National University of Sciences and Technology (NUST)

SEECS

Digital Image Processing

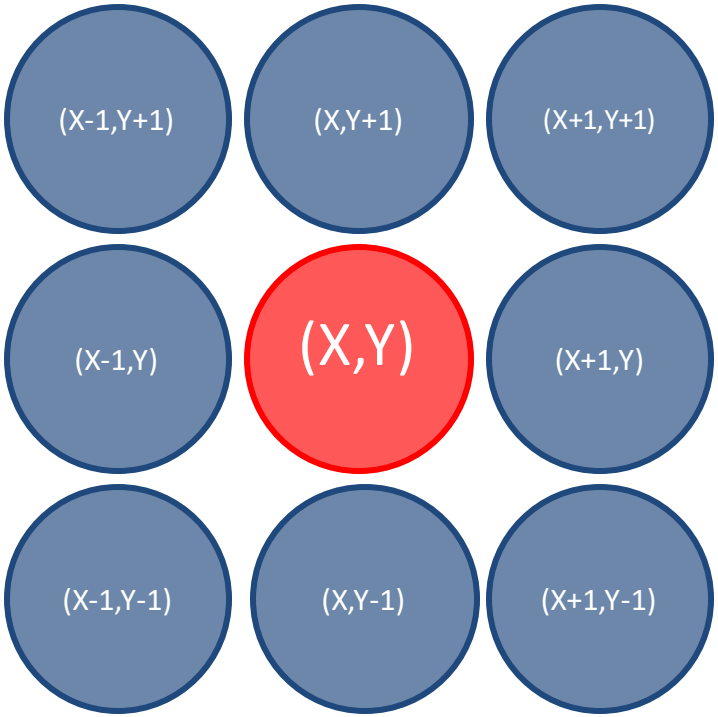
Pixel Connectivity

Pixel Neighborhood

- Neighbors of pixel are the pixels that are adjacent to the identified pixel.

(Diagonal Pixels)

(4 Connectivity)



(8 Connectivity)

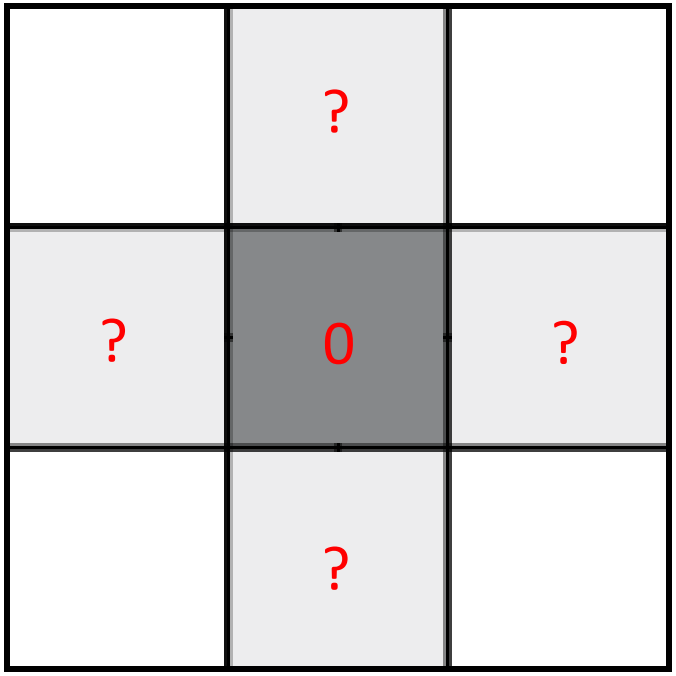
Distance Measures

We can divide distance between pixels in following categories

- City Block Distance - D_4
- Chess Board Distance - D_8
- Euclidean Distance - D_E

Distance Measures

City block distance (D_4 distance)

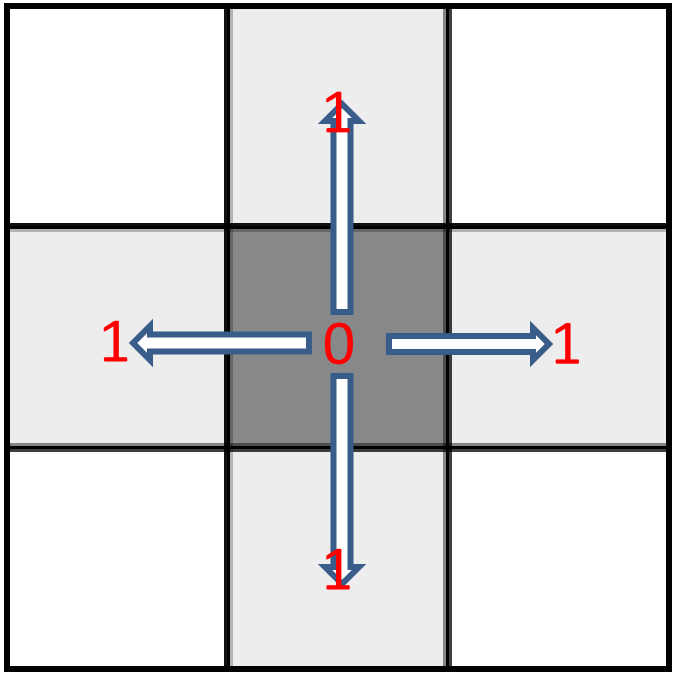


Calculate neighboring pixel distance if

1 small square = 1unit

Distance Measures

City block distance (D_4 distance)

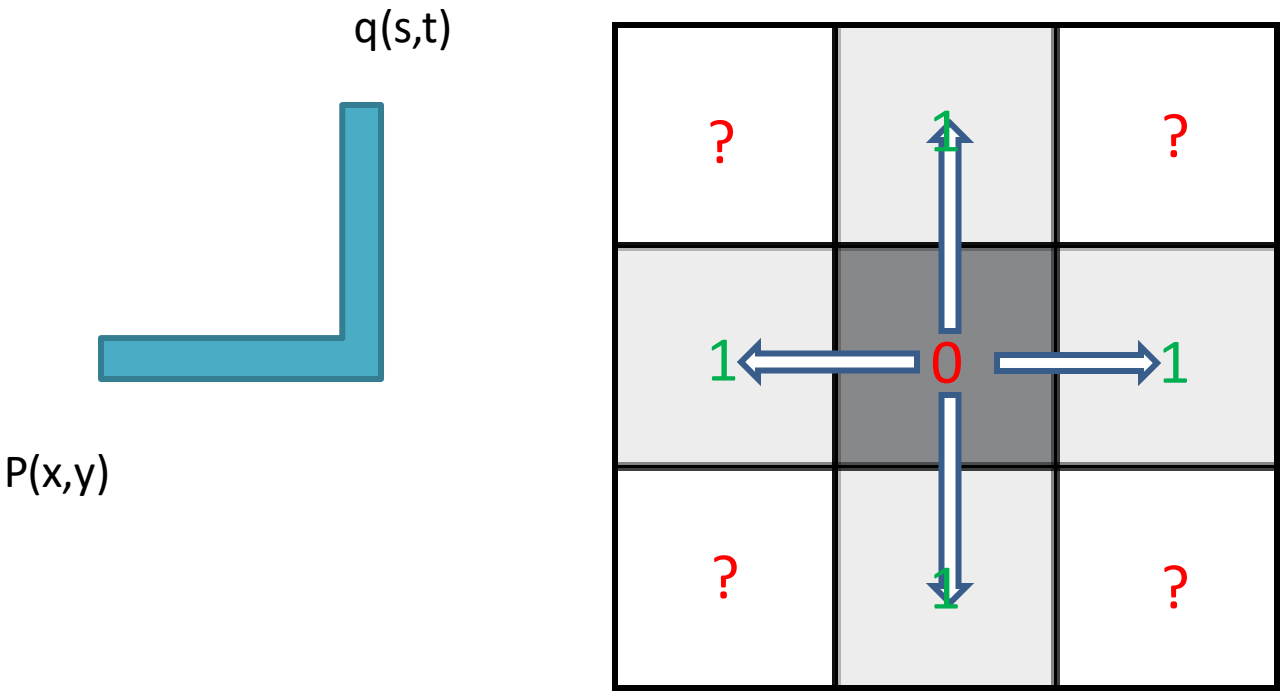


Calculate neighboring pixel distance if

1 small square = 1unit

Distance Measures

City block distance (D_4 distance)

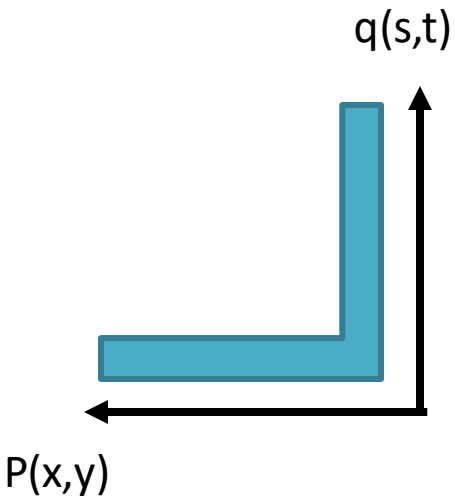


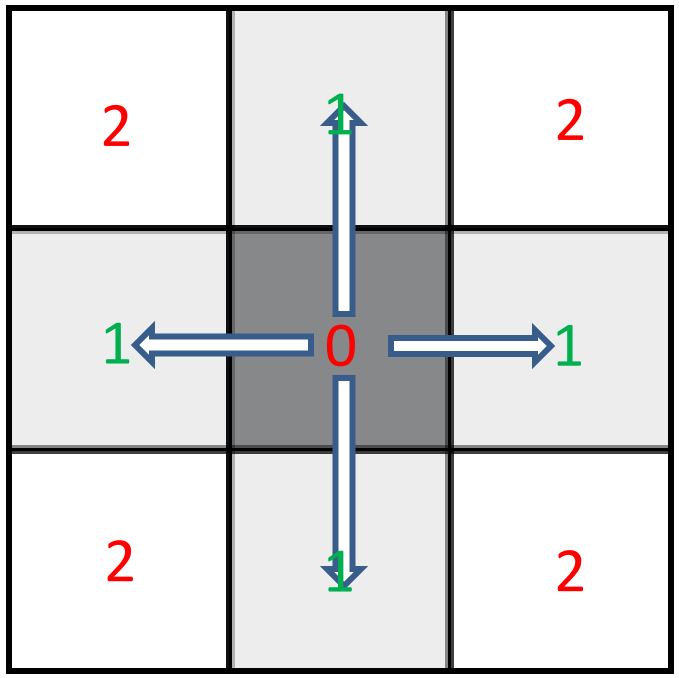
Calculate diagonal pixel distance if

1 small square = 1unit

Distance Measures

City block distance (D_4 distance)

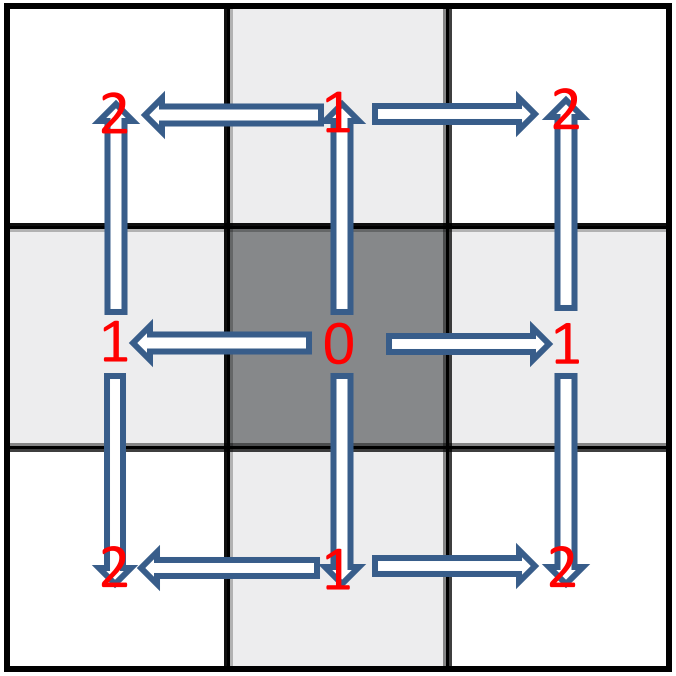




Can you write the equation to calculate the city block distance?

Distance Measures

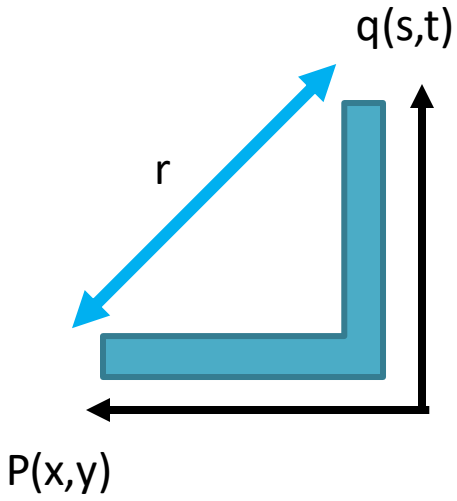
City block distance (D_4 distance)

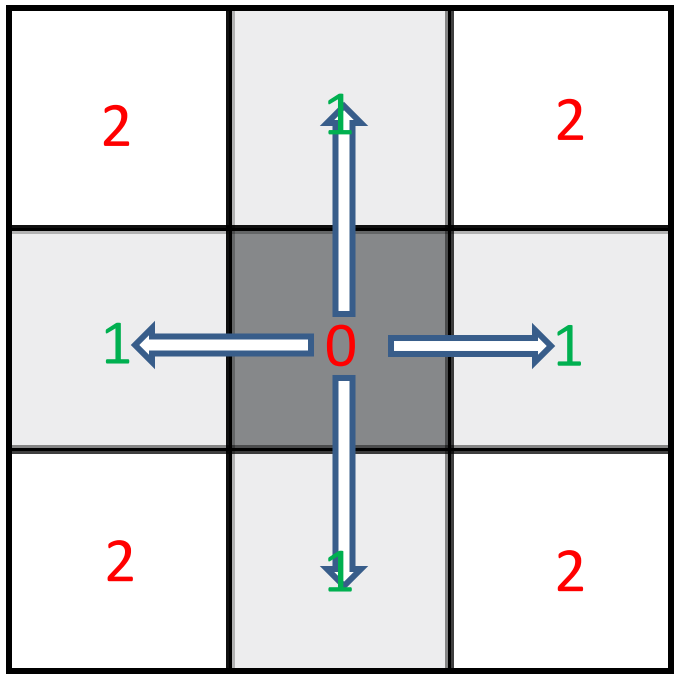


$$D_4(p,q) = |x-s| + |y-t|$$

Distance Measures

City block distance (D_4 distance)





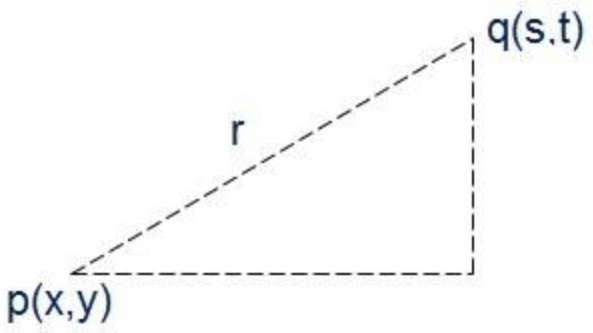
Can you write the equation to calculate the Euclidean distance?

Distance Measures

Euclidean Distance

$$D_e(p,q) = \sqrt{(x-s)^2 + (y-t)^2}$$

5	8	7	4	6
9	15	10	q(s,t)	2
17	14	1	5	18
27	2	9	19	22
p(x,y)	4	1	10	12

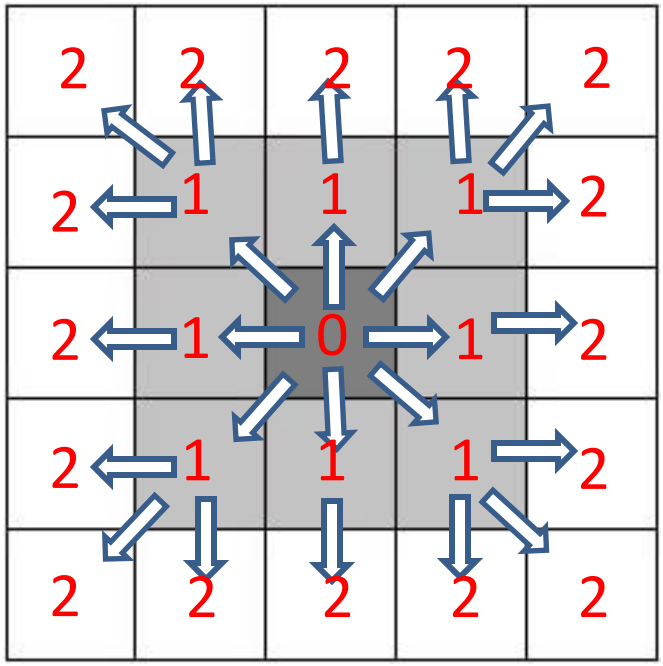


D = {(1-4)^2 + (1-4)^2}^0.5

D = 4.24

Distance Measures

Chessboard distance (D_8 distance)



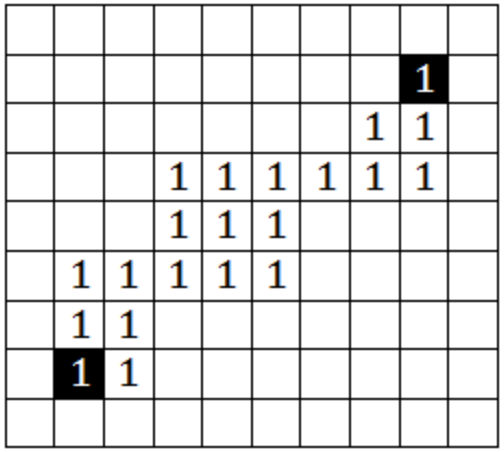
$D_8 = D_4 \cup D_d$

$$D_8(p,q) = \max(|x-s|, |y-t|)$$

Distance Measures

Find minimum number of pixels between highlighted pixels using

4 Connectivity ?
8 Connectivity ?
Euclidean Distance ?

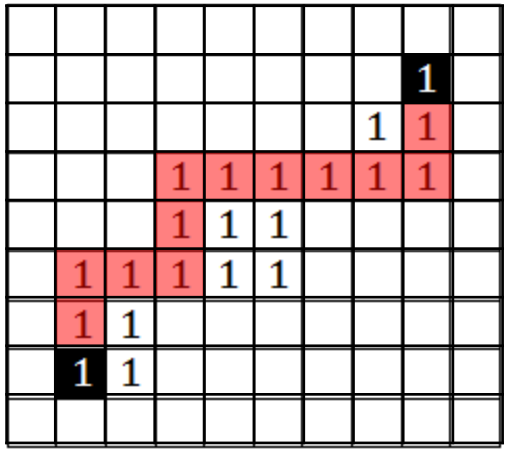


4 connectivity = 13

Distance Measures

Find minimum number of pixels between highlighted pixels using

4 Connectivity ?
8 Connectivity ?
Euclidean Distance ?

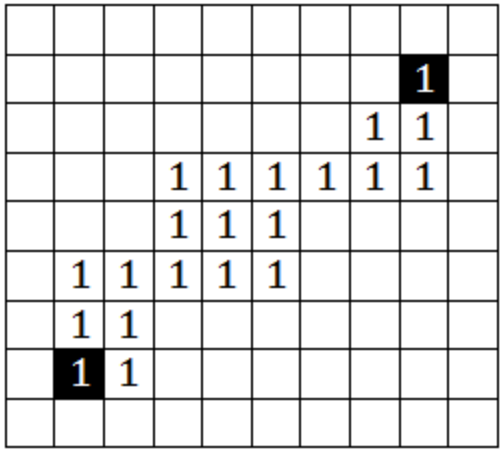


4 connectivity = 13

Distance Measures

Find minimum number of pixels between highlighted pixels using

4 Connectivity ?
8 Connectivity ?
Euclidean Distance ?



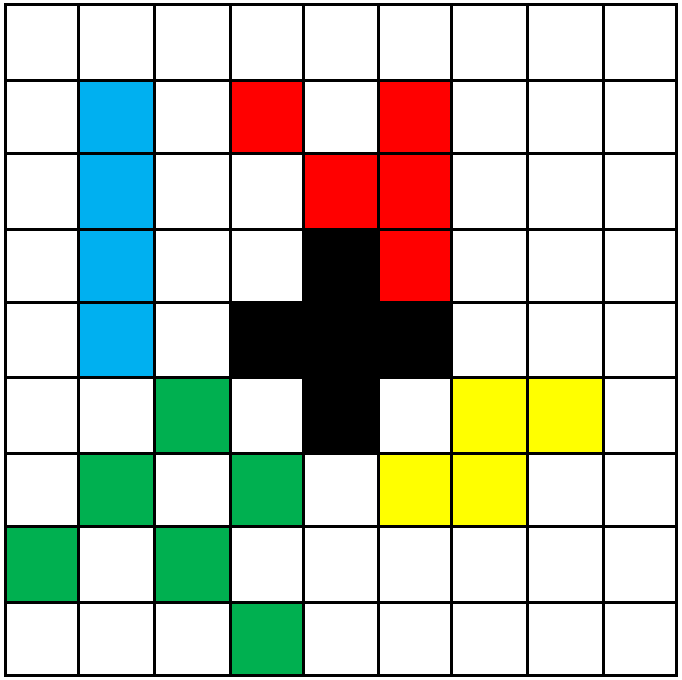
4 connectivity = 13

8 connectivity = 7

Euclidean Distance = 9.48

Distance Measures

Which color object is meeting the requirements for the 4 connectivity , 8 connectivity or both?



Black = 4 & 8 Connectivity

Red = 8 Connectivity

Yellow = 4 & 8 Connectivity

Green = 8 Connectivity

Blue = 4 & 8 Connectivity

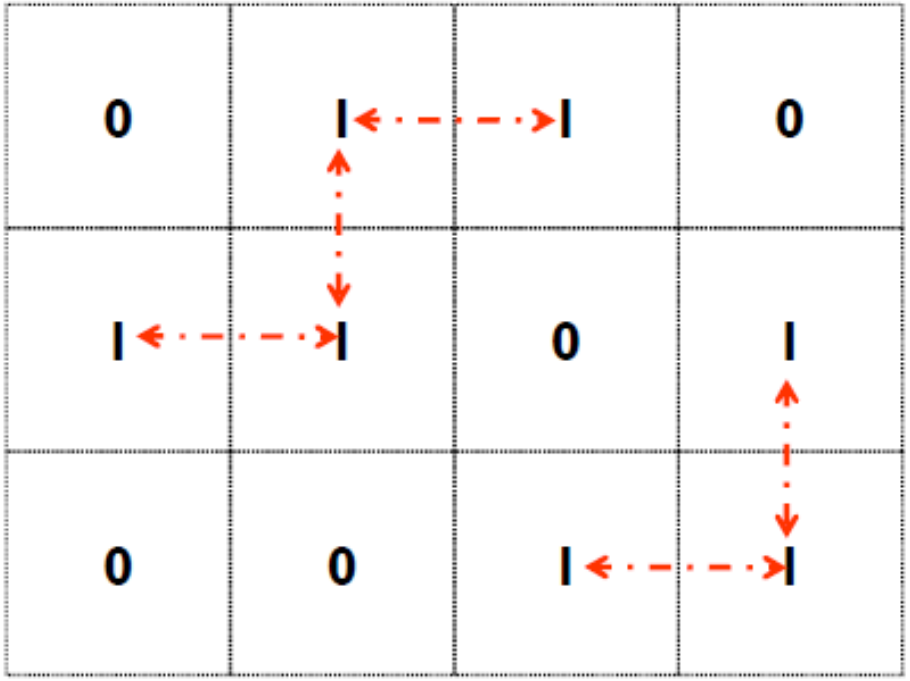
Connectivity

- Establishing boundaries of objects and components of regions in an image.
- Group the same region by assumption that the pixels are of same color or equal intensity
- Two pixels p & q are connected if
  - They are adjacent in some sense
  - If their gray levels satisfy a specified criterion of similarity

4-Connectivity

V: Set of gray levels used to define the criterion of similarity

p,q: Pixels being observed



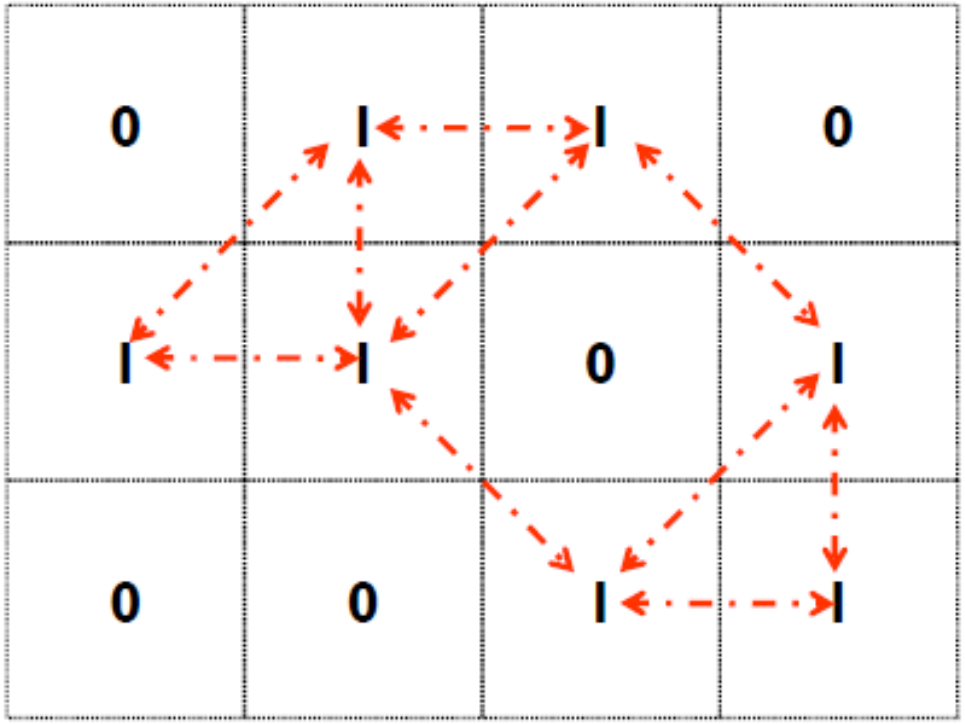
Set of gray levels V = {1}

$(p,q) \in V, and\ q \in N_4(p)$

8-Connectivity

V: Set of gray levels used to define the criterion of similarity

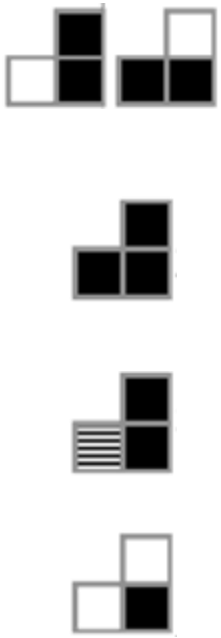
P,q: Pixels being observed



Set of gray levels V = {1}

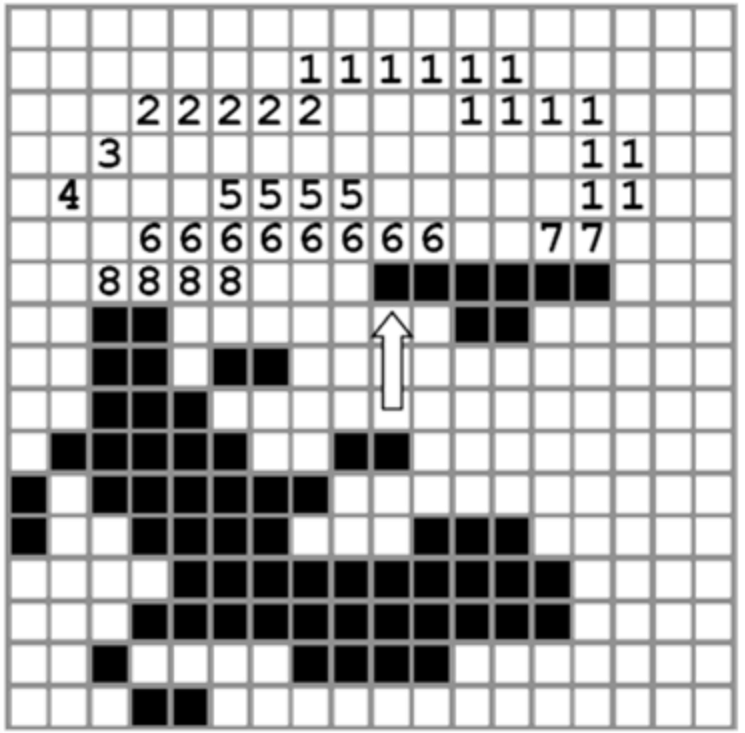
$$(p,q) \in V, and\ q \in N_8(p)$$

4-Connectivity Labeling



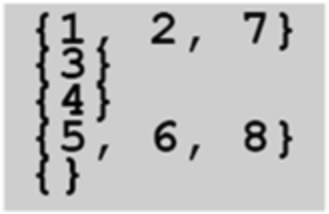
- Process the image from left to right, top to bottom:
  1.) If the next pixel to process is 1
    i.) If only one of its neighbors (top or left) is 1, copy its label.
    ii.) If both are 1 and have the same label, copy it.
    iii.) If they have different labels
      – Copy the label from the left.
      – Update the equivalence table.
    iv.) Otherwise, assign a new label.

Pass 1

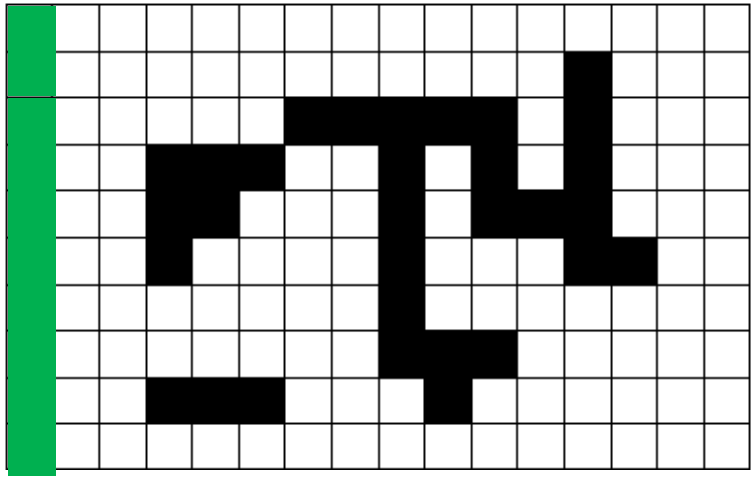


- Re-label with the smallest of equivalent labels

Pass 2



4-Connectivity Labeling

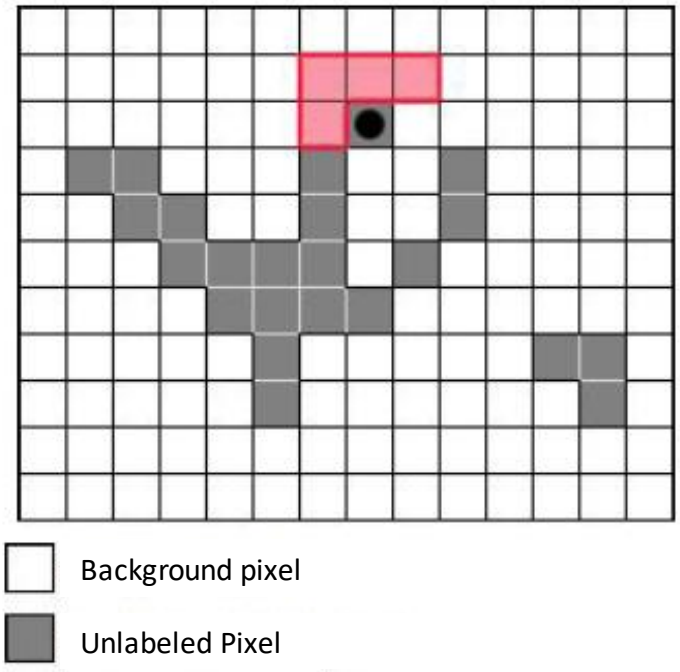


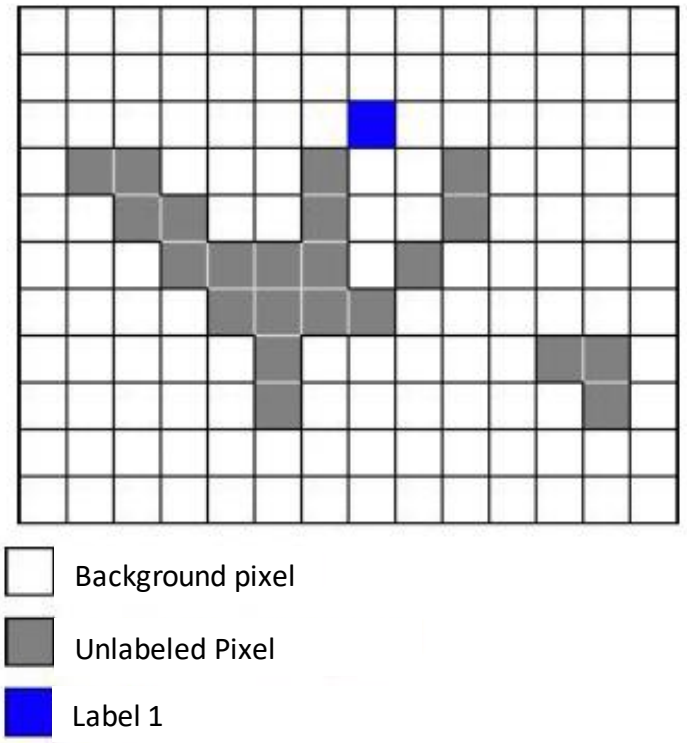
												1			
					2	2	2	2	2			1			
			3	3	3			2		2		1			
			3	3				2		2	2	2			
			3					2				2	2		
								2							
								2	2	2					
			4	4	4				2						

Table : 1 , 2
2
3
4

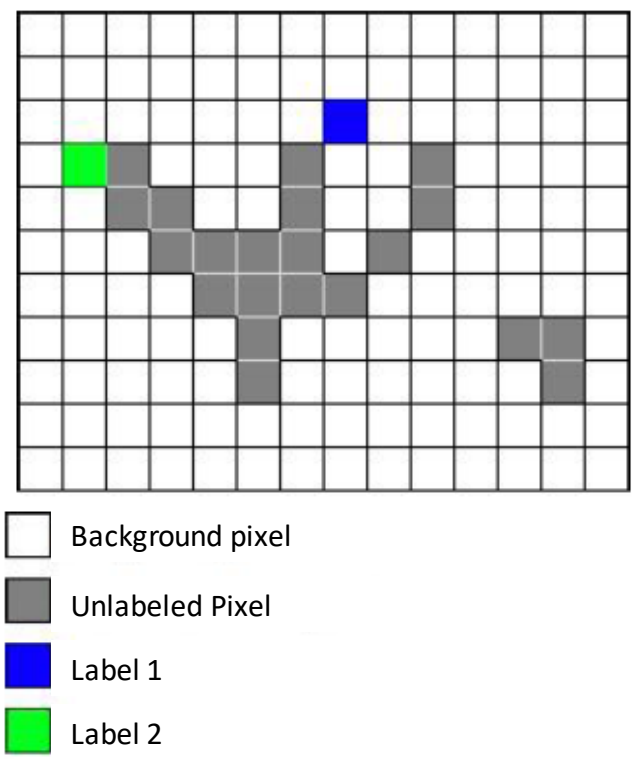
What will be values of table in second scan ?

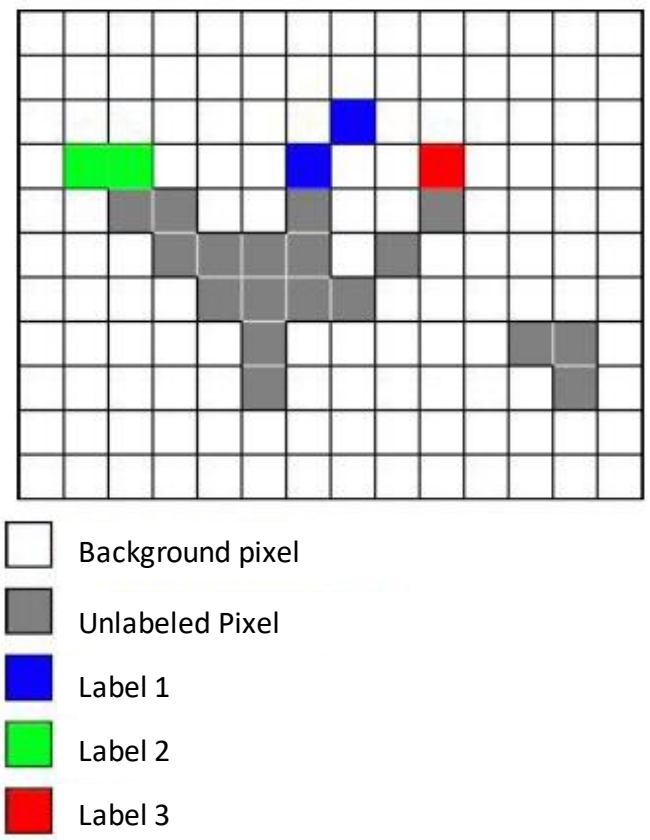
8-Connectivity Labeling



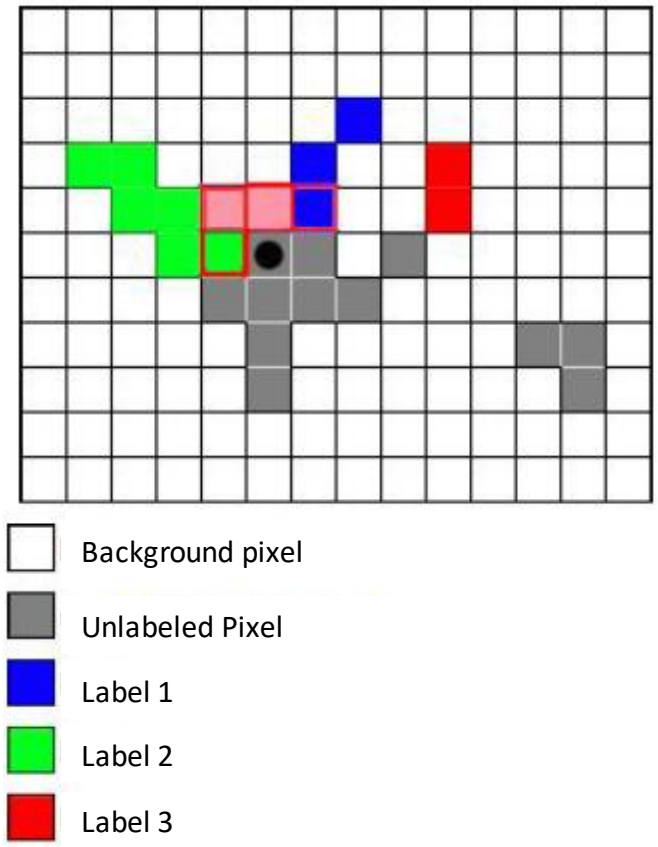


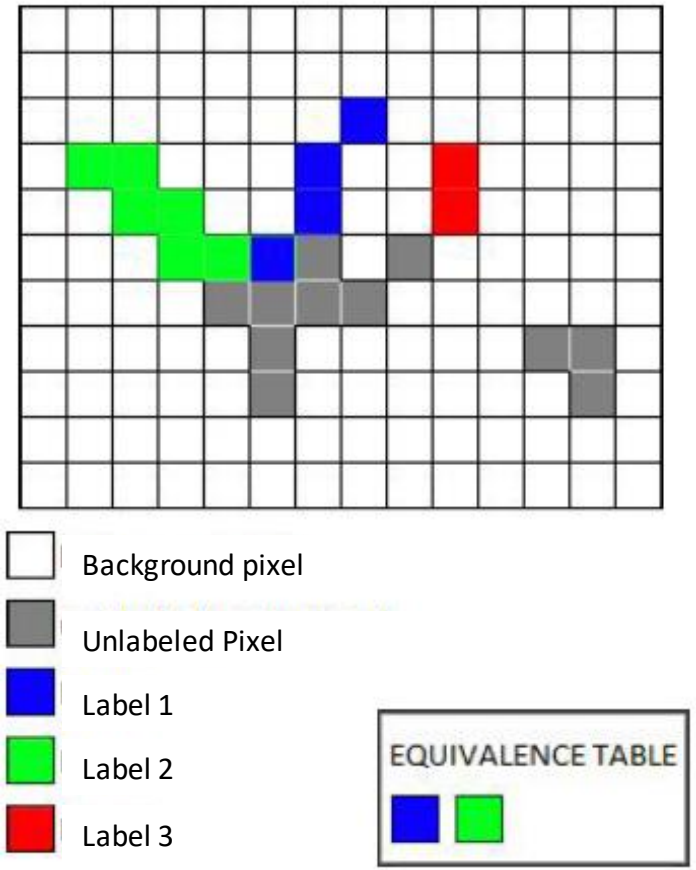
8-Connectivity Labeling



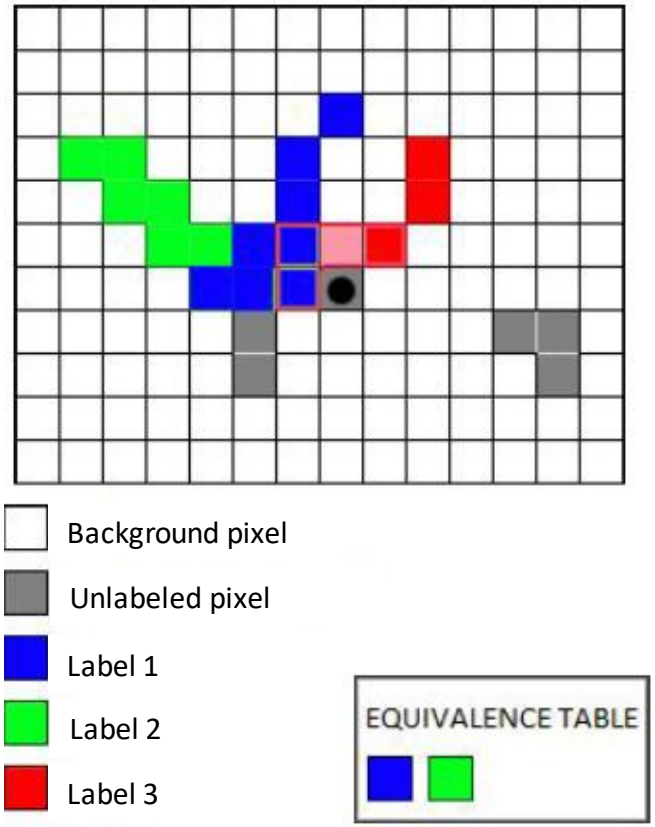


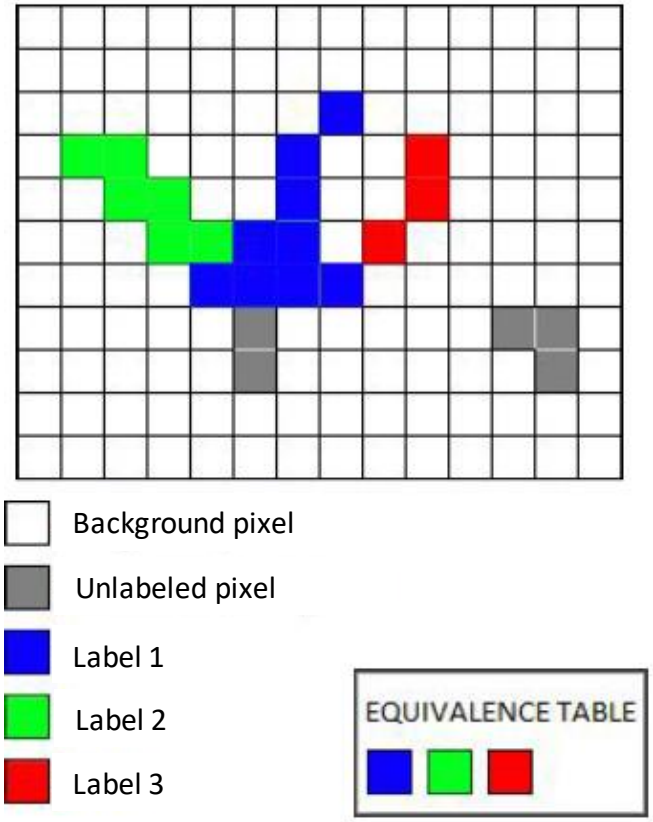
8-Connectivity Labeling



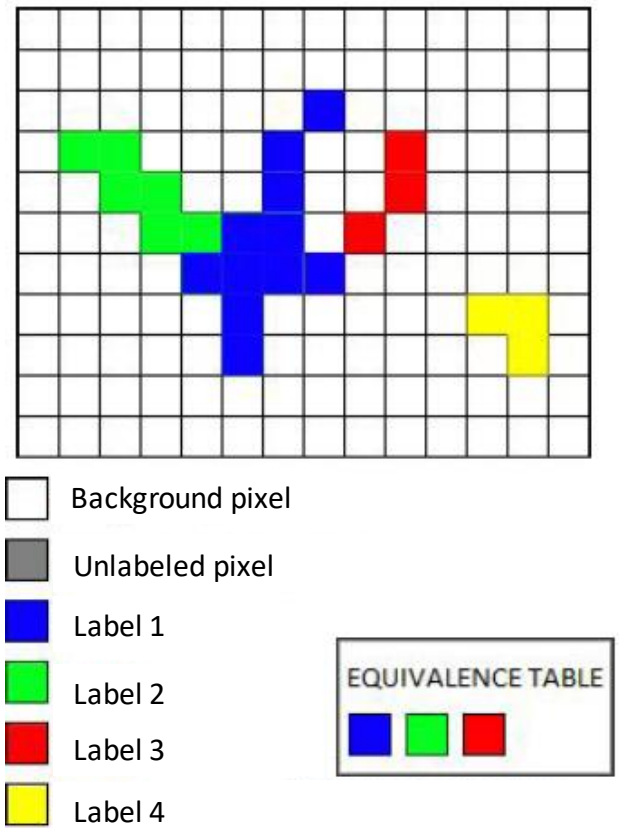


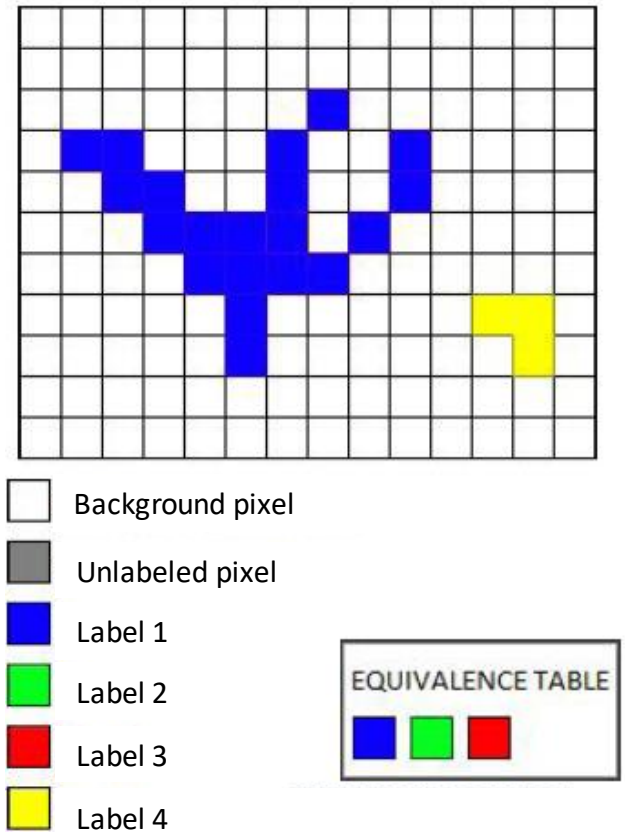
8-Connectivity Labeling





8-Connectivity Labeling

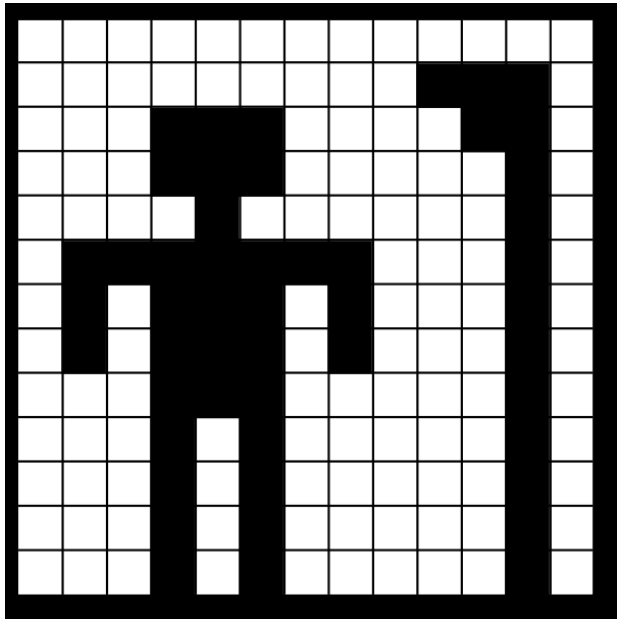




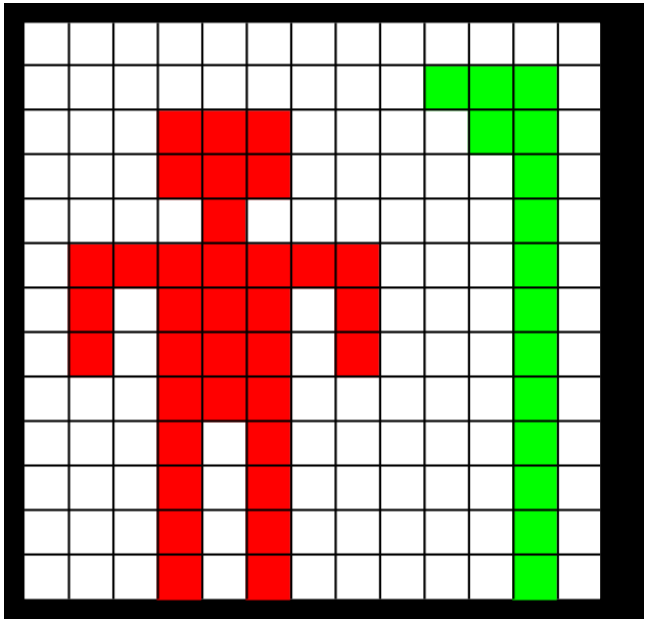
Labeling - Example

NUST

Original Image

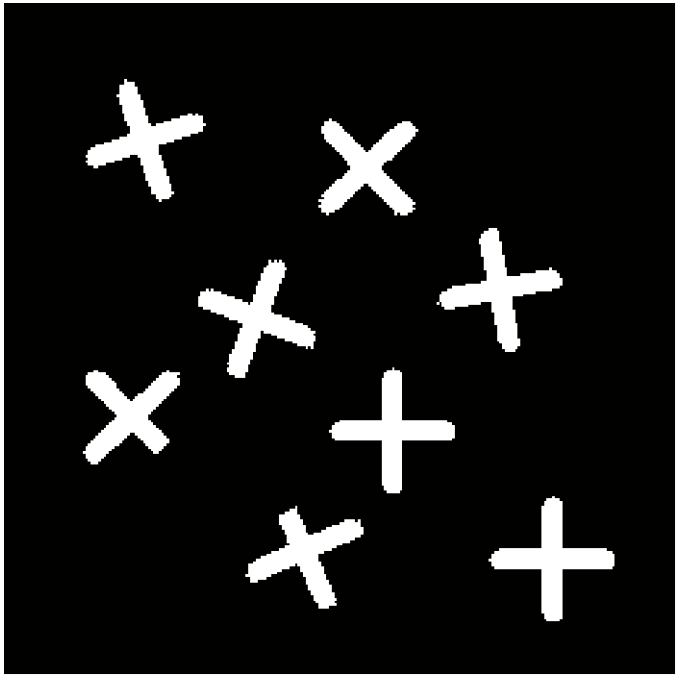


Labeled Objects

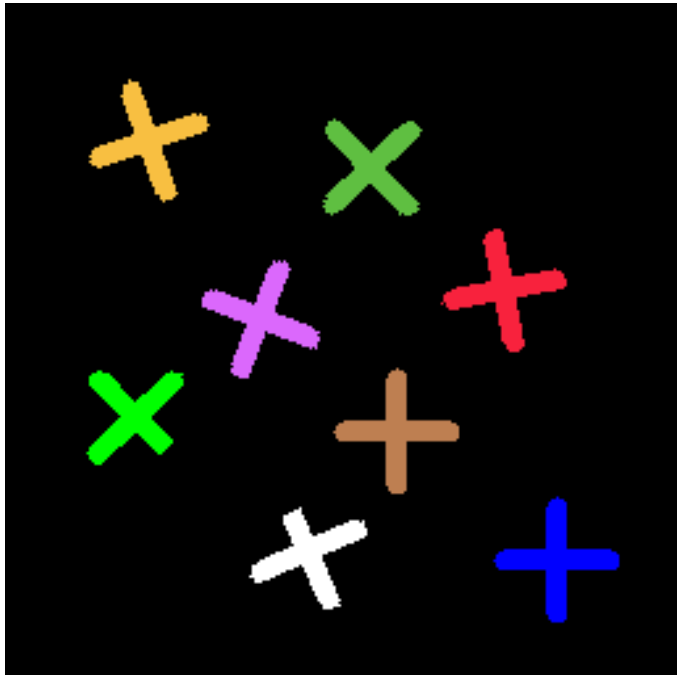


Labeling - Example

Original Image



Labeled Objects



End

Pixel Connectivity