Image Processing

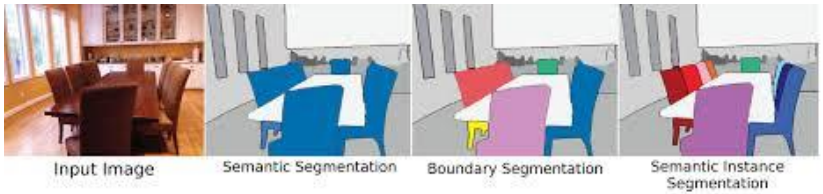
Segmentation

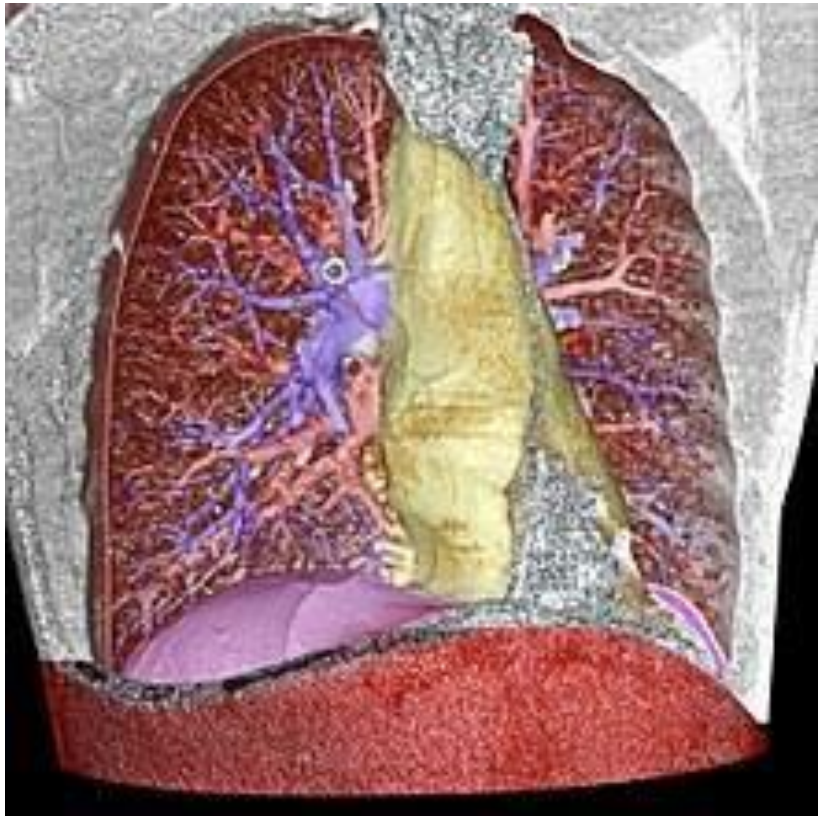
Slide Title

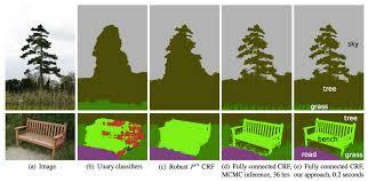
- **Segmentation Detention**
- **In Edge-based Segmentation**
- **Image Thresholding Techniques**
- ***Region Growing***

Segmentation

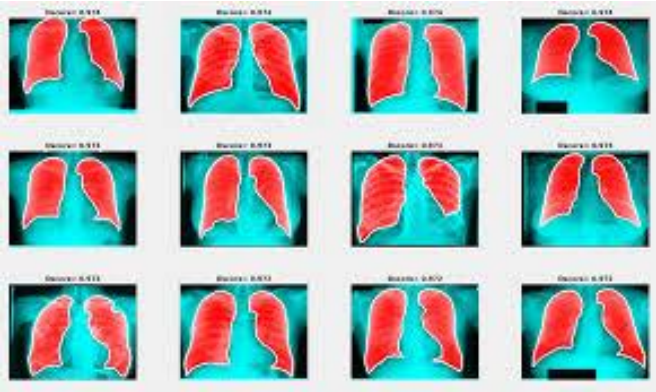
- Image Segmentation Is The Division Of An Image Into Regions Or Categories, Which Correspond To Different Objects Or Parts Of Objects.
- Every Pixel In An Image Is Allocated To One Of A Number Of These Categories.
- A Good Segmentation Is Typically One In Which:
  - ❖ Pixels In The Same Category Have Similar Greyscale Of Multivariate Values And Form A Connected Region,
  - ❖ Neighbouring Pixels Which Are In Different Categories Have Dissimilar Values.

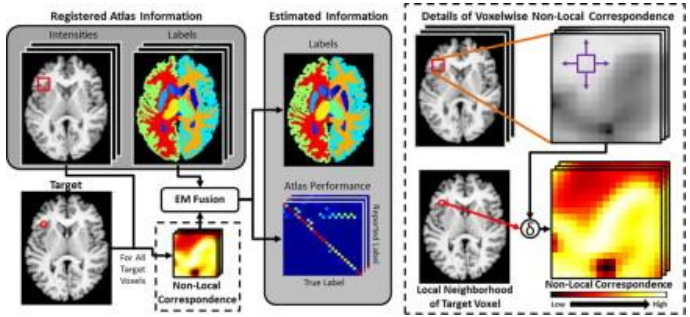

Input Image
Semantic Segmentation
Boundary Segmentation
Semantic Instance Segmentation

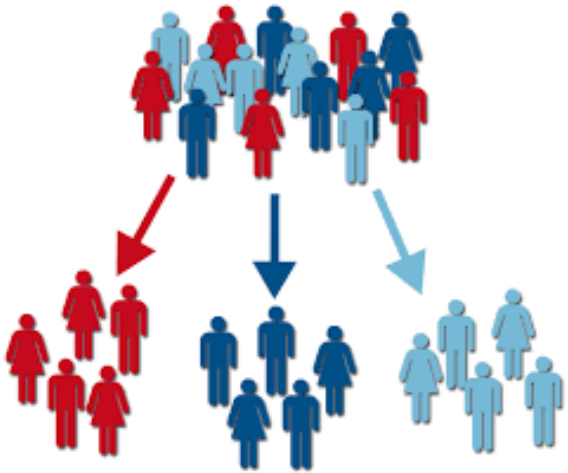



sky
tree
grass
tree
bench
road
grass


Segmentation





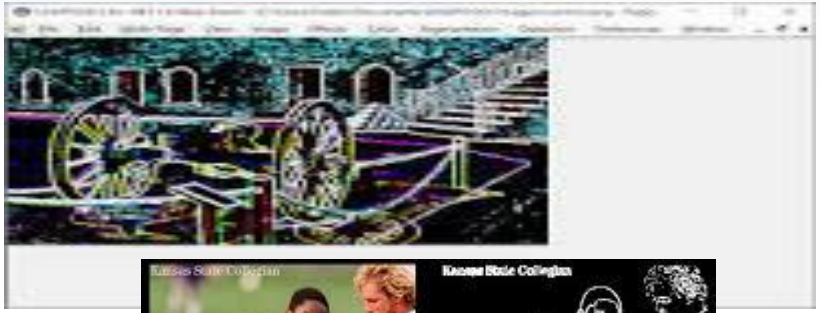


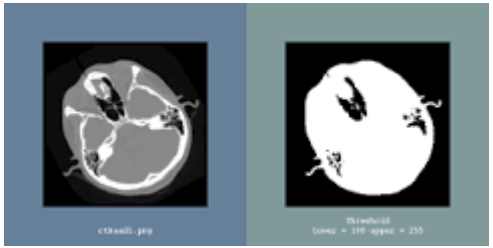
segmentations

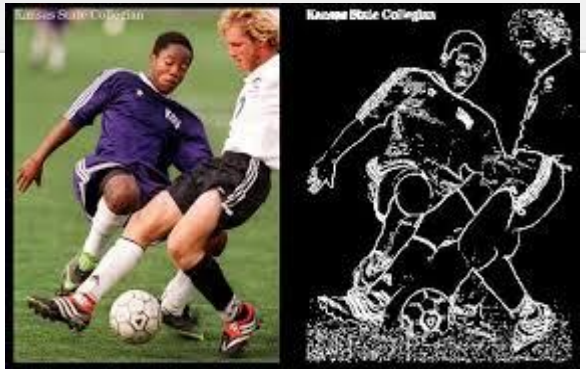
- An image is thus defined by a set of regions that are connected and nonoverlapping, so that each pixel in the image acquires a unique region label that indicates the region it belongs to.
- Segmentation algorithms are based on one of the two basic properties of gray-level values ***discontinuity*** **and** ***similarity among the pixels*****.**
- There are three general approaches to segmentation, termed thresholding, edge-based methods and region-based methods.

In edge-based segmentation

- an edge filter is applied to the image, pixels are classified as edge or non-edge depending on the filter output, and pixels which are not separated by an edge are allocated to the same category.



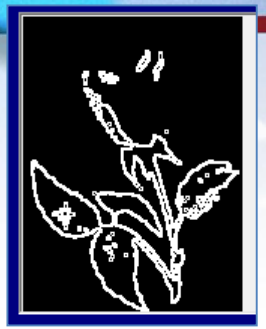




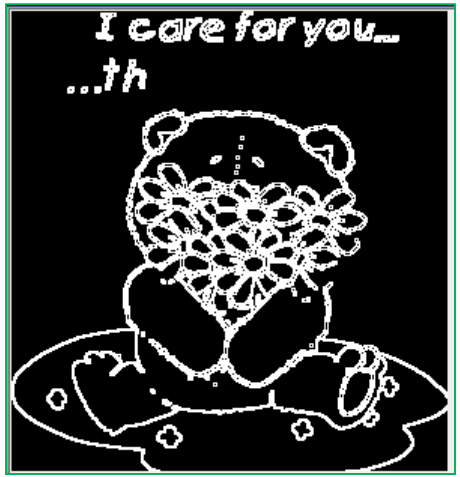
Edge Detection

- Detecting edges is a basic operation in image processing. The edges of items in an image hold much of the information in the image.
- The edges tell you where:
  - items are.
  - their size.
  - shape
  - and something a bout their texture.

- Edge detection methods are used as a first step in the line detection processes.
- they are used to find object boundaries by marking potential edge points corresponding to place in an image where rapid changes in brightness occur.
- After these edge points have been marked, they can be merged to form lines and objects outlines.




I care for you...
...th

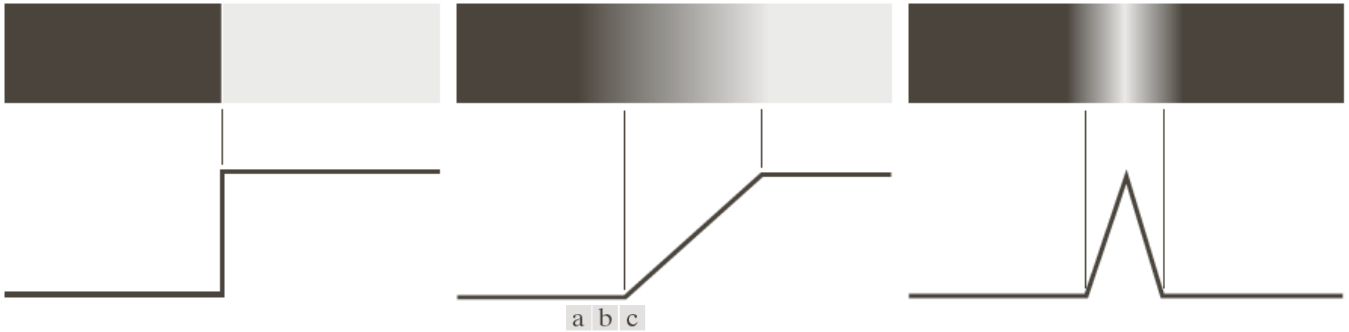

I care for you...
...th

Methods of detection edge / line

- ✓ Edge detection operations are based on the idea that edge information in an image is found by looking at the relationship a pixel has with its neighbors.
- ✓ If a pixel gray_level values similar to those a round it, there is probably not an edge at that point at that point. However, if a pixel has neighbors with widely varying gray levels, it may represent an edge point. In other words, an edge is defined by a discontinuity in gray-level values.
- ✓ Ideally, an edge separates two distinct objects. In practice, edges are caused by:
  - Change in color or texture or
  - Specific lighting conditions present during the image acquisition process.

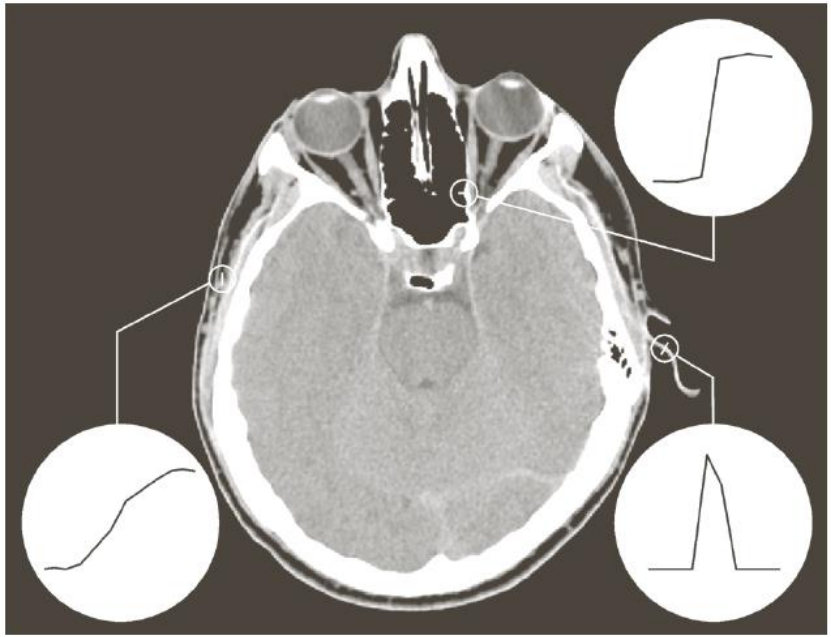
Edge Detection

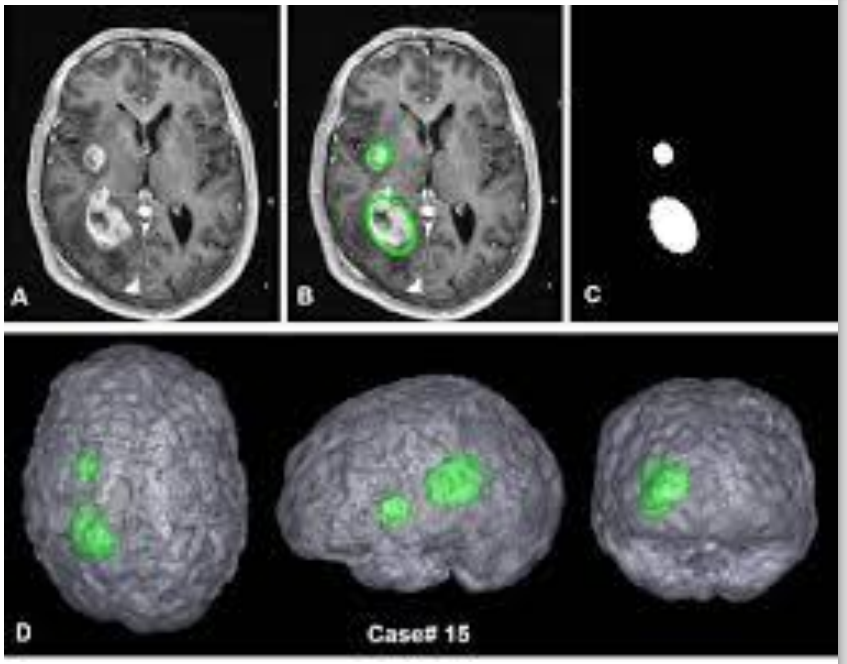
- Edges are pixels where the brightness function changes abruptly
- Edge models



a b c

FIGURE 10.8
From left to right, models (ideal representations) of a step, a ramp, and a roof edge, and their corresponding intensity profiles.




A
B
C
D
Case# 15

To detect the edge/line detection we need to use same mask to detect the edge or line in any image. There are many masks use to detect the edge/line .The masks are:

1. Roberts operator
2. Sobol operator
3. Prewitt operator
4. Kirsch compass masks
5. Robinson compass masks
6. Laplacian operator
7. LoG edge detection
8. Cany edge detection

Sobel edge detection operator

- The Sobel method of edge detection for image segmentation finds edges using the Sobel approximation to the derivative. It precedes the edges at those points where the gradient is highest. The Sobel technique performs a 2-D spatial gradient quantity on an image and so highlights regions of high spatial frequency that correspond to edges.

Example: Sobel Operator

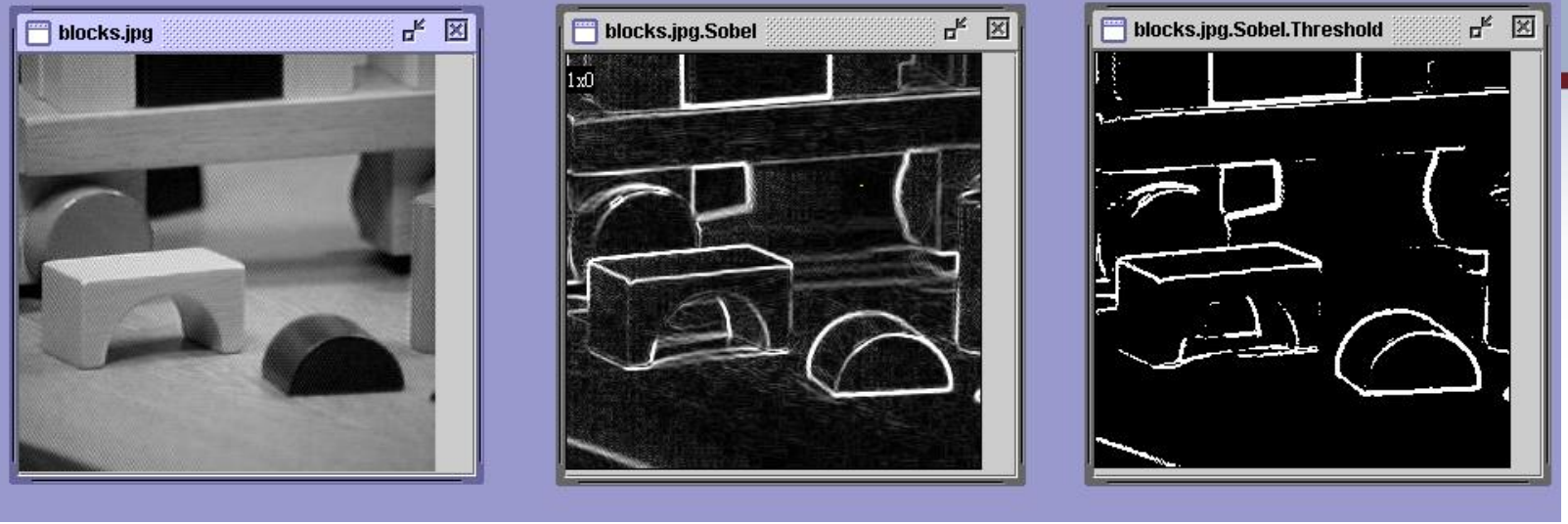
$$Sx = \begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix} \qquad Sy = \begin{pmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{pmatrix}$$

On a pixel of the image

- let gx be the response to Sx
- let gy be the response to Sy

Then $g = (gx^2 + gy^2)^{1/2}$ is the gradient magnitude.

$\theta = \text{atan2}(gy, gx)$ is the gradient direction.



original image

gradient magnitude

thresholded gradient magnitude

LoG edge detection

The Laplacian of Gaussian (LoG) was proposed by Marr(1982). The LoG of an image f(x $\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2}$ ond order derivative defined as,

It has two effects, it smooths the image and it computes the Laplacian, which yields a double edge image. Locating edges then consists of finding the zero crossings between the double edges. The digital implementation of the Laplacian function is usually made through the mask below,

0	-1	0
-1	4	-1
0	-1	0

G_x

-1	-1	-1
-1	8	-1
-1	-1	-1

G_y

The Laplacian is generally used to found whether a pixel is on the dark or light side of an edge.

Canny Edge Detection

In industry, the Canny edge detection technique is one of the standard edge detection techniques. It was first created by John Canny for his Master's thesis at MIT in 1983, and still outperforms many of the newer algorithms that have been developed. To find edges by separating noise from the image before find edges of image the Canny is a very important method. Canny method is a better method without disturbing the features of the edges in the image afterwards it applying the tendency to find the edges and the serious value for threshold.

Ex:- apply Sobel operation for edge detection

3	**9**	**7**
2	4	9
1	8	6

3	**9**	**7**
2	7	9
1	8	6

3	9	7
2	4	3
1	8	6

×

-1	-2	-1
0	0	0
1	2	1

=

-3-18-7+1+16+6= - 5

S1

3	9	7
2	4	3
1	8	6

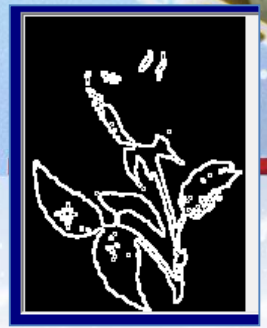
×

-1	**0**	**1**
-2	0	2
-1	0	1

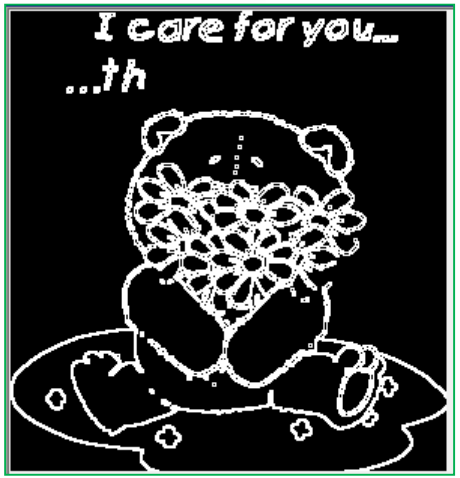
=

-3+7-4+6-1+6 = -5

S2

Sobel operator



6.Laplacian Operator

-1	**-1**	**-1**
-1	8	-1
-1	-1	-1

The Laplacian operator described here are similar to the ones used for pre-processing (as described in enhancement filter).

The three Laplacian masks that follow represent different approximation of the Laplacian masks are rationally symmetric, which means edges at all orientation contribute to the result. They are applied by selecting one mask and convolving it with the image selecting one mask and convolving it with the image.

0	**-1**	**0**
-1	4	-1
0	-1	0

0	**-2**	**0**
-2	4	-2
0	-2	0

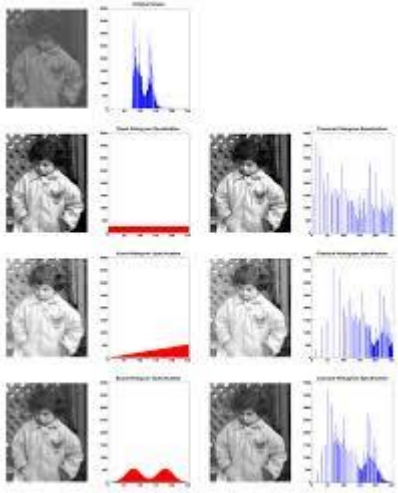
In Thresholding

- pixels are allocated to categories according to the range of values in which a pixel lies.
- Pixels with values less than 128 have been placed in one category, and the rest have been placed in the other category.
- The boundaries between adjacent pixels in different categories has been superimposed in white on the original image.
- It can be seen that the threshold has successfully segmented the image into the two predominant fibre types.

- Histogram-based thresholding
- Multivariate classifiers
- Contextual classifiers

1. Histogram-based thresholding

We will denote the histogram of pixel values by h0,h1,...,hN, where hk specifies the number of pixels in an image with greyscale value k and N is the maximum pixel value (typically 255).



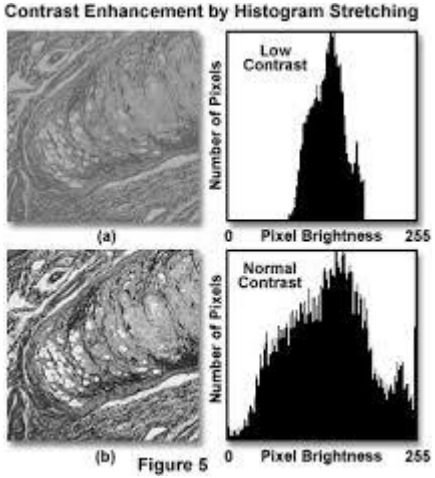
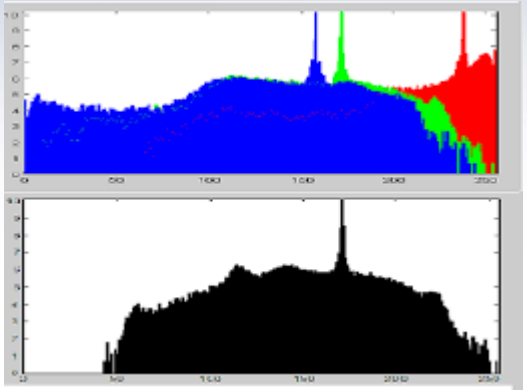
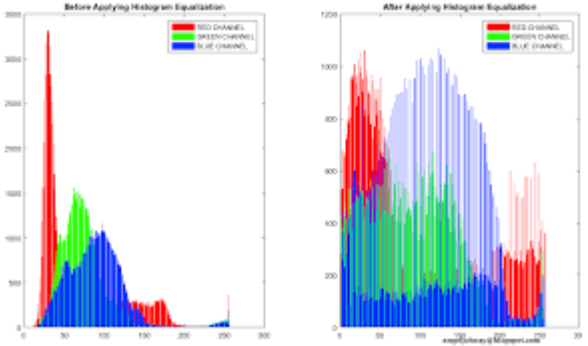


Figure 5





2. Multivariate classifiers

- Multivariate thresholding criteria are more difficult to specify than univariate ones.
- Therefore the approach often adopted in a segmentation which is manual (i.e. under the user's control) is to choose pixels which are known to belong to target categories (known as the training set)
- and then use them to classify the rest of the image. This is called supervised classification.

3. Contextual classifiers

Thresholding is most successful when there is little overlap in distributions of pixel values from the different categories in an image. Noise is one cause of overlap, which can be reduced by using a smoothing filter. Unfortunately, filters, linear ones in particular, also blur edges to some extent and therefore produce pixels with values intermediate between category means.

region-based segmentation algorithms

operate iteratively by grouping together pixels which are neighbors and have similar values and splitting groups of pixels which are dissimilar in value.

Segmentation may be regarded as **spatial clustering**:

- *clustering* in the sense that pixels with similar values are grouped together, and
- *spatial* in that pixels in the same category also form a single connected component.

Clustering algorithms may be agglomerative, divisive or iterative .Region-based methods can be similarly categorized into:

- those which **merge** pixels,
- those which **split** the image into regions, and
- those which both **split-and-merge** in an iterative search scheme.

splitting groups of pixels which are heterogeneous in value. Three methods were considered:

- Regions may be grown from manually-positioned `seed' points, for example, by applyinga watershed algorithm to output from Prewitt's Filter.

- The watershed algorithm may also be run fully automatically, for example, by using local minima from a variance Filter as seed points.

- One split-and-merge algorithm finds a partition of an image such that the variance in pixel values within every segment is below a specified threshold, but no two adjacent segments can be amalgamated without violating the threshold.