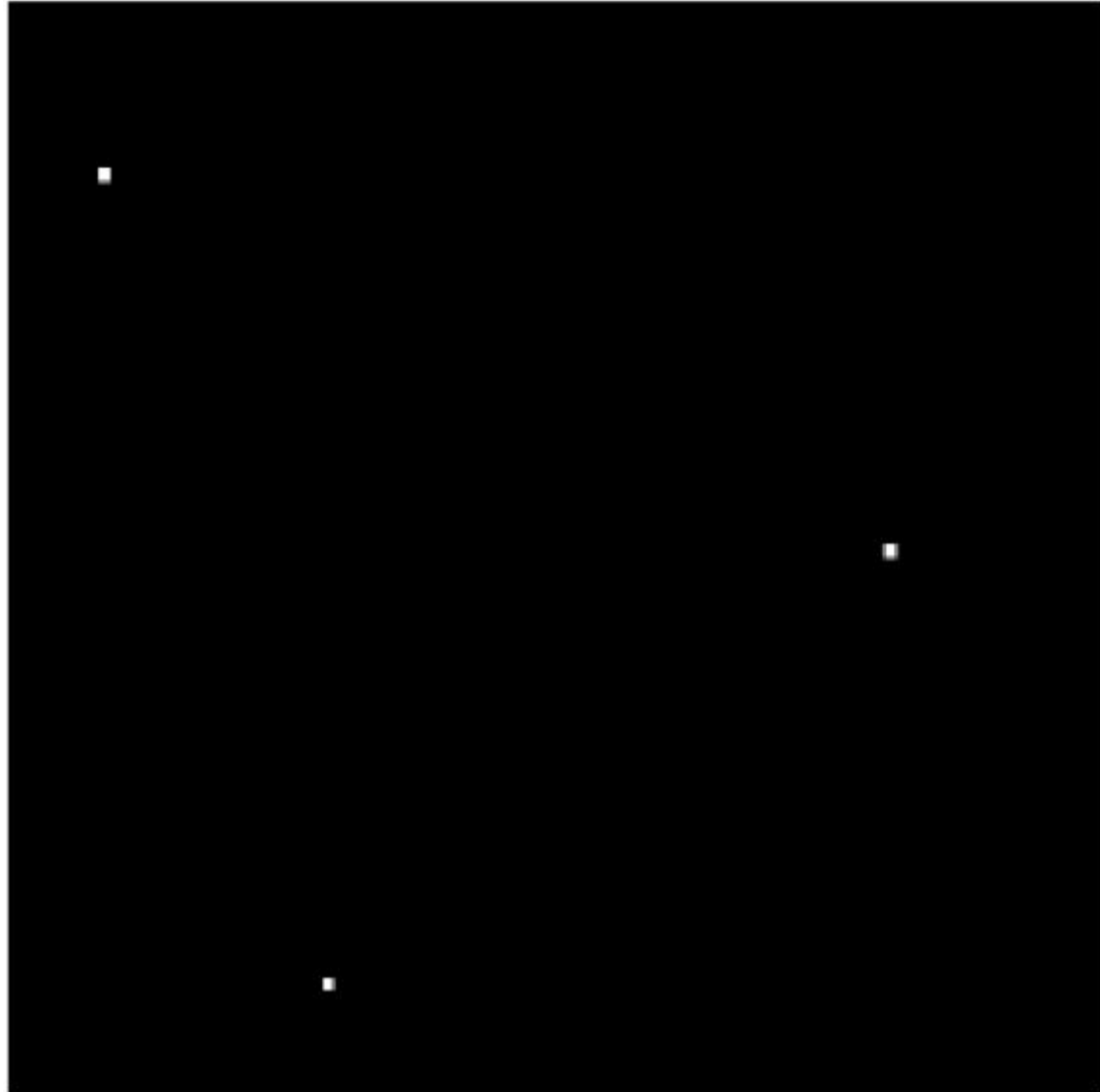
# Find object of size 15 “max size”

1- erode by structure element 15, will give pixel 1 at the origin of objects 15, and zero otherwise.



# Find object of size 15 “max size”

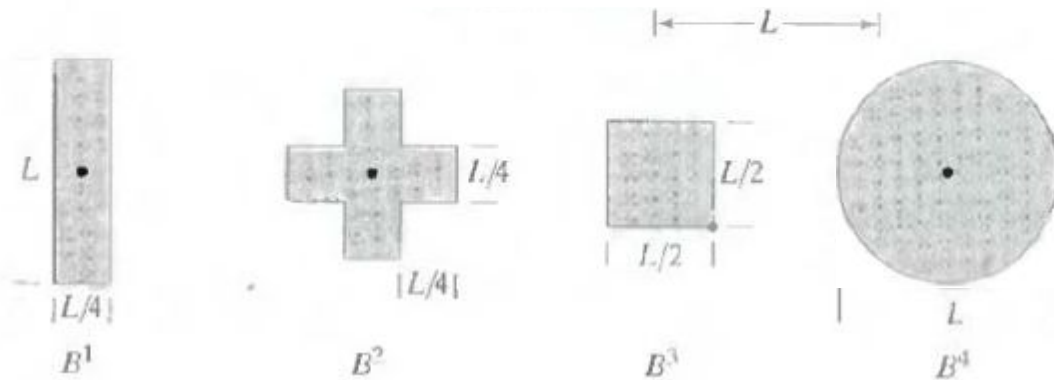
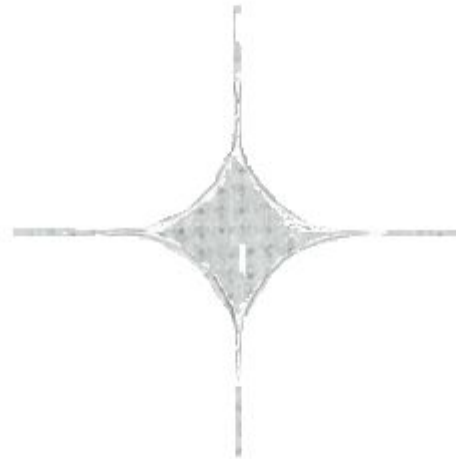
2- dilate by structure element 15, will retrieve the objects of size 15.



# Problem 9.6

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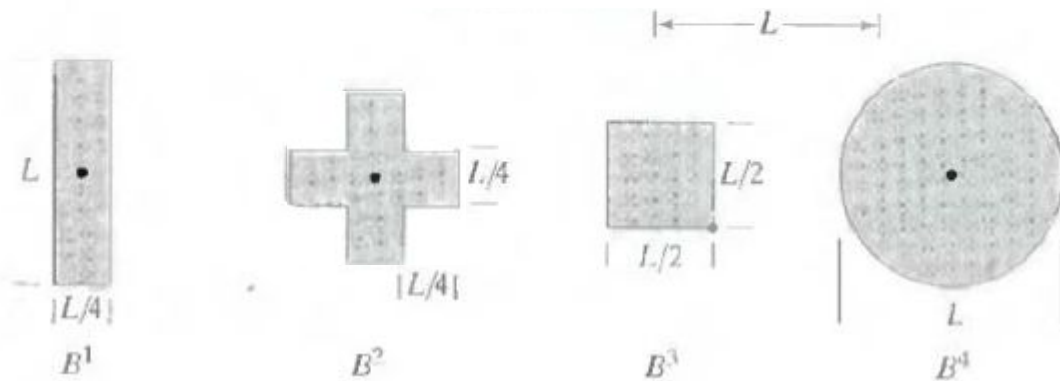
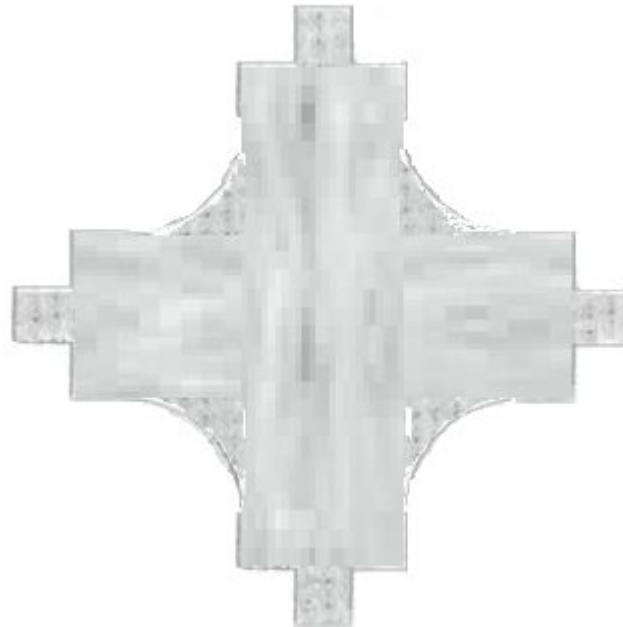
- (a)  $(A \ominus B^4) \oplus B^2$
- (b)  $(A \ominus B^1) \oplus B^3$
- (c)  $(A \oplus B^1) \oplus B^3$
- (d)  $(A \oplus B^3) \ominus B^2$



# Problem 9.6

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- (a)  $(A \ominus B^4) \oplus B^2$
- (b)  $(A \ominus B^1) \oplus B^3$
- (c)  $(A \oplus B^1) \oplus B^3$
- (d)  $(A \oplus B^3) \ominus B^2$





# Open and Close

Open:

Erode first then Dilate.

$$A \circ B = (A \ominus B) \oplus B$$

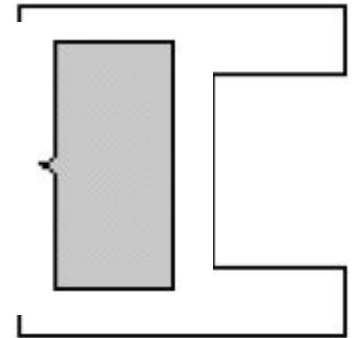
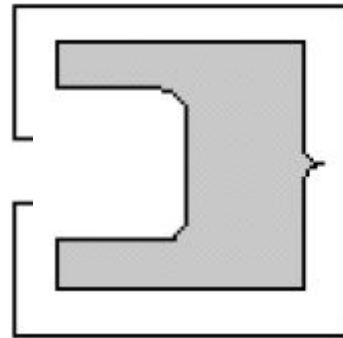
Close:

Dilate first then Erode.

$$A \bullet B = (A \oplus B) \ominus B$$

open

1- Erode

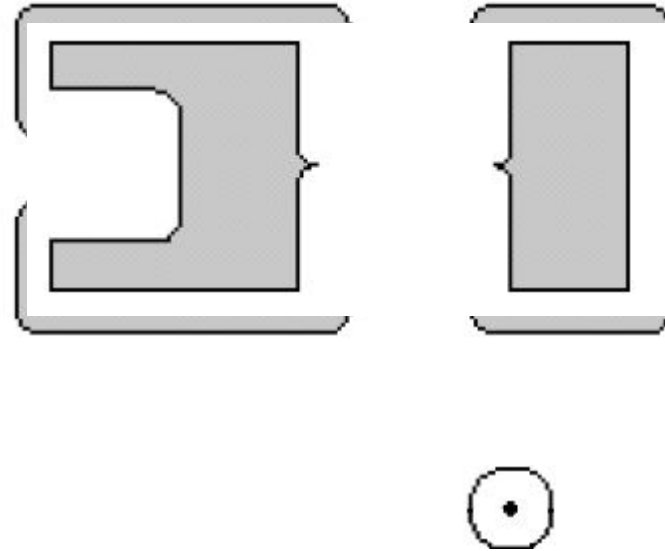


A



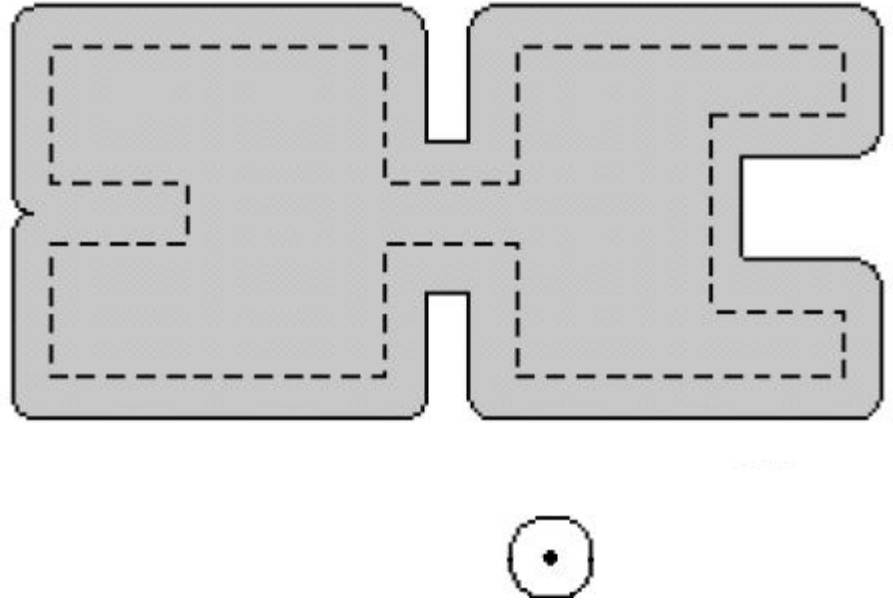
open

2- Dilate



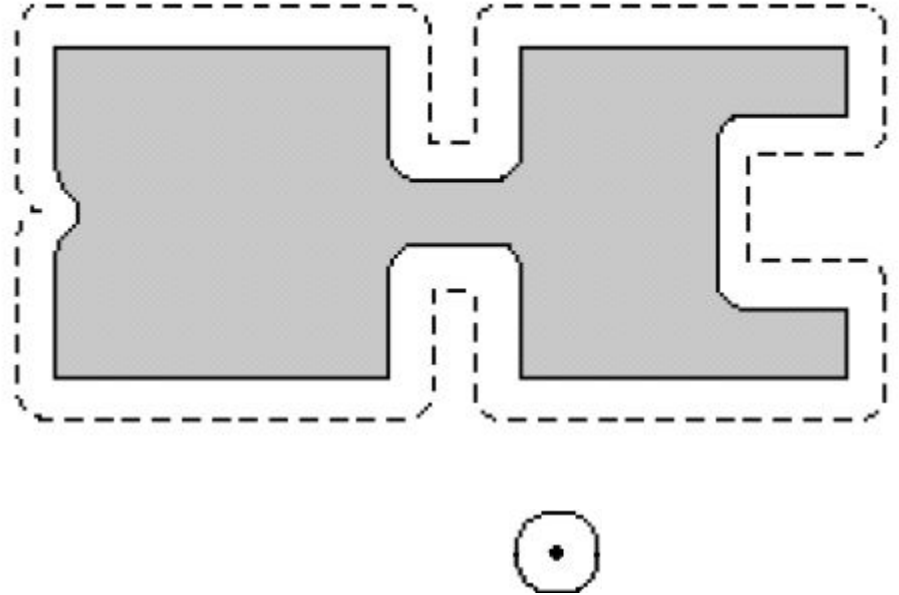
# Close

## 1- Dilate



Close

2- Erode



# Hit or Miss

We want to identify specific object.

1. Make a structure element with the same shape of the required object,
2. Erode the image with the structure element,
3. The required object and bigger will be replaced by 1 pixel at the origin.
4. Complement the image , complement the structure element,
5. Erode the inverted image with the inverted structure element.

# Hit or Miss

Output  
No.1

## Image

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	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
0	0	<i>a</i>	0	0	0	0	0	0	0	0	0	0	<del>x</del>	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
0	0	0	0	0	<i>a</i>	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Structure  
element

0	1	0
1	<b>1</b>	1
0	1	0

We want elements of  
cross of ones with 4 zeros  
at the corners not this

1	1	0
1	1	1
0	1	0

# Hit or Miss

Here we will check the 4 zeros at the corners

## Image

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

*a*

*a*

*a*

Structure  
element

0	1	0
1	1	1
0	1	0

Structure  
element  
complement

## Image complement

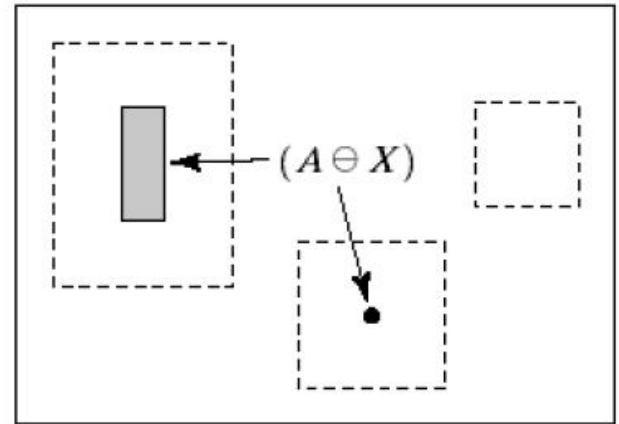
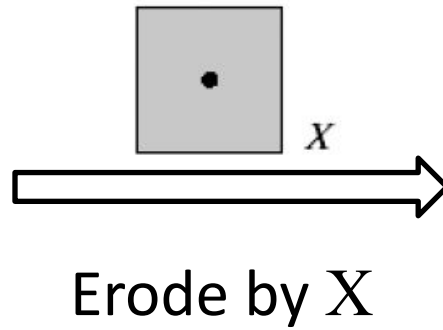
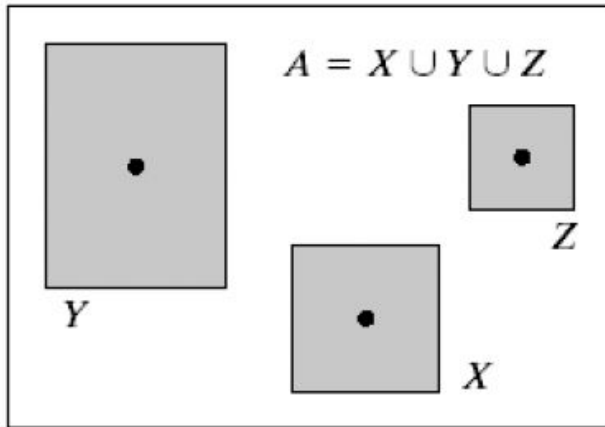
Output  
No.2



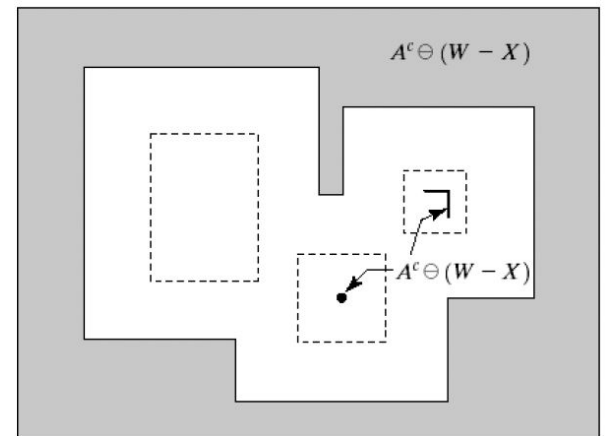
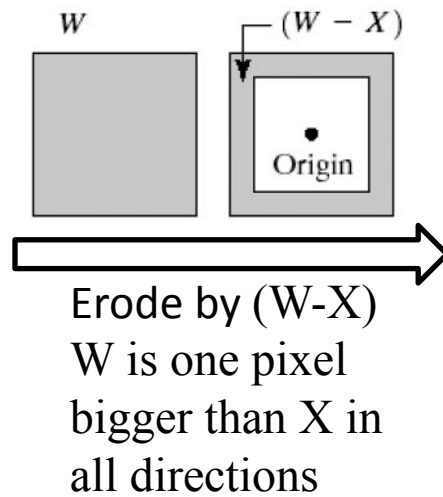
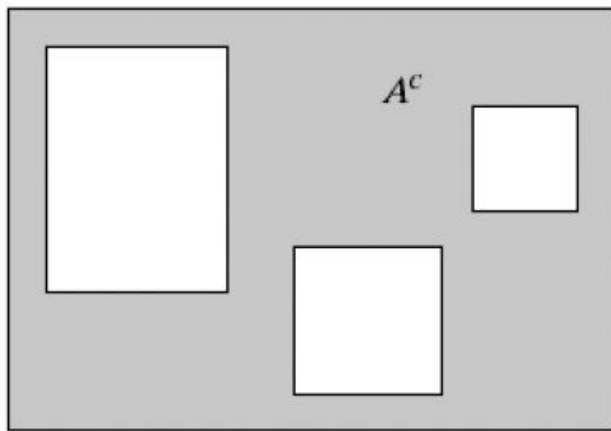


# Find X

# Hit or Miss

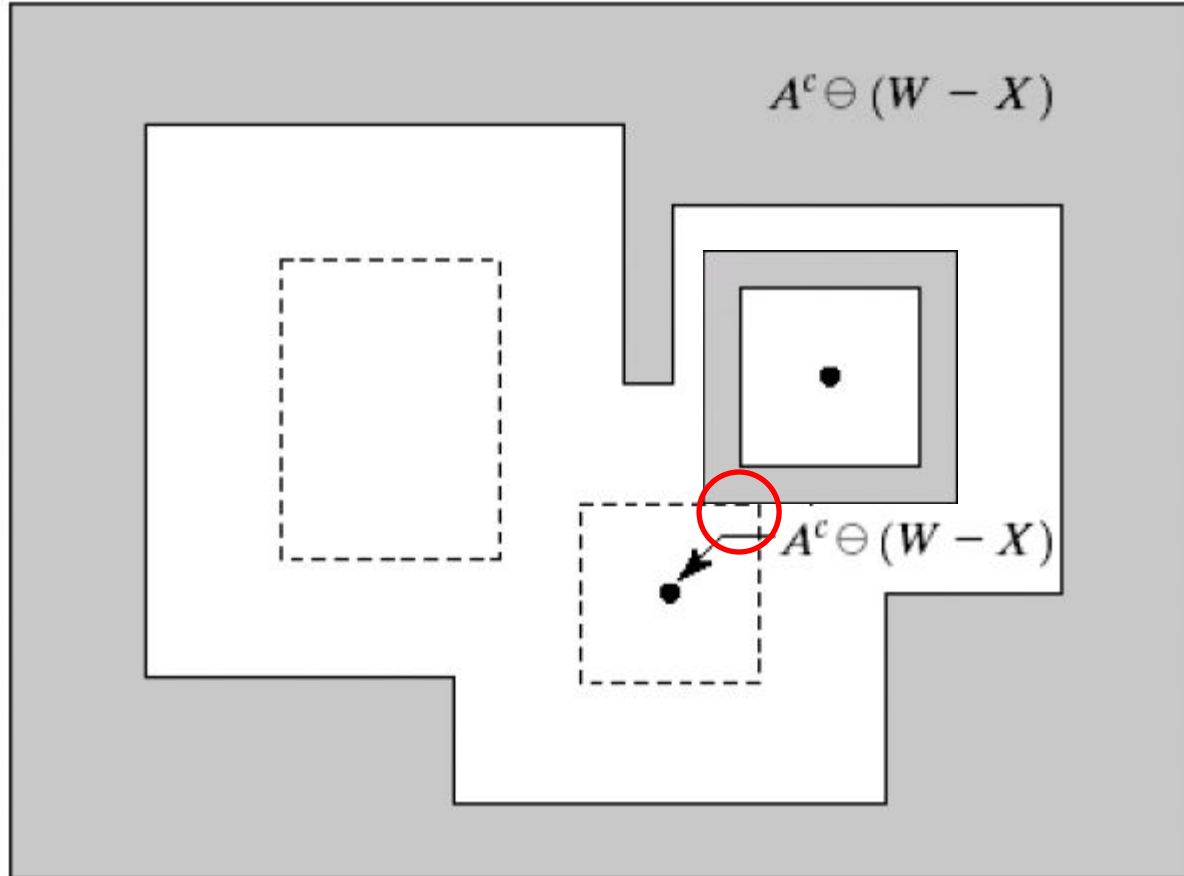


↓ Complement



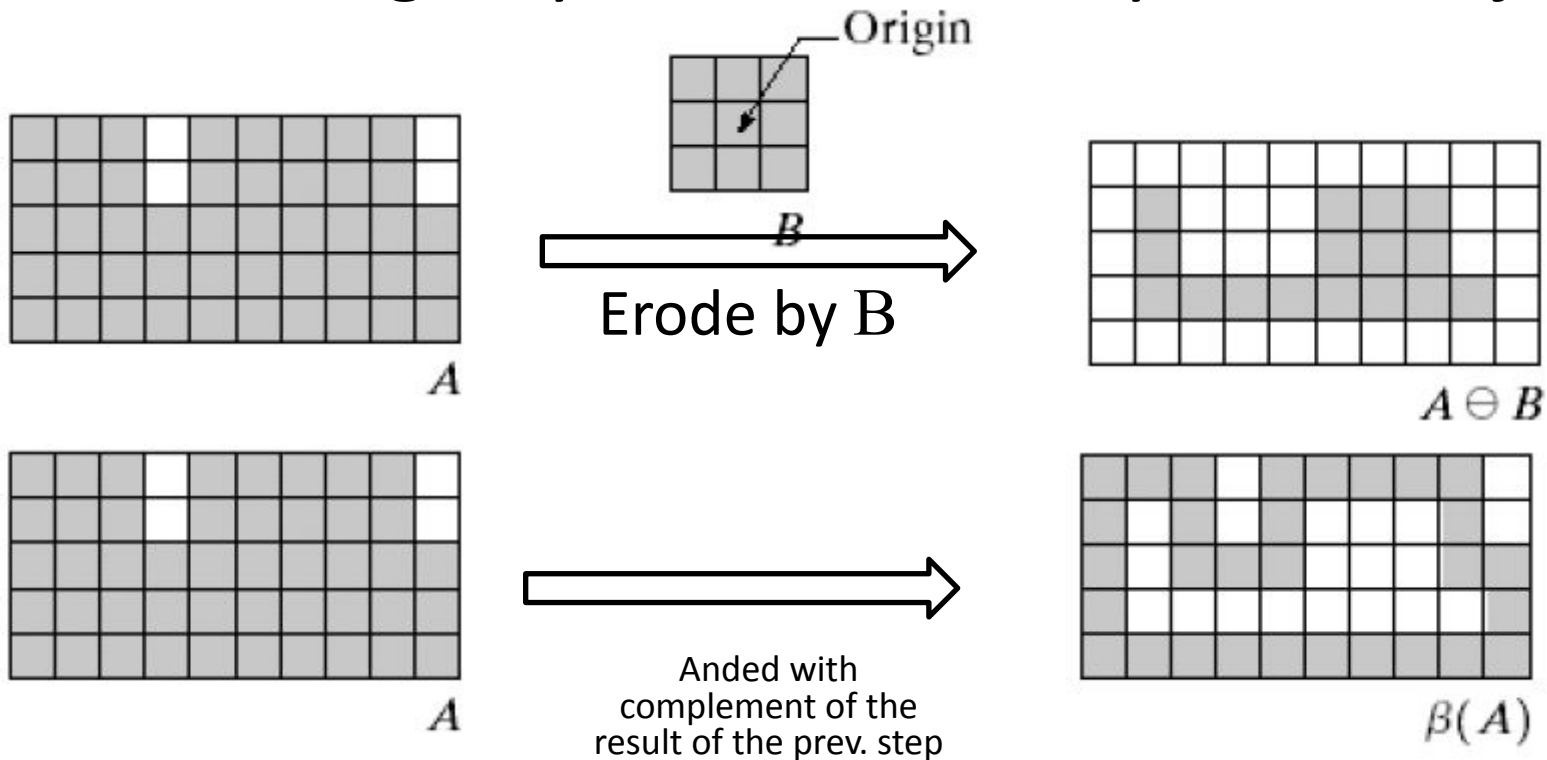
# Hit or Miss

While eroding Z the structure element hit the gap of X creating the L shape



# Boundary Extraction

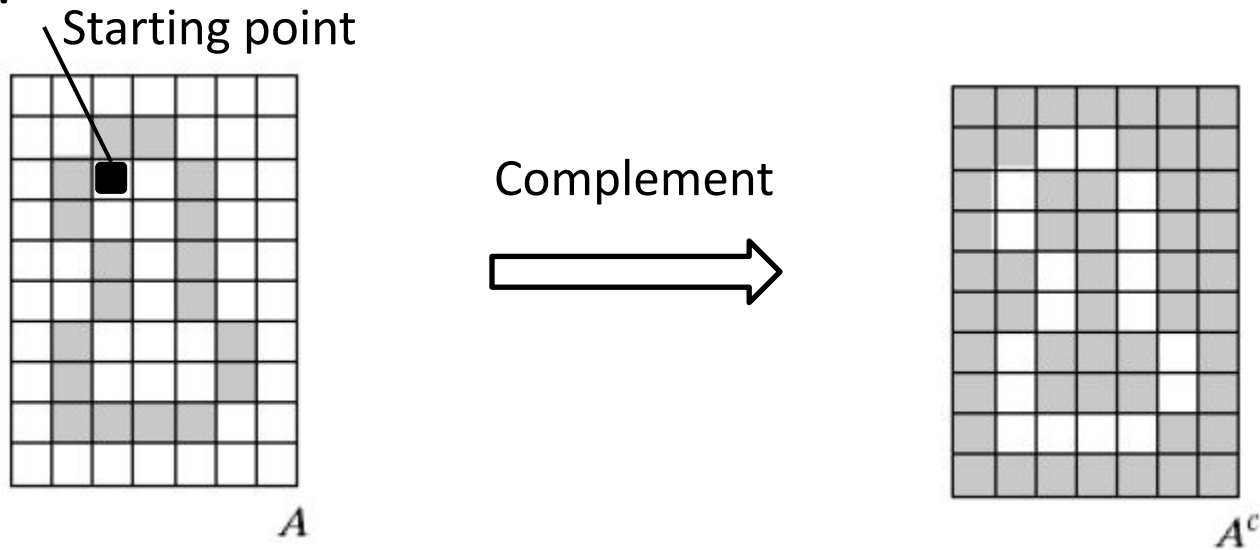
Eroding an object by small structure element then substitute the original image – the result of erosion will give you the boundary of the object.

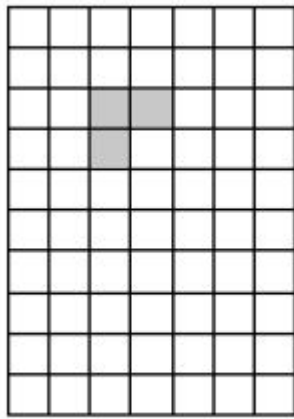


# Region Filling

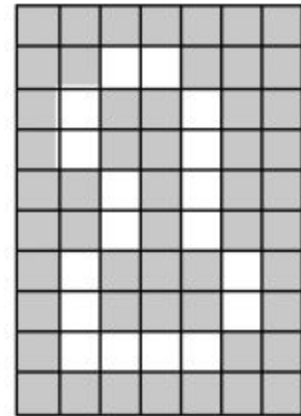
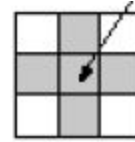
It needs many iterations to be done.

Starting by point inside the region, dilate with cross structure element (+), And the output with the complement of original image.

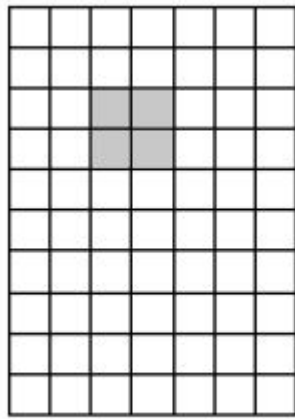




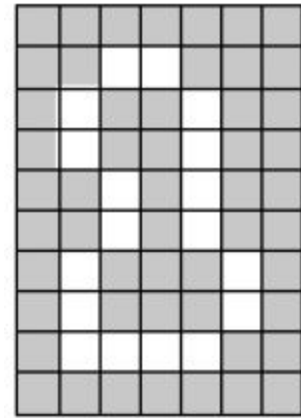
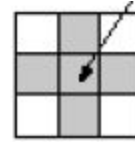
Anding  
Dilate



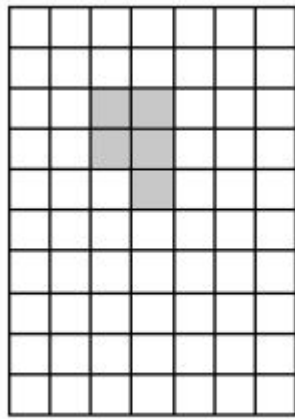
$A^c$



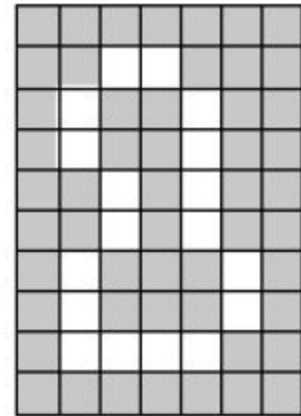
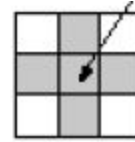
Anding  
Dilate



$A^c$

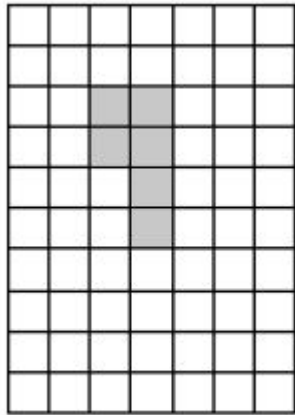


Anding  
Dilate

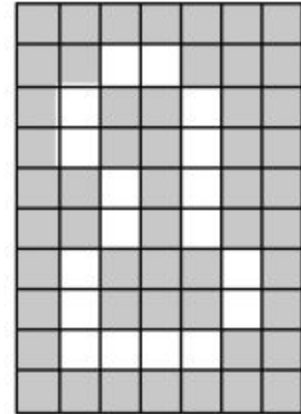
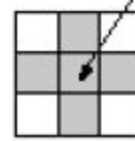


$A^c$

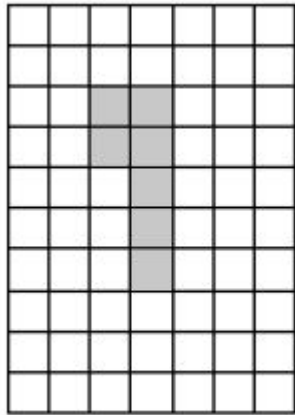




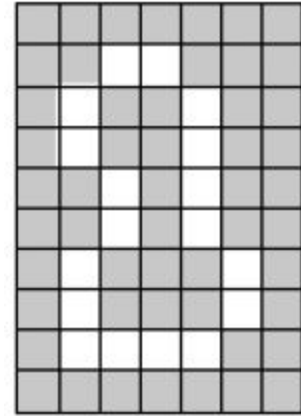
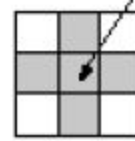
Anding  
Dilate



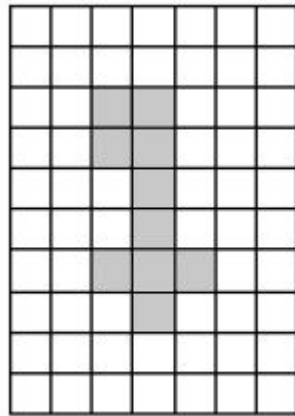
$A^c$



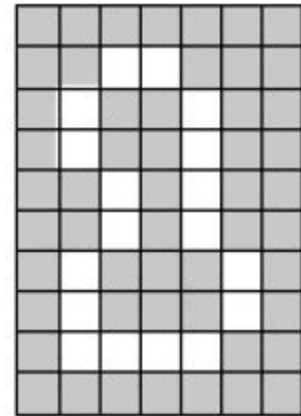
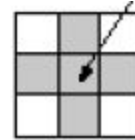
Anding  
Dilate



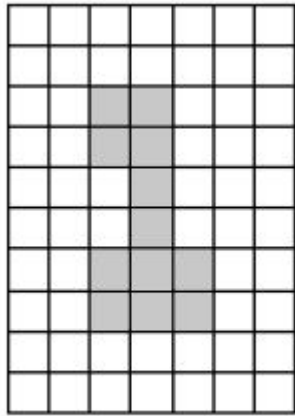
$A^c$



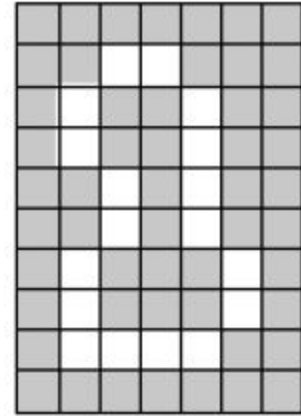
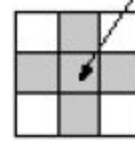
Anding  
Dilate



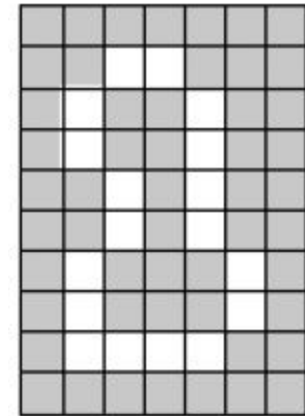
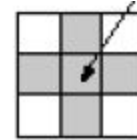
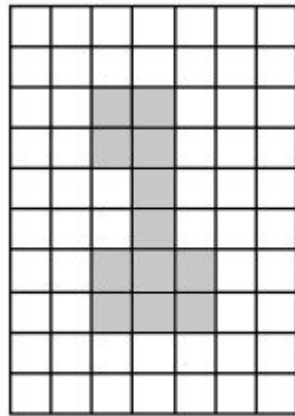
$A^c$



Anding  
Dilate



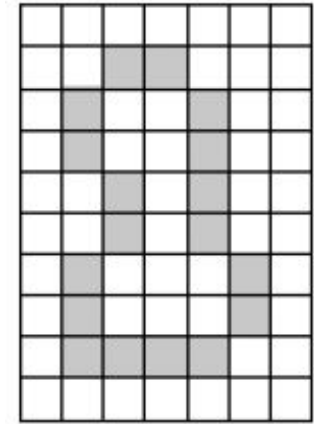
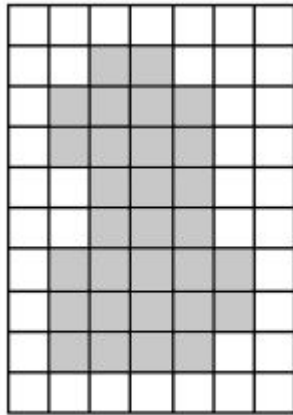
$A^c$



$A^c$

Anding  
Dilate

The last 2 iterations are  
the same  **stop**



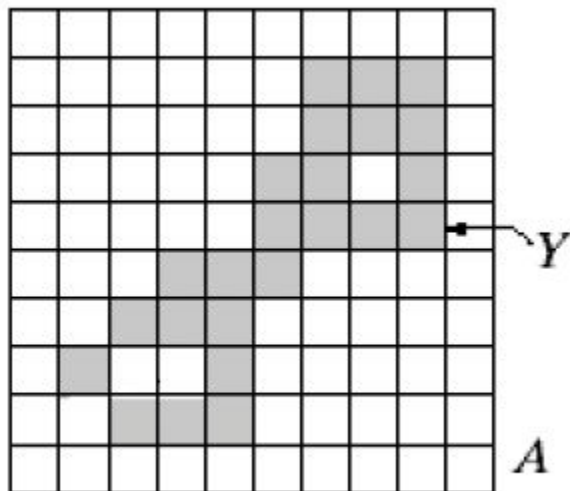
A

The Result is the union  
of the region fill and the  
boundary

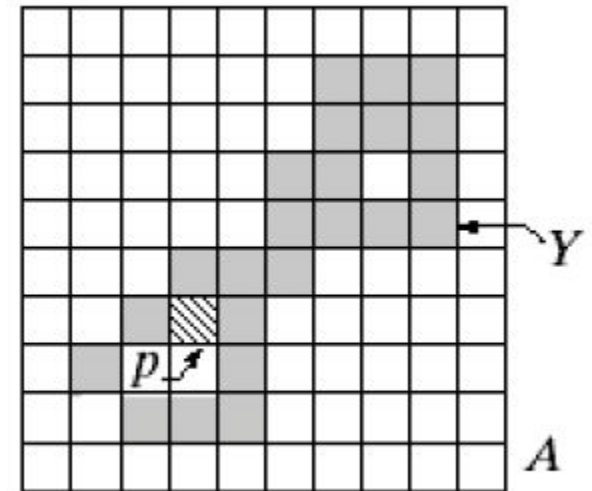
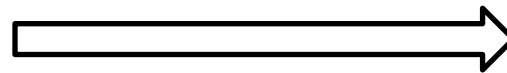
# Extraction of Connected Component

It needs many iterations to be done.

Starting by point inside the component, dilate with square structure element, And the output with the original image.

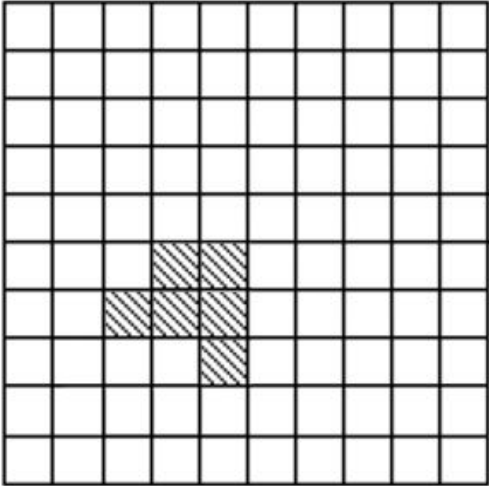


Select a starting point on the component

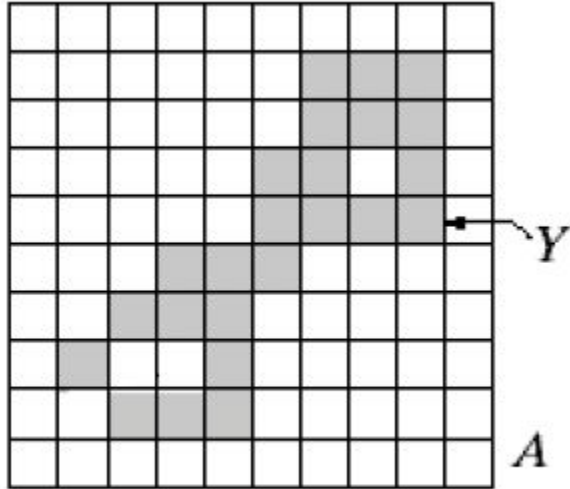
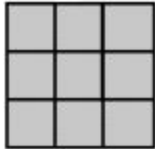


$$X_0 = p$$

# Extraction of Connected Component

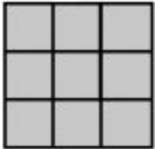
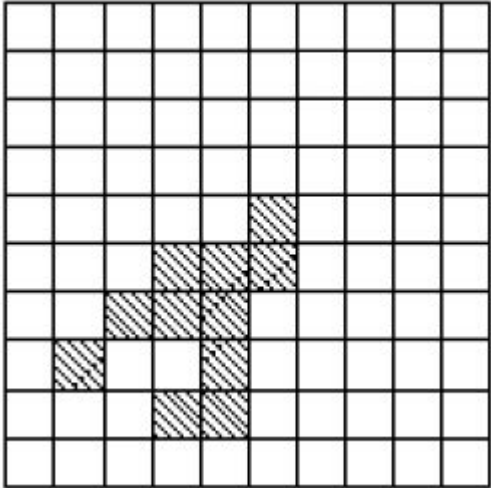


Anding  
Dilate

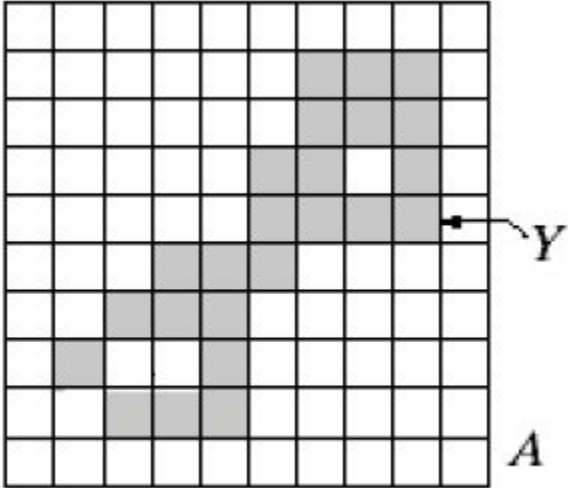




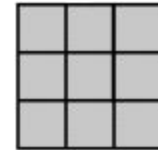
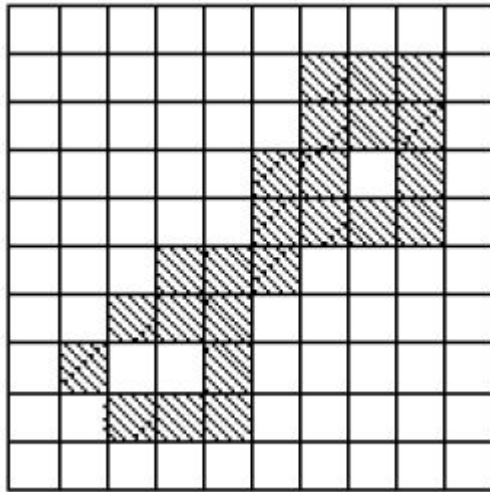
# Extraction of Connected Component



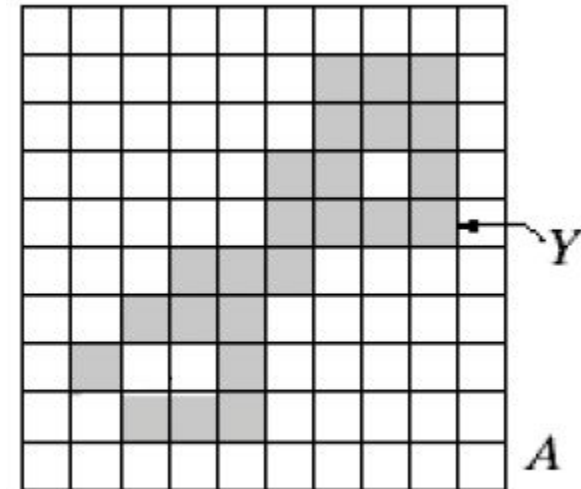
Anding  
Dilate



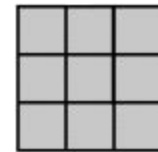
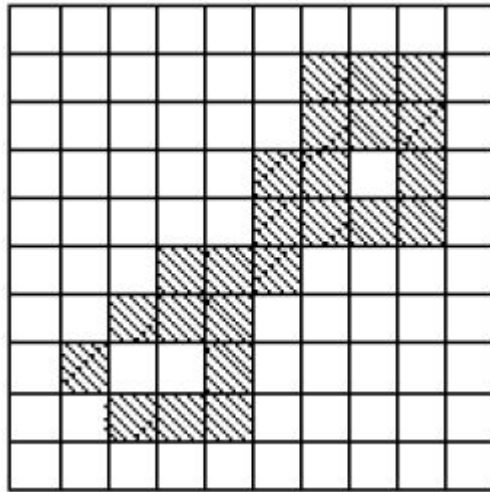
# Extraction of Connected Component



After many iterations  
we will get this shape



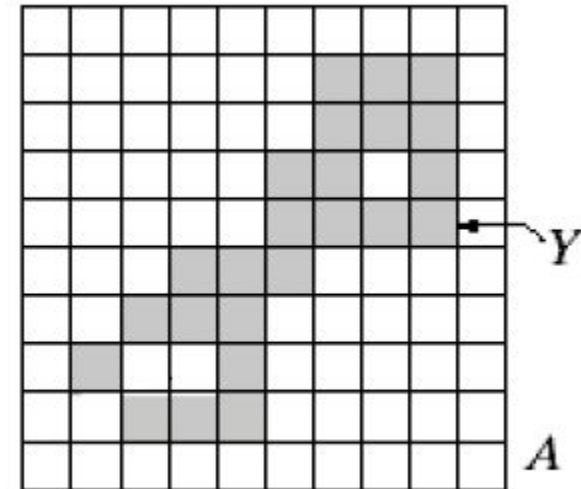
# Extraction of Connected Component



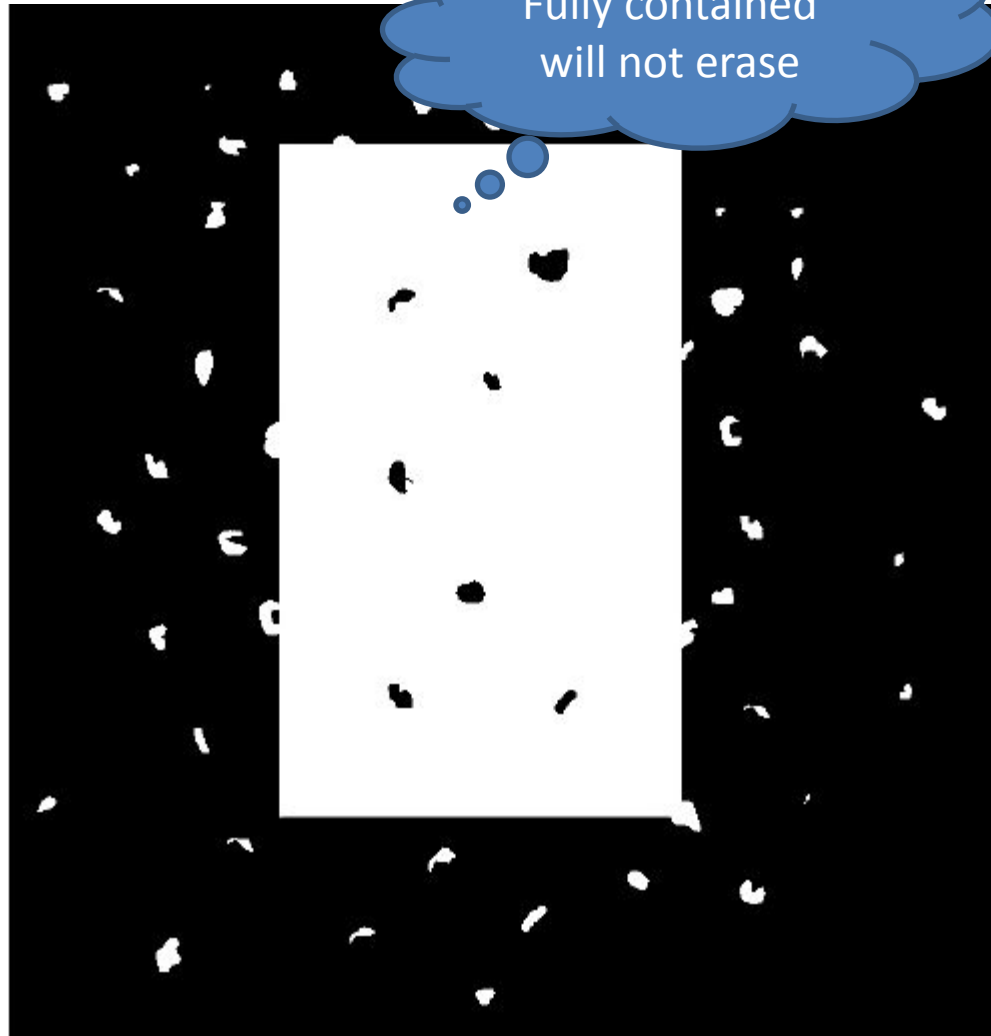
By dilating this shape then anding this shape with the original image we will get the same shape.

The last 2 iterations are the same

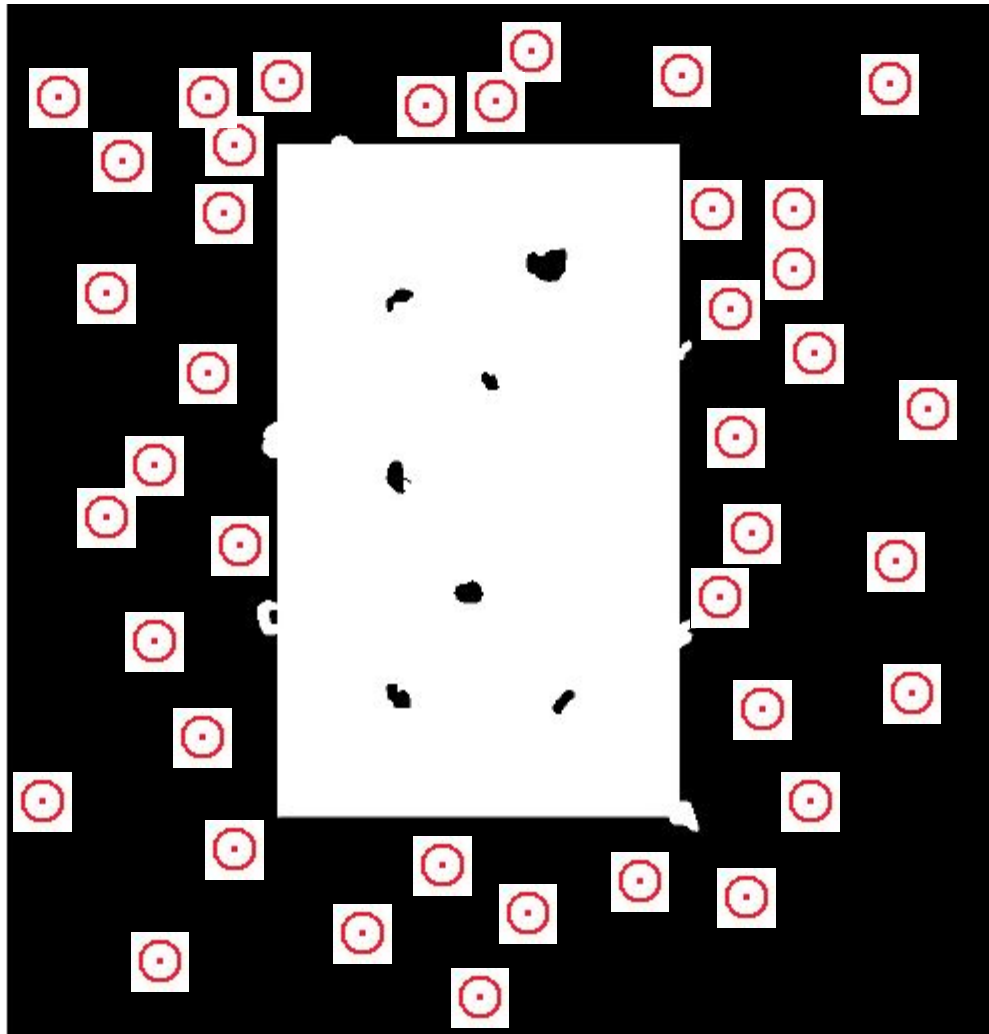
**stop**



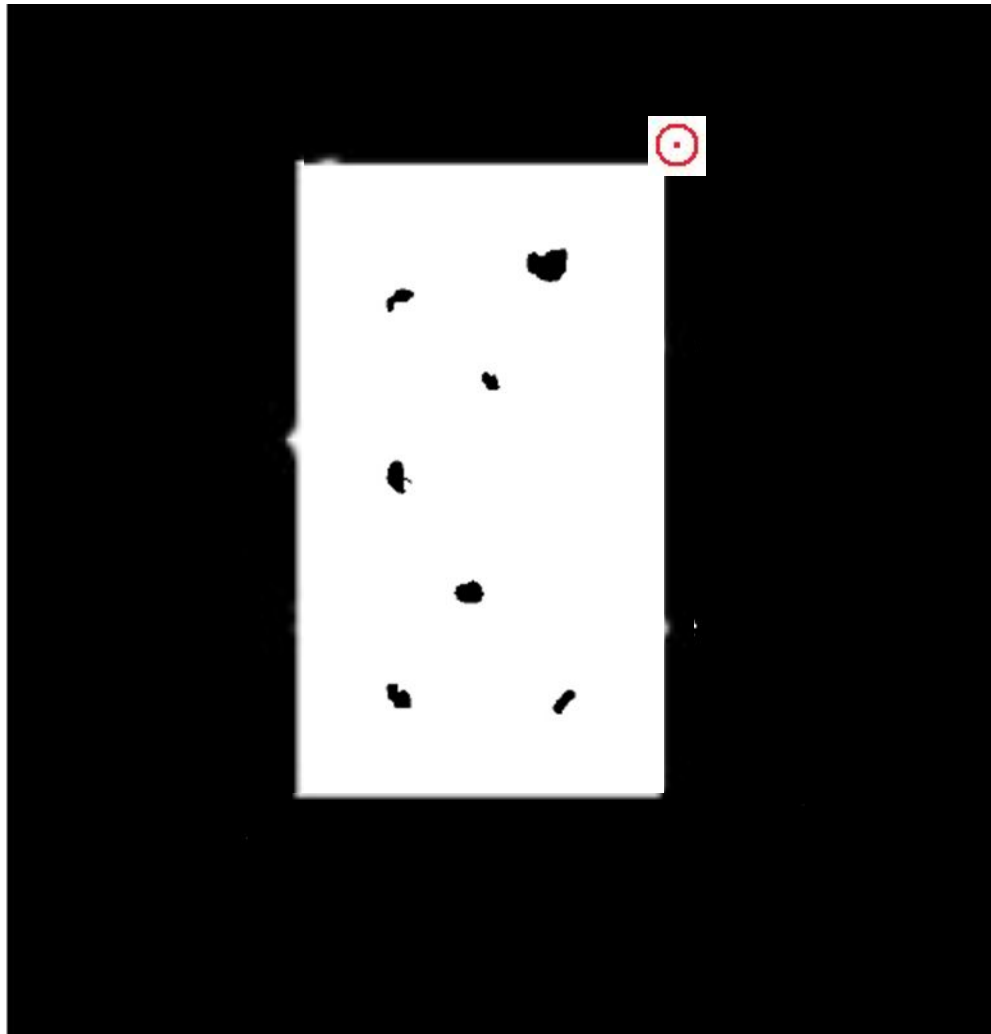
# Problem 9.17



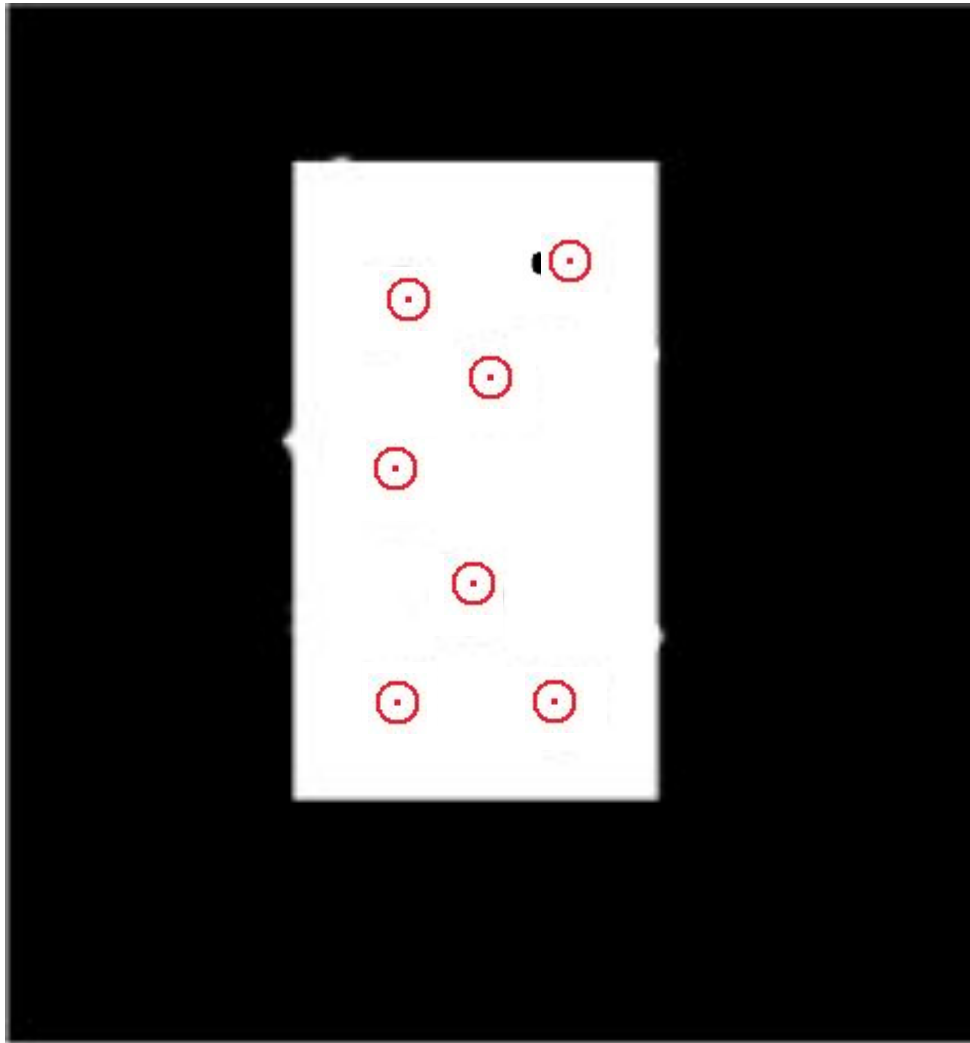
Not fully  
contained



Not fully  
contained



Not fully  
contained

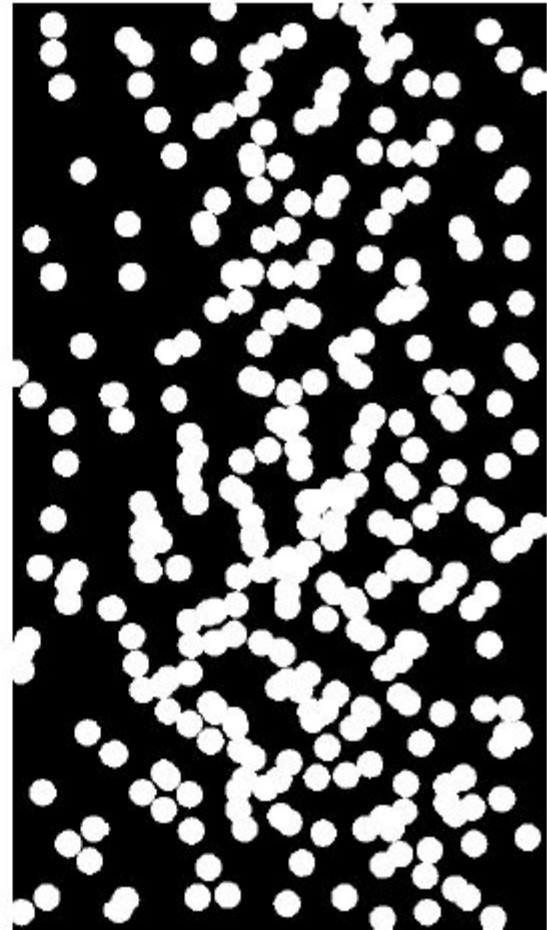


## Problem 9.36

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A preprocessing step in an application of microscopy is concerned with the issue of isolating individual round particles from similar particles that overlap in groups of two or more particles. Assuming that all particles are of the same size, propose a morphological algorithm that produces three images consisting respectively of

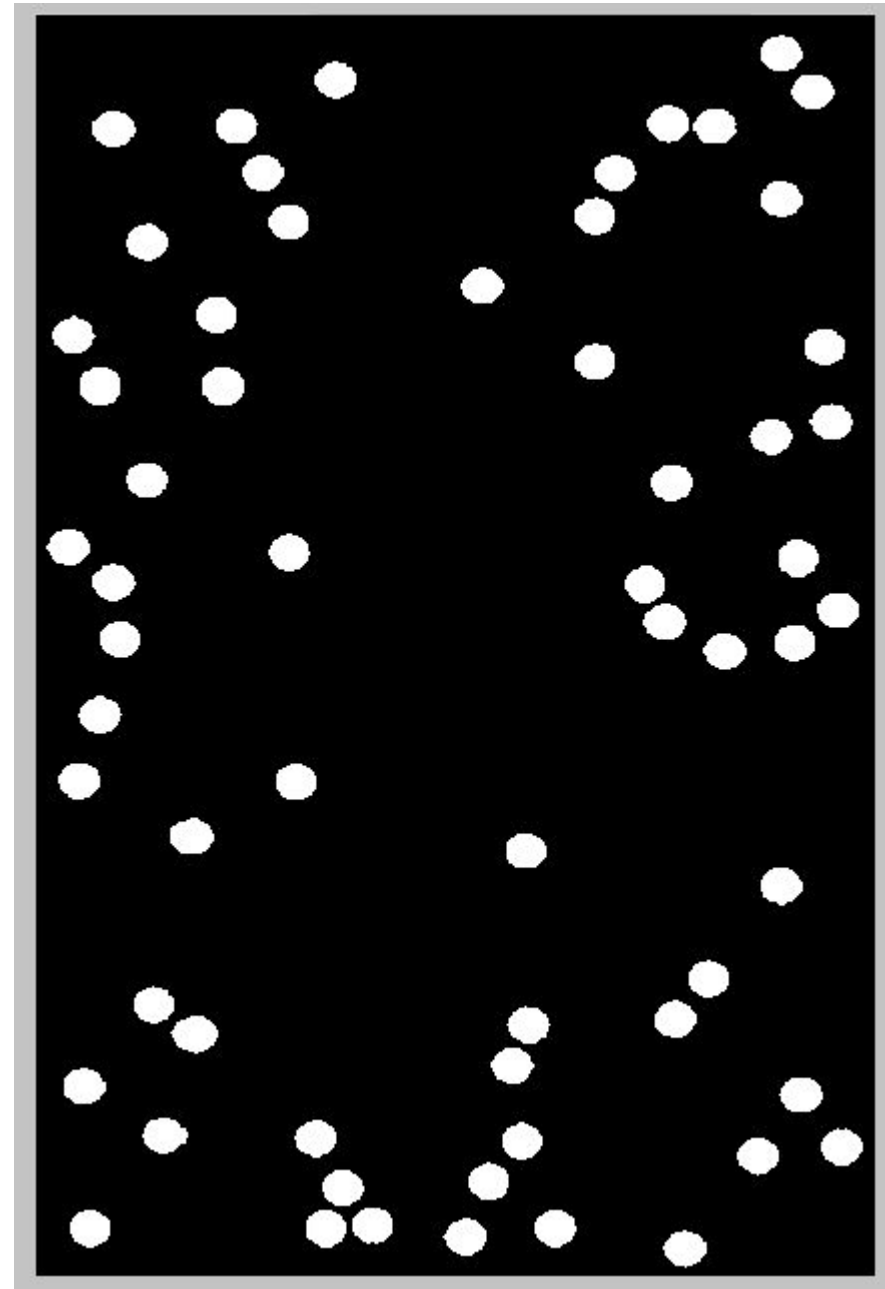
- Only of particles that have merged with the boundary of the image.
- Only overlapping particles.
- Only nonoverlapping particles.





(c) Only Non overlapping particles:

Hit or miss

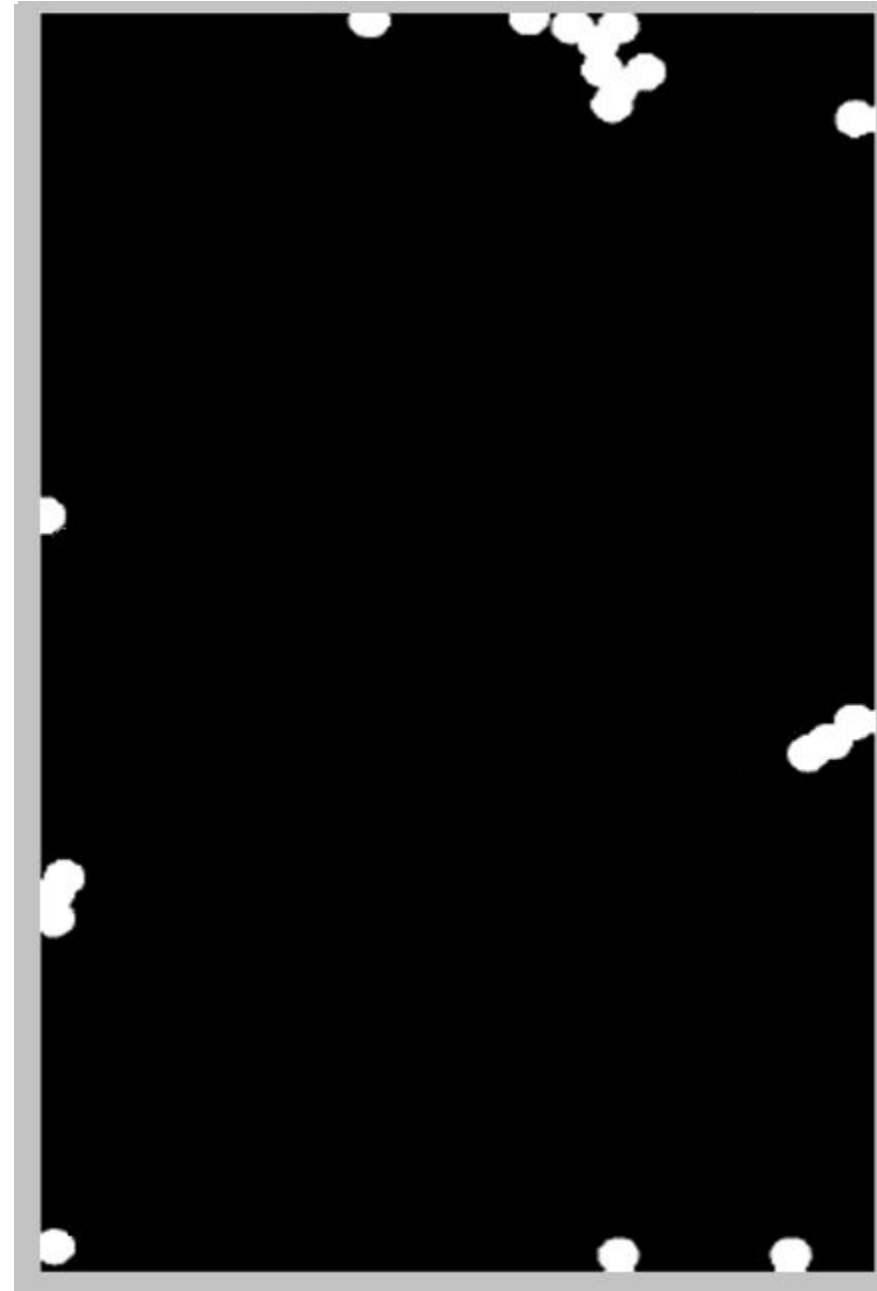


(a) Only of particles that have merged with boundary of the image

1- make a boundary of the image.

2- And the image with the boundary.

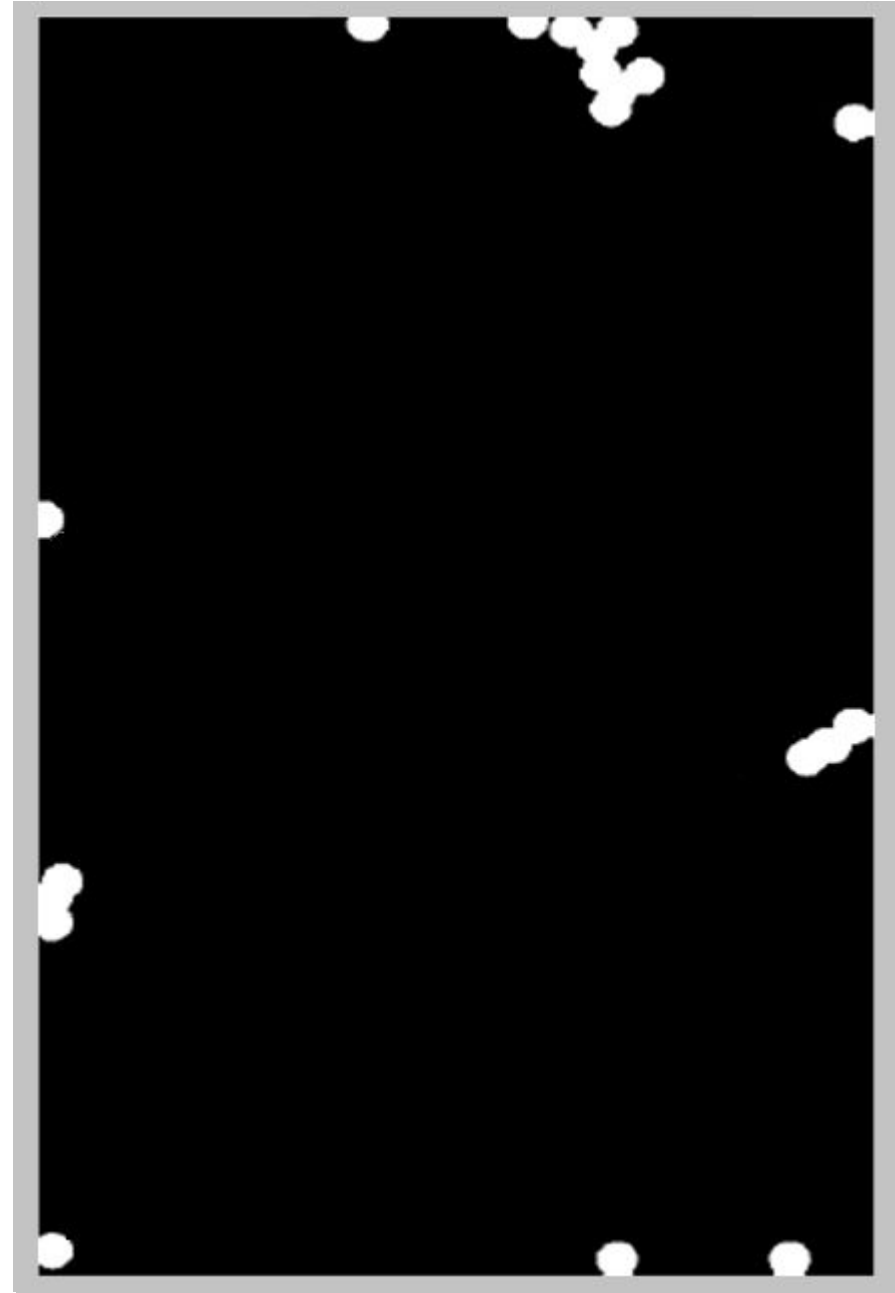
3- Extract Connected Component by expansion starting with this seed.



(b) Only Overlapped particles:

Original Image – the 2 previous results , such that the image only contain 3 types of particles:

- Overlapped.
- non overlapped.
- On boundary.



Thanks