Image Type & Image Representation

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- Multispectral Images.

2- **Image Representation. Some basic relationships between pixels:**

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- Connectivity.

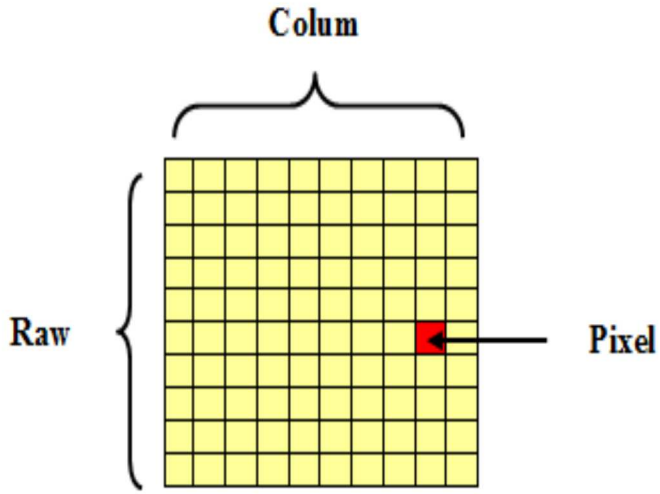

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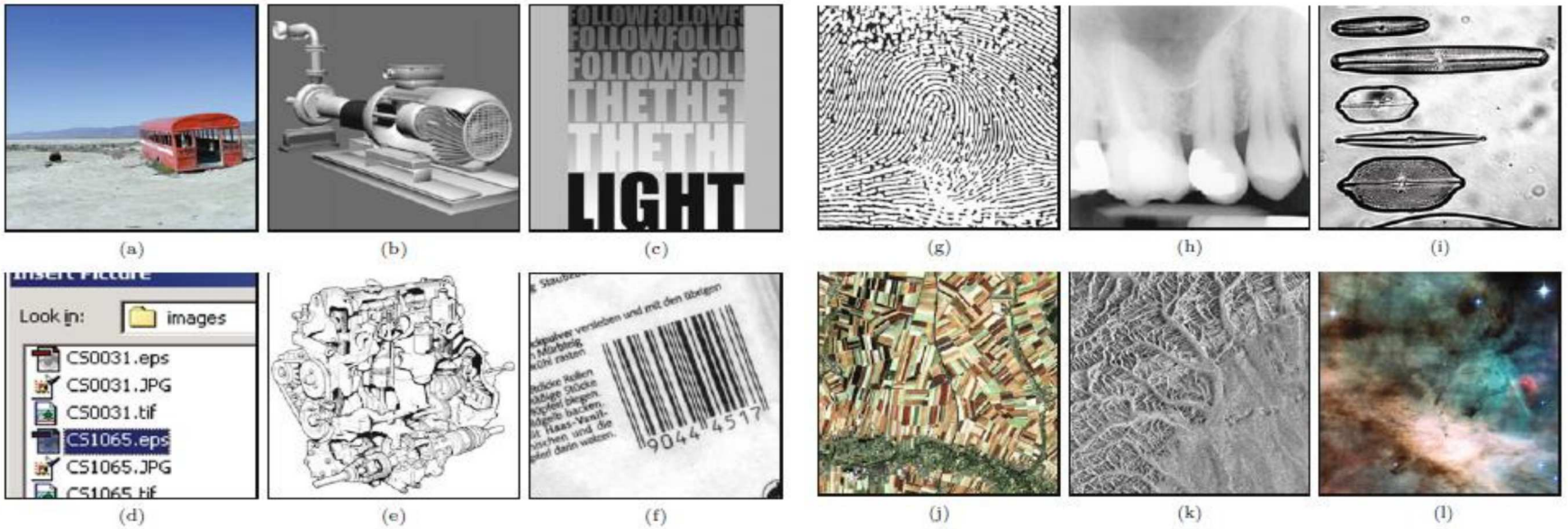
Image Type

Every day, people work with a large variety of digital raster images such as color photographs of people and landscapes, grayscale scans of printed documents, building plans, faxed documents, screenshots, medical images such as x-rays and ultrasounds, and a multitude of others (see Figure below for examples). Despite all the different sources for these images, they are all, as a rule, ultimately represented as rectangular ordered arrays of image elements.



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1- Binary image :

Binary images are images whose pixels have only two possible intensity values. They are normally displayed as black and white. Numerically, the two values are often 0 for black, and either 1 or 255 for white.

- **Binary images are often produced by thresholding a grayscale or color image, in order to separate an object in the image from the background.**
- **The color of the object (usually white) is referred to as the foreground color. The rest (usually black) is referred to as the background color**

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2- Grayscal image :

Grayscale is a range of monochromatic shades from black to white. Therefore, a grayscale image contains only shades of gray and no color.

- **Most image file formats support a minimum of 8-bit grayscale, which provides 2^8 or 256 levels of luminance per pixel.**
- **Some formats support 16-bit grayscale, which provides 2^{16} or 65,536 levels of luminance.**
- **Many image editing programs allow you to convert a color image to black and white, or grayscale. This process removes all color information, leaving only the luminance of each pixel.**

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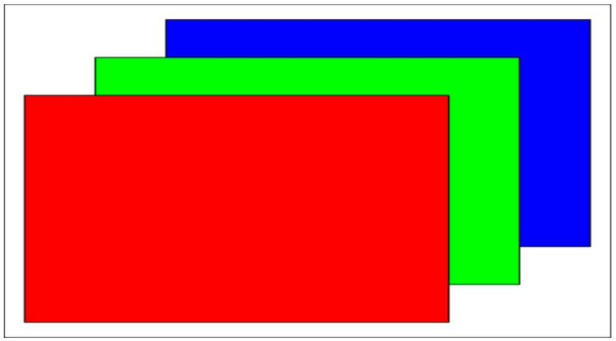
3- Color image :

Image consist of three components red, green and blue. These three components are combined together to produce composite colorful images. Each image pixel is formed by a number of bits.

- **The number of colors supported by RGB depends on how many possible values can be used for red, green, and blue. This is known as "color depth" and is measured in bits.**
- **The most common color depth is 24-bit color, also known as "true color." It supports eight bits for each of the three colors, or 24 bits total.**
- **This provides 2^8 , or 256 possible values for red, green, and blue. 256 x 256 x 256 = 16,777,216 total possible colors in the "true color" palette.**



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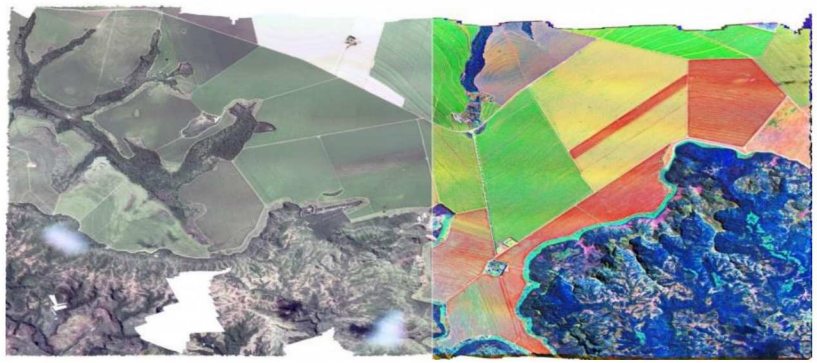
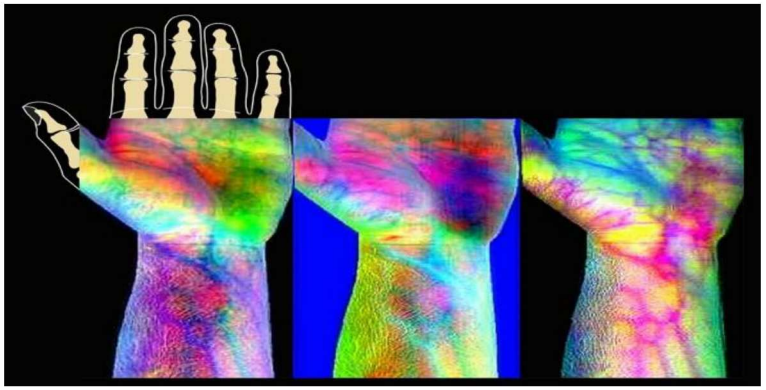
3- Multispectral Images :

Multispectral imaging measures radiation that's inherent to an object, regardless of the presence of any external light source.

- **This type of detection is also known as thermal imaging.**
- **The wavelengths may be separated by filters or detected via the use of instruments that are sensitive to particular wavelengths, including light from frequencies beyond the visible light range, i.e. infrared and ultra-violet.**

Spectral imaging can allow extraction of additional information the human eye fails to capture with its visible receptors for red, green and blue. It was originally developed for military target identification and reconnaissance.





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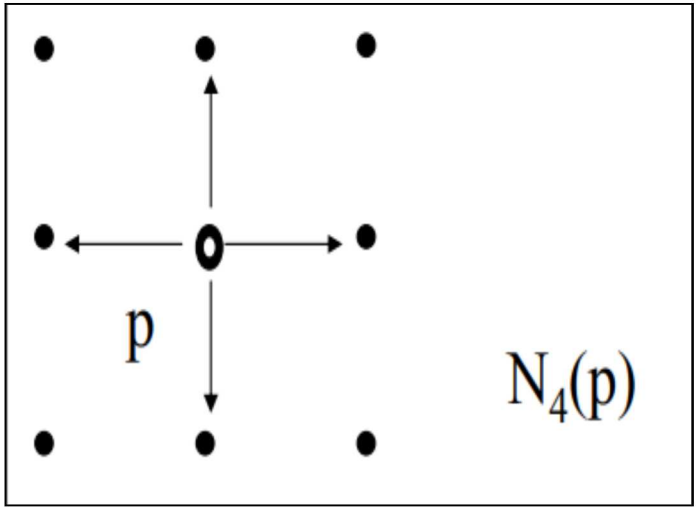
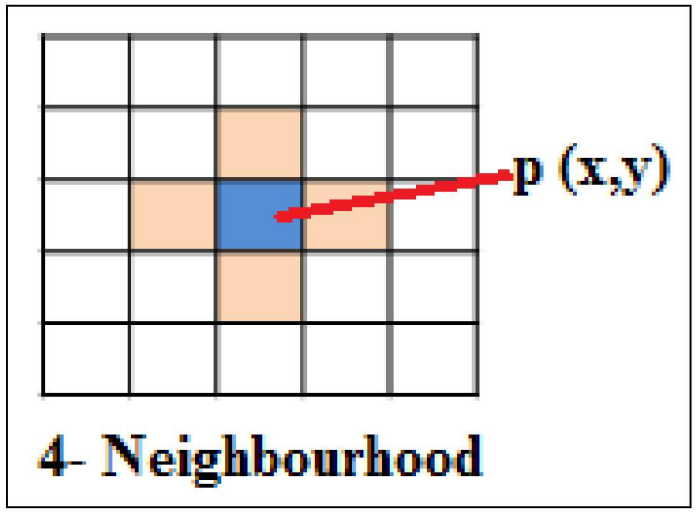
Basic relationship between pixels

1- Neighbors of pixel

Assuming that a pixel has the coordinates (x , y).

- **A pixel p has two horizontal neighbors (x−1, y), (x+1, y) and two vertical neighbors (x, y−1), (x, y+1). These 4 pixels together constitute the 4-neighbors of pixel p, denoted as $N_4(p)$.**





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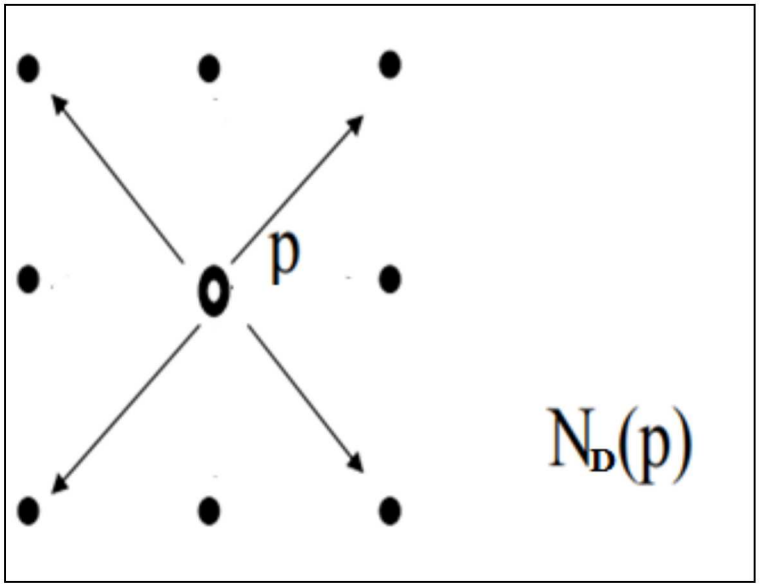
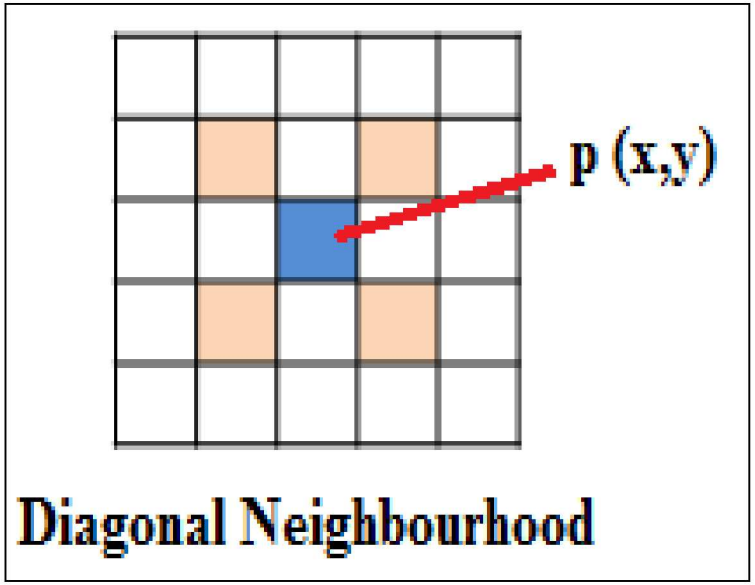
Assuming that a pixel has the coordinates (x , y).

- **The pixel p also has 4 diagonal neighbors which are: (x+1, y+1), (x+1, y−1), (x−1, y+ 1), (x−1, y−1). The set of 4 diagonal neighbors forms the diagonal neighborhood denoted as $N_D(p)$.**





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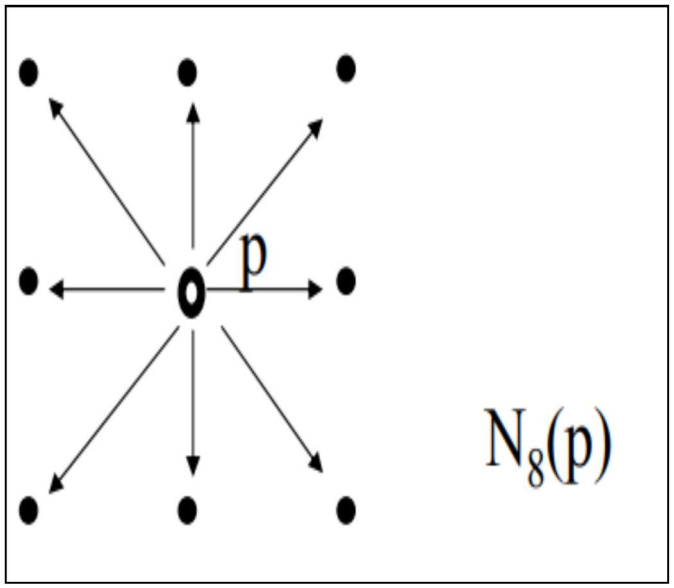
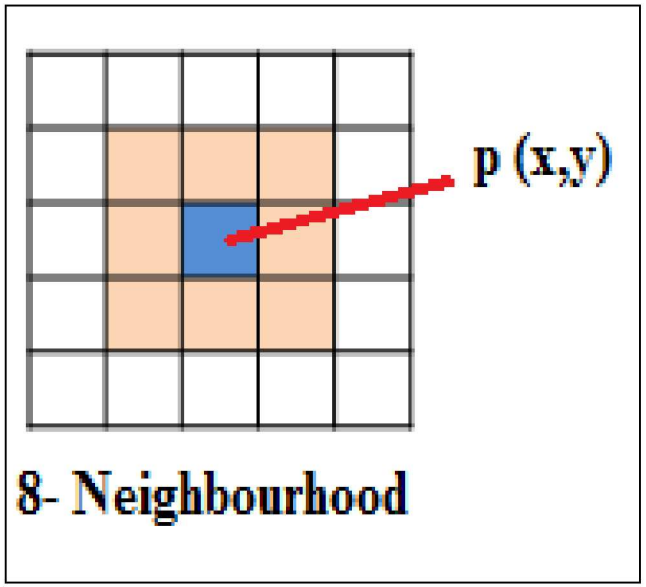
Assuming that a pixel has the coordinates (x , y).

- **The set of 8 pixels surrounding the pixel p forms the 8-neighborhood denoted as $N_8(p)$. We have $N_8(p) = N_4(p) \cup N_D(p)$.**





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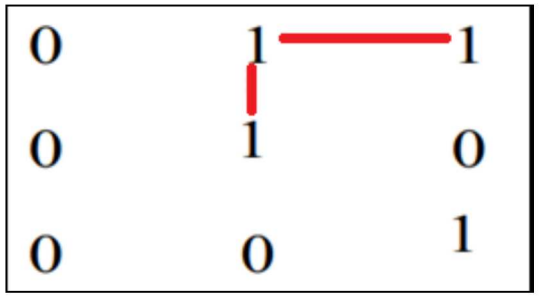
Basic relationship between pixels

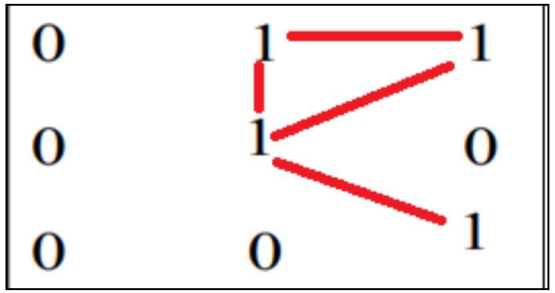
2- Adjacency, connectivity, regions, and boundaries

If two pixels are neighbors and their gray level values satisfy some specified criterion, then they are connected. A set of intensity values (V) is used to define adjacency and connectivity. There are three types of adjacency

4-adjacency: **Two pixels p and q with values from V are 8-adjacent if q is in the set $N_4(p)$**



8-adjacency: **Two pixels p and q with values from V are 8-adjacent if q is in the set $N_8(p)$**



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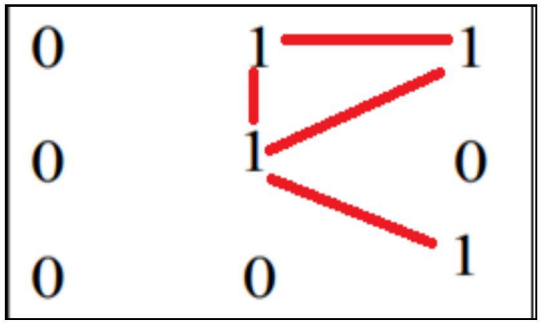
Mixed adjacency or m-adjacency : Two pixels p and q with values from V are m-adjacent if

- $q \in N_4(p)$

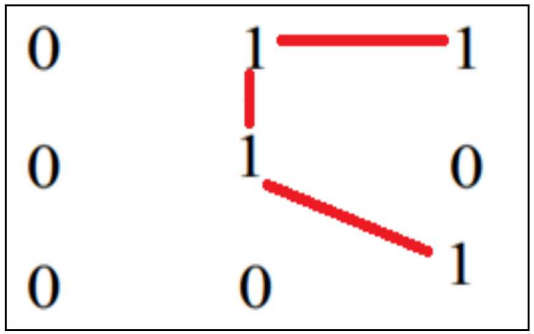
  Or

- $q \in N_D(p)$ **and the set** $N_4(p) \cap N_4(q)$ **has no pixel whose values are from v (No intersection).**

Mixed adjacency is a modification of 8-adjacency "introduced to eliminate the ambiguities that often arise when 8- adjacency is used. (eliminate multiple path connection)



8-adjacency



m-adjacency

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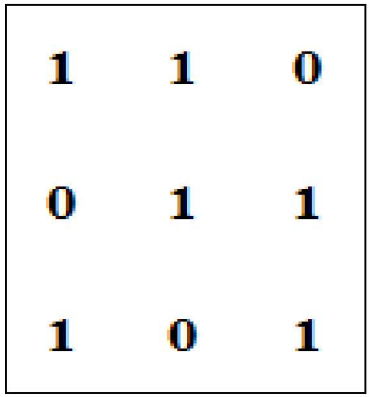
Example:

Consider the pixel arrangement shown in fig.(a) for V={1}.

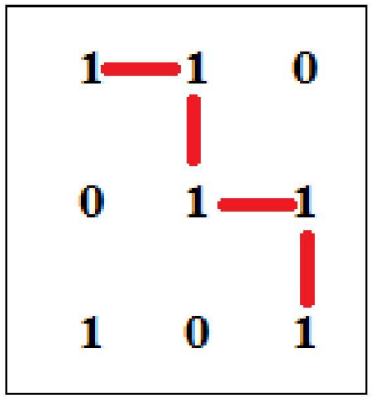
4-adjacency

8-adjacency

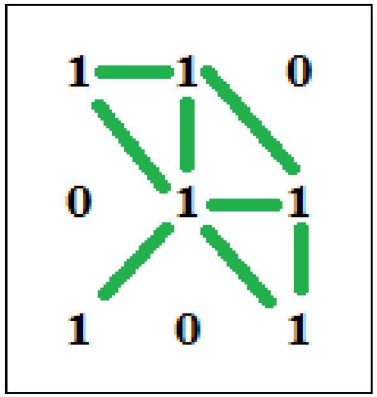
m-adjacency



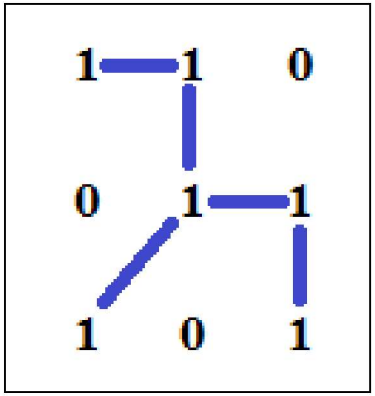
(a)



(b)
4-adjacency



(c)
8-adjacency



(d)
m-adjacency

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connectivity

Connectivity between pixels is important for establishing boundaries of objects and components of regions in an image

Let S represent a subset of pixels in an image. Two pixels p and q are said to be connected in S if there exists a path between them consisting entirely of pixels in S.

- **For any pixel p in S, the set of pixels that are connected to it in S is called a connected component of S.**
- **If it only has one connected component, then set S is called a connected set.**

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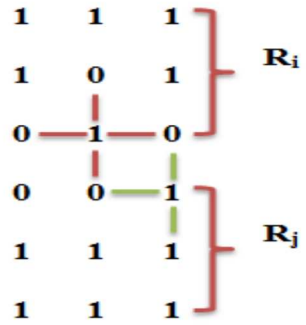
Region

Let R to be a subset of pixels in an image, we call a R a region of the image If R is a *connected* set.

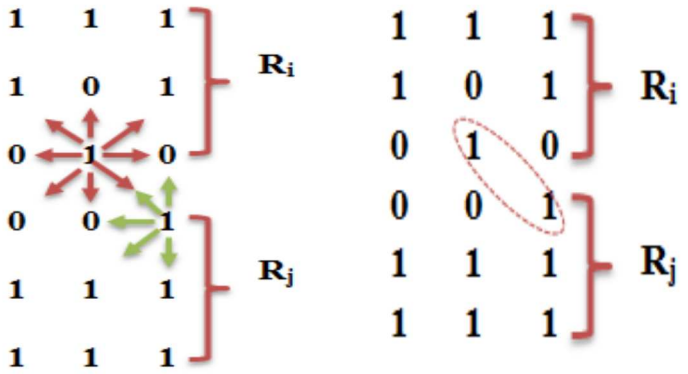
- **Two regions Ri and Rj are said to be adjacent if their union forms a connected set.**
- **Region that are not adjacent are said to be disjoint.**
- **We consider 4- and 8- adjacency when referring to region.**

***Example*:**

The two regions (of 1s) in figure, are adjacent only if 8-adjacany is used.



A 4-path between the two regions does not exist



The two regions are adjacent only if 8-adjacent is used

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Boundaries

The boundary of the region R is the set of pixels in the region that have one or more neighbors that are not in R.

If R happens to be an entire image, then its boundary is defined as the set of pixels in the first and last rows and columns of the image.