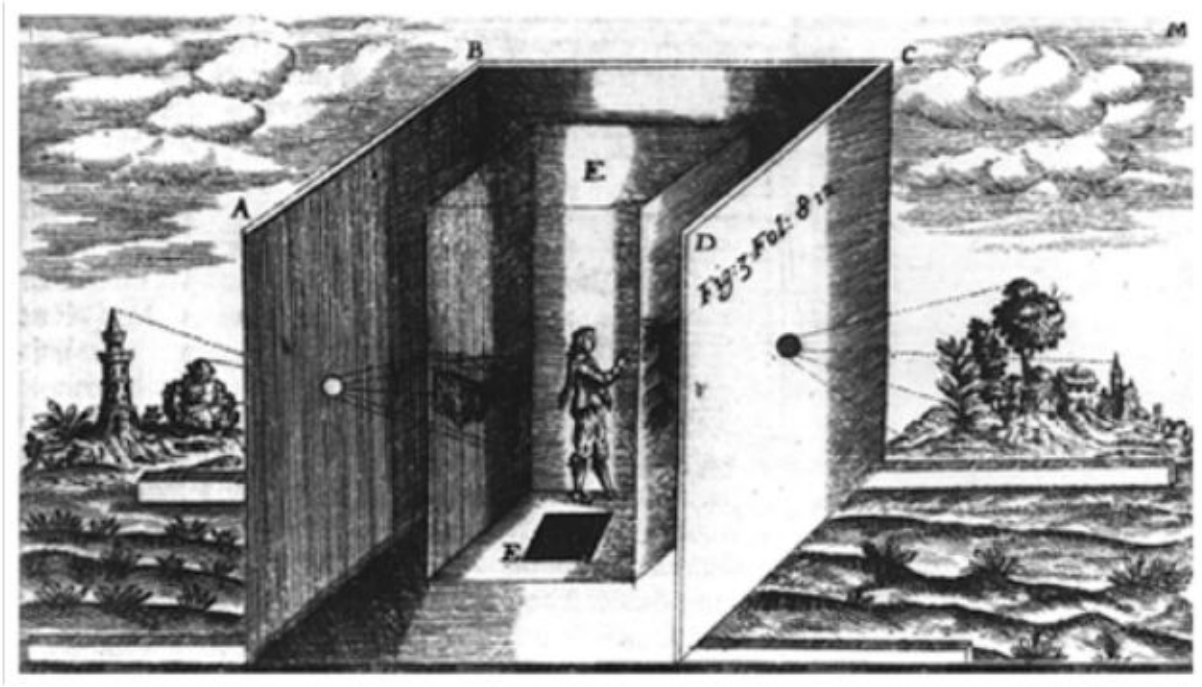
Digital Image Processing

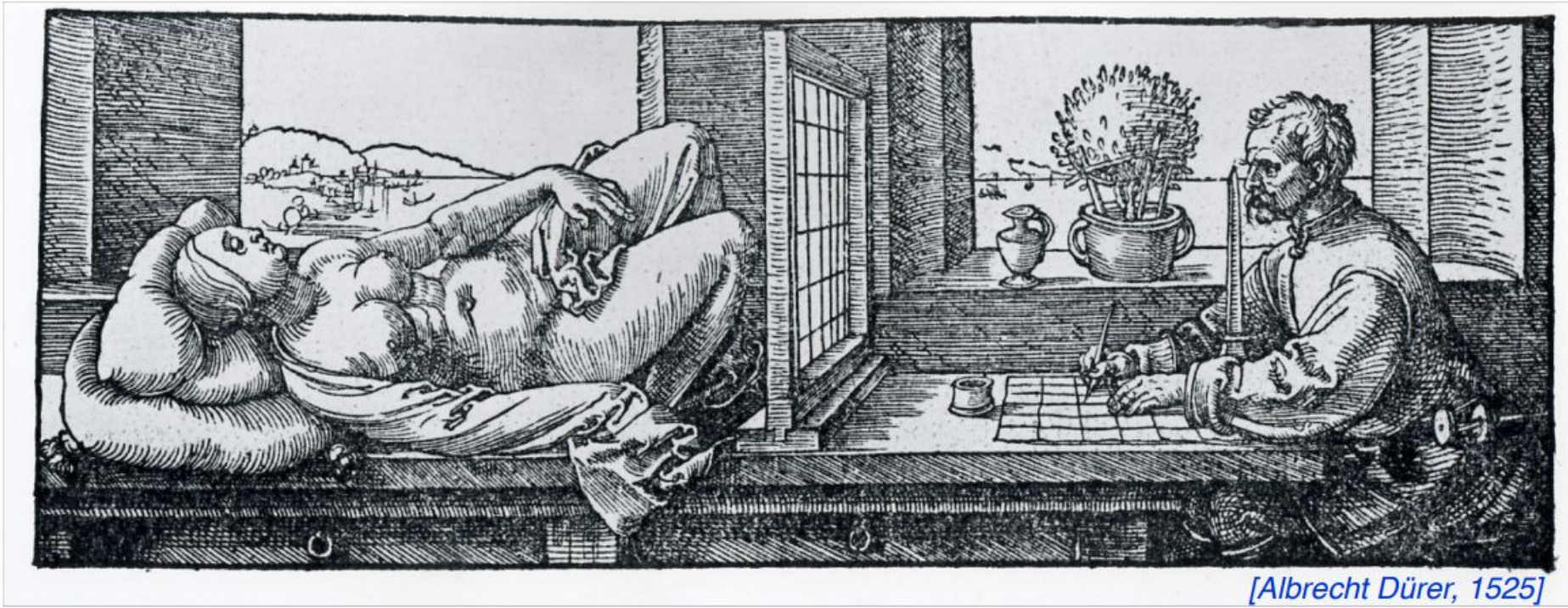
Lecture 1

Introduction



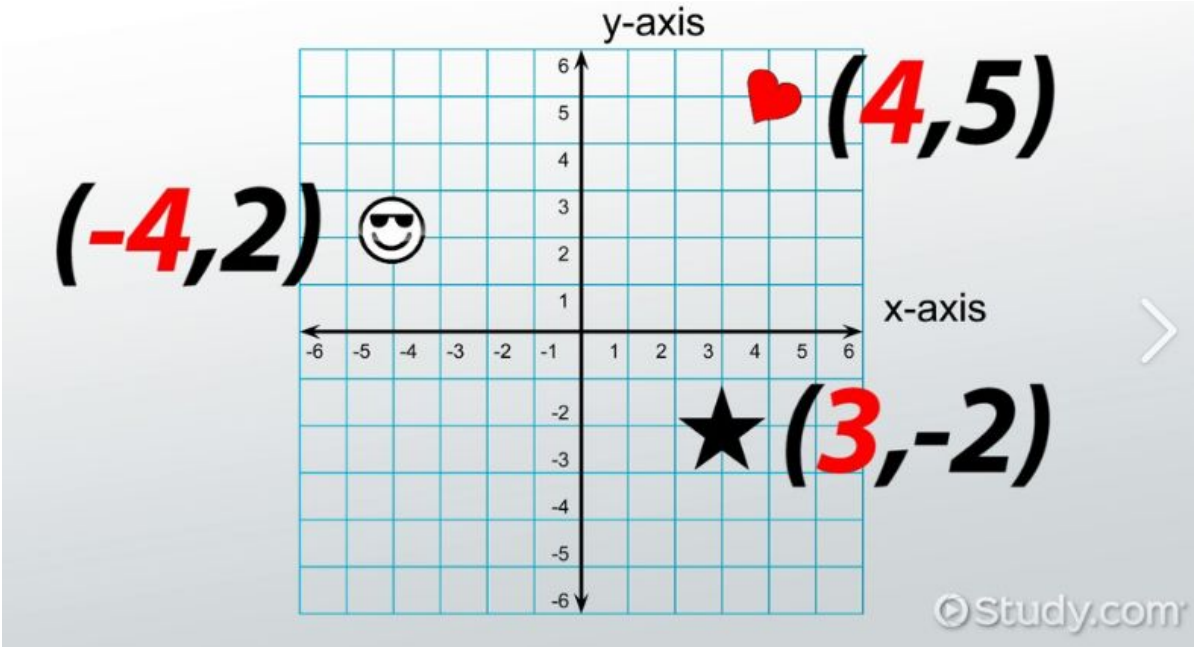
Dark chamber with lenses *[Kircher 1646]*

- Image is a visual representation of a function f(x,y)
- Where f is related to the brightness (or color) at point (x,y)
- Most images are defined over a rectangle
- Continuous in amplitude and space

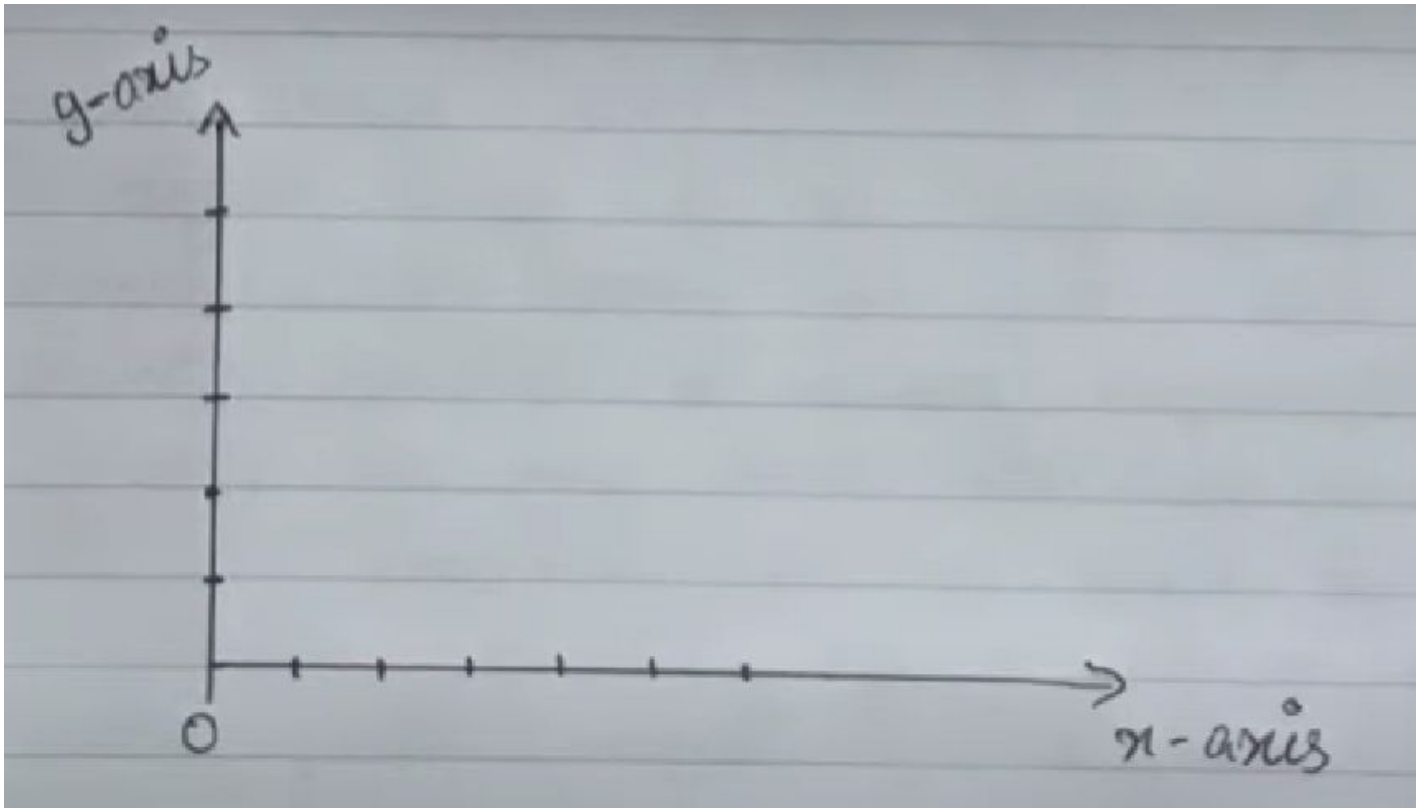


[Albrecht Dürer, 1525]

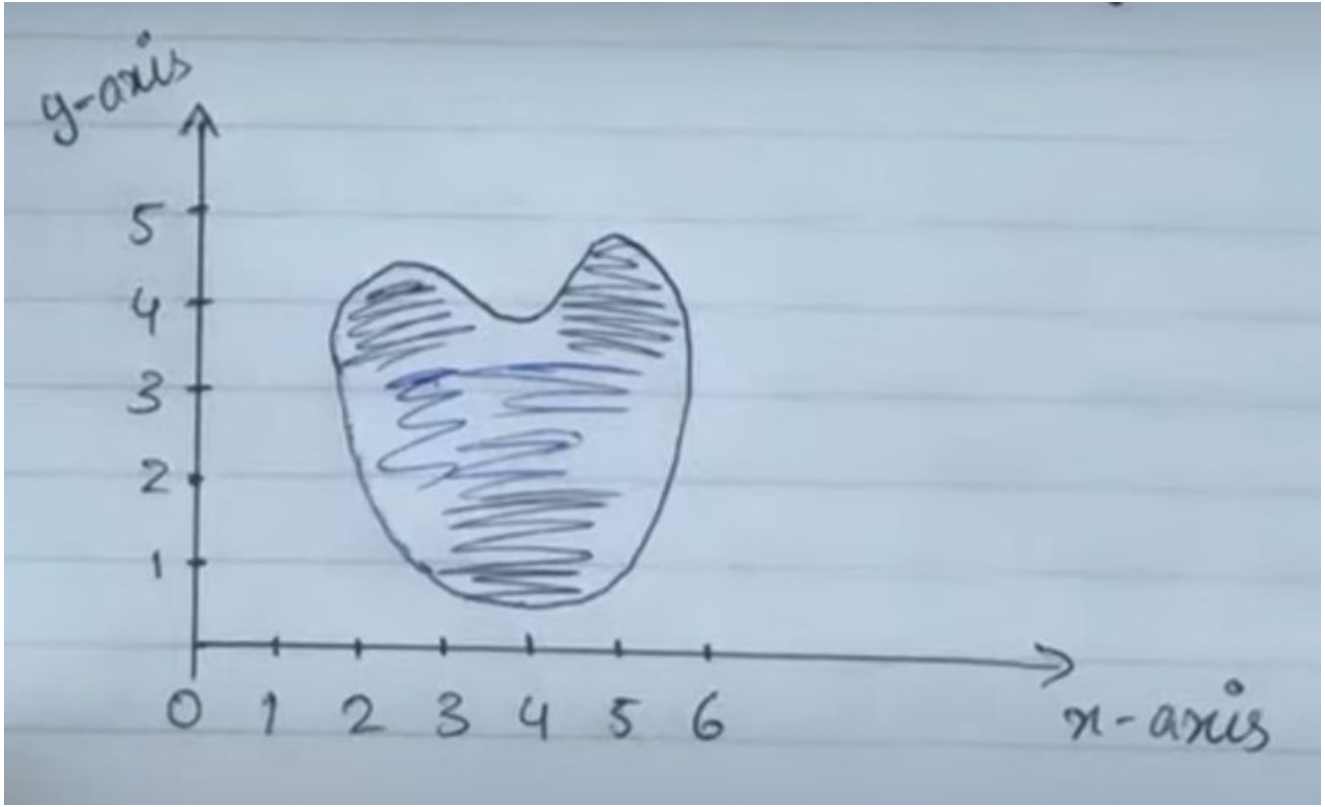
The **2-D function** can be written as f(x,y), where x and y are spatial coordinates



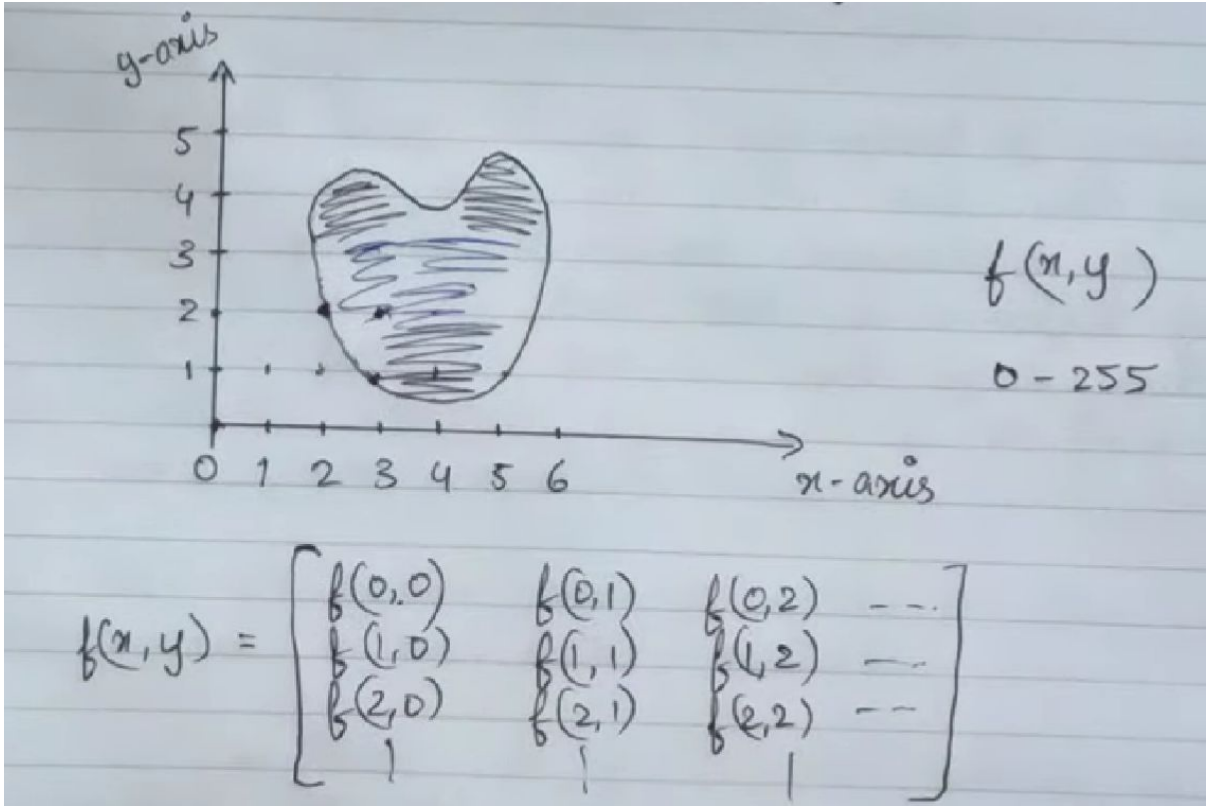
Digital Image Processing



Digital Image Processing



Digital Image Processing



The amplitude of f is called the **intensity or gray level** at the point (x,y).

Note: x, y, & amplitude of f => finite and discrete

Digital Image is an image composed of picture elements, also known as pixels, each with finite, discrete qualities of numeric representation for its intensity or gray level that is an output from its 2-D functions fed as input by its spatial coordinates denoted by x and y on the x-axis and y-axis respectively.

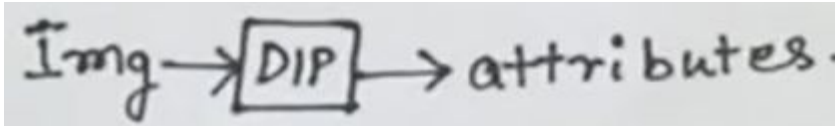
Note: Digital image discrete samples f(x,y) representing continuous image f(x,y)

Digital Image Processing is the use of a digital computer to process digital images through an algorithm.

Types of Digital Image Processing

Low level inputs and outputs images

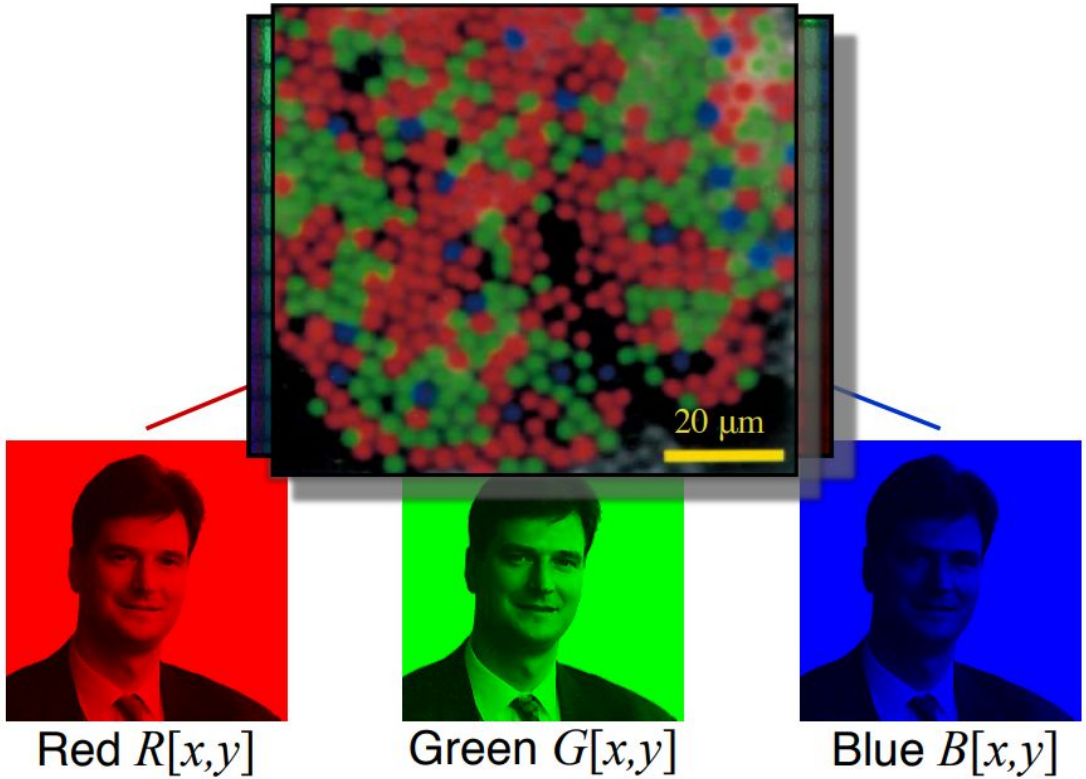
Mid level outputs are attributes extracted from input images



High level an ensemble of recognition of individual objects

Finite elements => Locations & Values

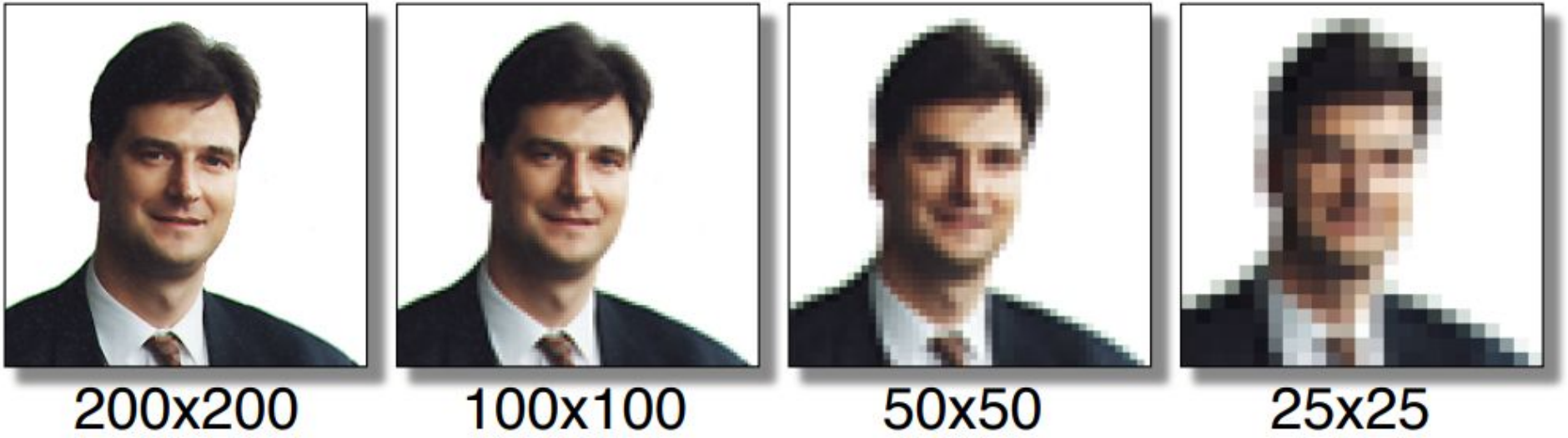
Color Components



Monochrome image

$R[x,y] = G[x,y] = B[x,y]$

Pixel is the smallest controllable element of a picture represented on the screen.



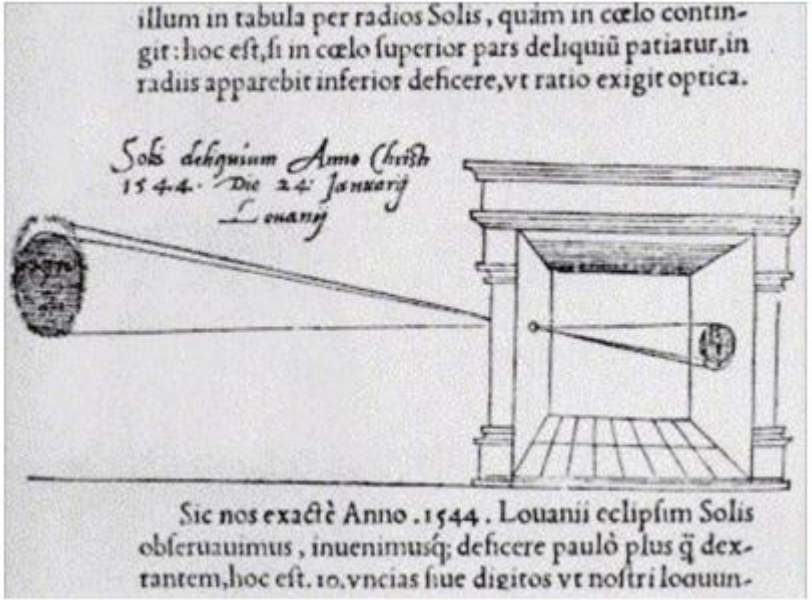
Each element of the 2-d array f(x,y) is called a pixel or pel (from "picture element")

Finite elements => image elements, picture elements, pels or

A Simple Image Formation Model

An object is represented in the form of a 2-D image.

For an image to be reduced, there should be a light source illuminating the object



A Simple Image Formation Model

When an image is generated from a physical process, Its values are proportional to the energy radiated by a physical source (ex. Electromagnetic values).

The intensity/amplitude of f at spatial coordinates is a positive scalar quantity whose physical incoming is determined by the source of the image

Therefore the function must be non-zero and finite ie.,

$$0<f(x,y)<\infty$$

The function may be characterized by 2 components:

- The mount of source illumination accident on the scene being viewed
- The amount of illumination reflected by the objects in the scene

These illumination and reflectance components can be denoted by i(x,y) and r(x,y) respectively

These two functions combine to form f(x,y):

$$f(x,y) = i(x,y)*r(x,y)$$

therefore: $f(x,y) = i(x,y) * r(x,y)$

where :

$f(x,y)$: intensity at the point (x,y)

$i(x,Y)$: illumination at the point (x,y)

$r(x,y)$: reflectance/transmisitivity at the point (x,y)

$0 <= i(x,y) < \infty$

$0 <= r(x,y) <= 1$

Reflectance is bounded by 0 (total absorption) and 1 (total reflectance)

The nature of i(x,y) is determined by the illumination source

The nature of r(x,y) is determined by the characteristics of the imaged objects.

Why do we process images?

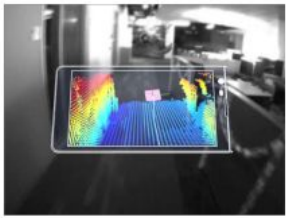
- Acquire an image
  - *Correct aperture and color balance*
  - *Reconstruct image from projections*
- Prepare for display or printing
  - *Adjust image size*
  - *Color mapping, gamma-correction, halftoning*
- Facilitate picture storage and transmission
  - *Efficiently store an image in a digital camera*
  - *Send an image from space*
- Enhance and restore images
  - *Touch up personal photos*
  - *Color enhancement for security screening*
- Extract information from images
  - *Read 2-d bar codes*
  - *Character recognition*
  - *Depth estimation*
- Many more ... image processing is ubiquitous











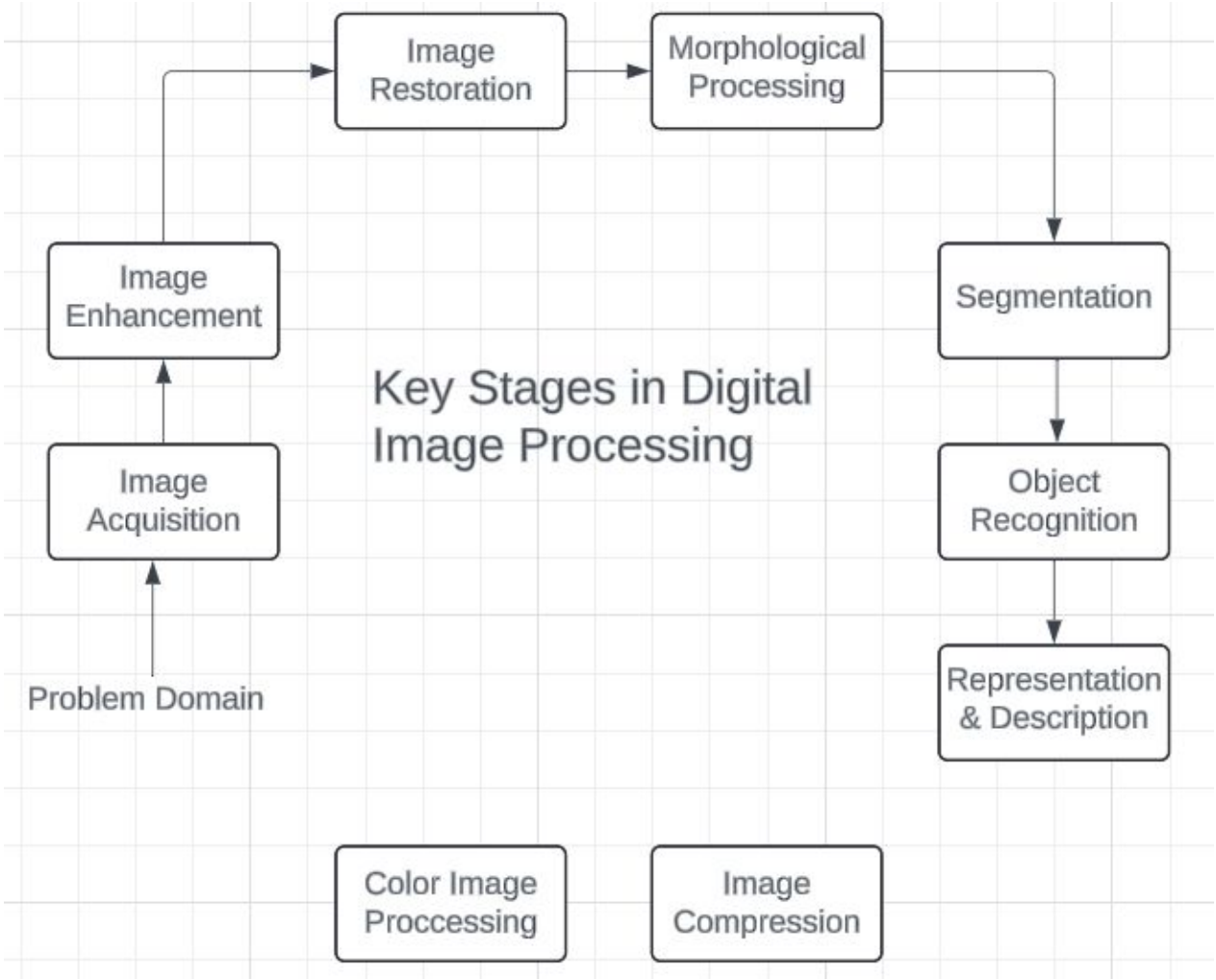


Image Restoration
Morphological Processing
Image Enhancement
Segmentation
Key Stages in Digital Image Processing
Image Acquisition
Object Recognition
Problem Domain
Representation & Description
Color Image Proccessing
Image Compression

Image Acquisition

The image is captured by a sensor (example : camera) and digitized if the output of the camera or sensor is not already in digital form, using analog to digital converter

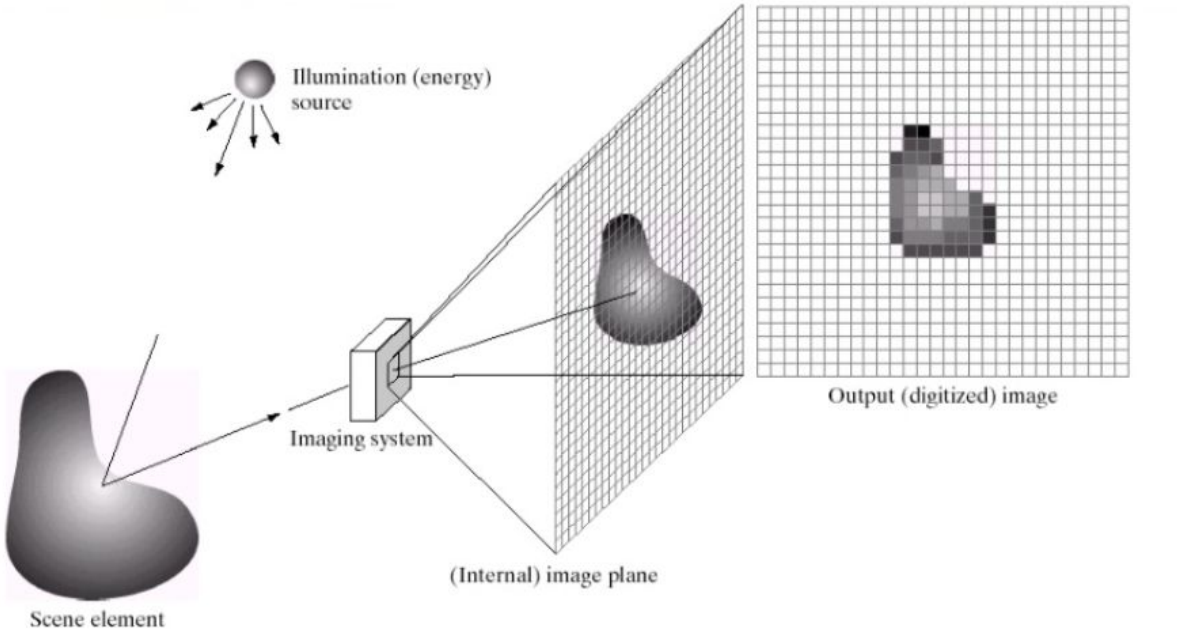


Image Enhancment

The process of manipulating an image so that the result is more suitable than the original for specific applications

Enhancing an image brings out the hidden details of an image and highlights feature which may be important

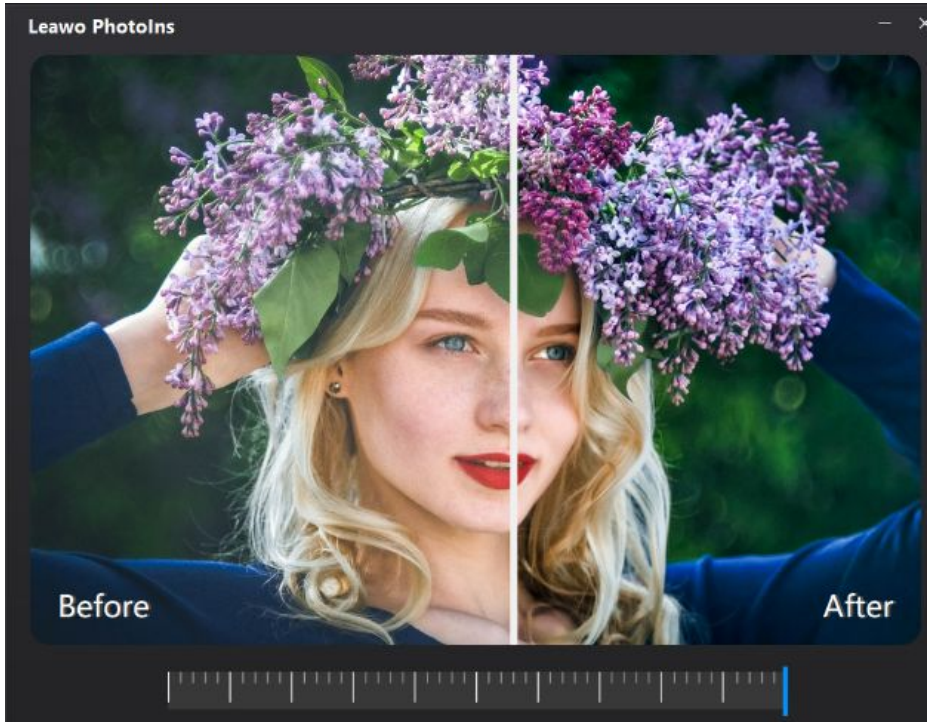
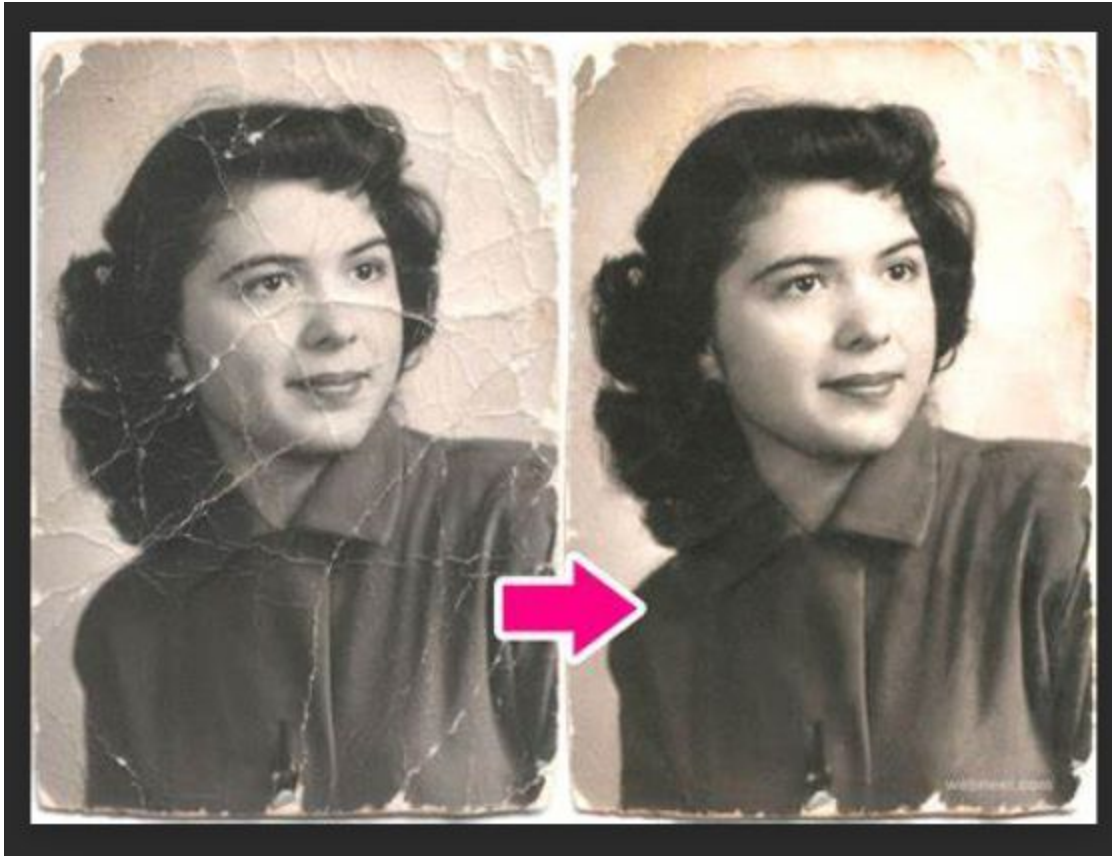


Image Restoration

The process od improving the appearance of an image. This mainly includes mathematical or probabilistic models of image degradation instead of human subjective preferences used in enhancement



Morphological Processing

It deals with tools for extracting image components that are useful in the representation and description of shape.

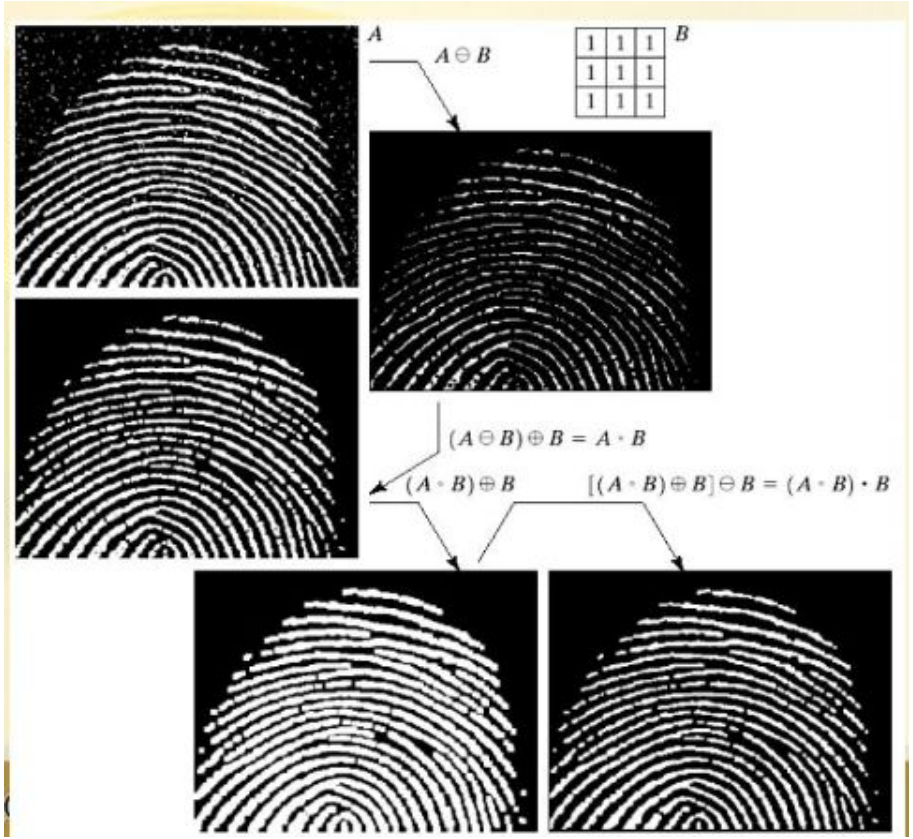
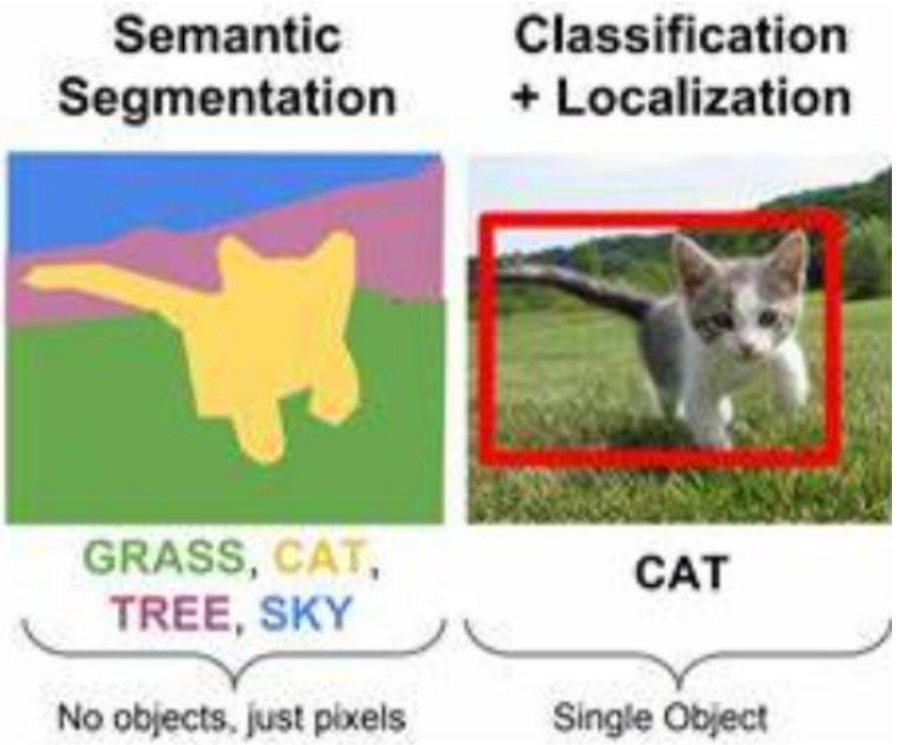


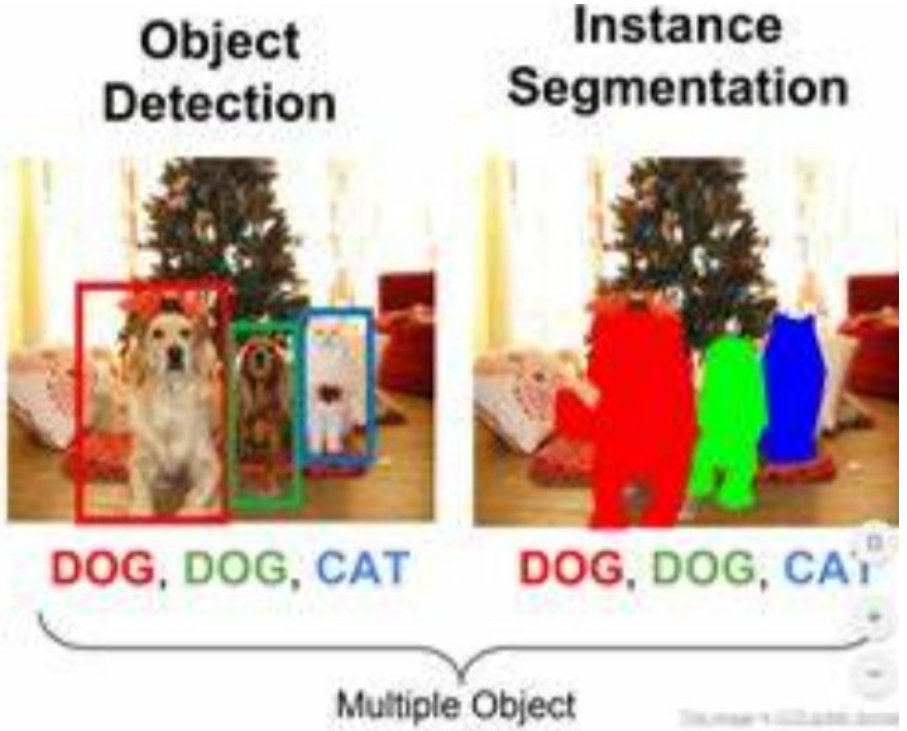
Image Segmentation

Segmentation procedures partition an image into its constituent parts or objects. The more accurate the segmentation, the more likely the recognition is to succeed.



Object Segmentation

The process that assigns a block to an object based on the information provided by its description



Representation and Description

Choosing a representation is only part of the solution for transforming how data into a form suitable for subsequent computer processing (mainly recognition)

Description also called feature selection, deals with extracting attributes that result in some information of interest

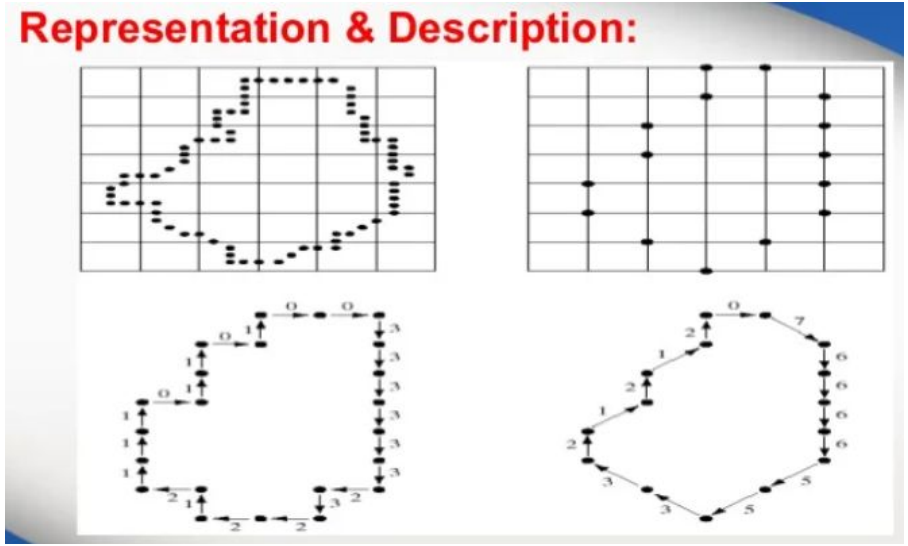
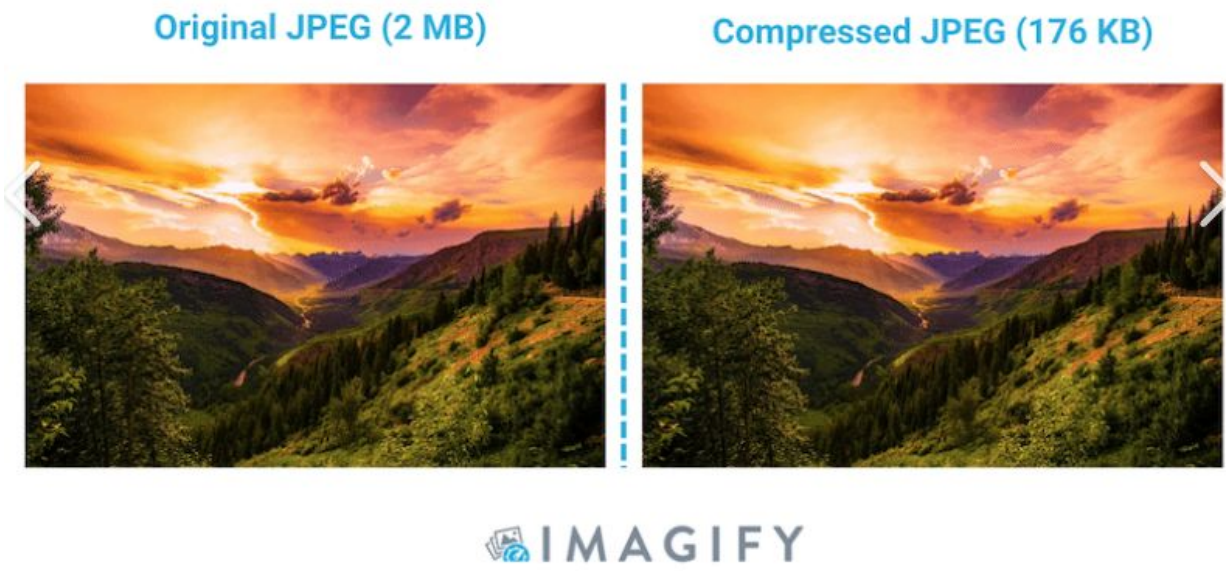


Image Compression

It includes techniques for reducing the storage required to save an image or the bandwidth required to transmit it



Color Image Processing

It is an area that haas been gaining in importance because of the significant increase in the use of digital images over the internet. It includes tha use of colour of the image to extract features of interest in the image.