# UNIT-I

# INTRODUCTION

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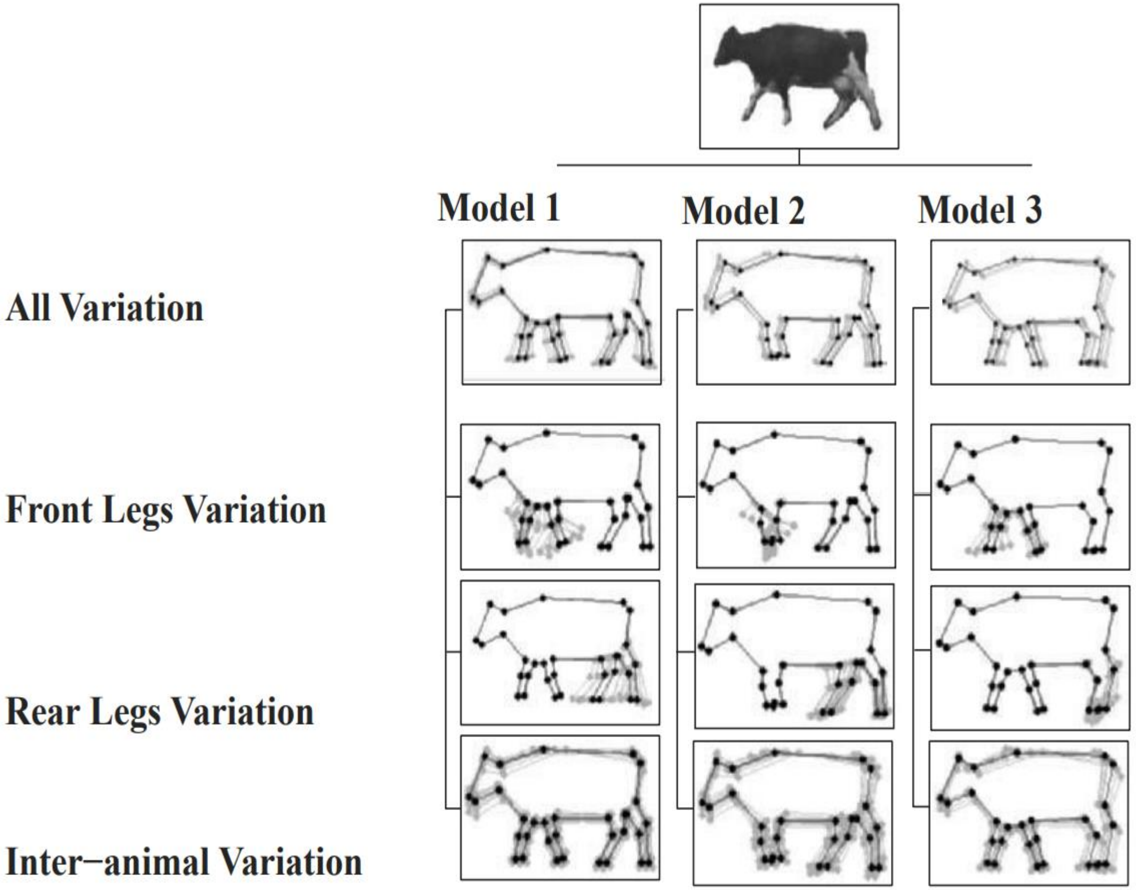
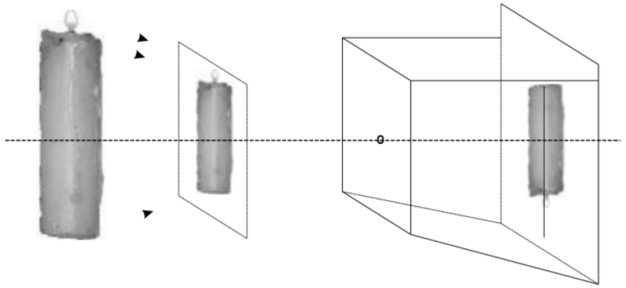



- The sequence of operations—image capture, early processing, segmentation, model fitting, motion prediction, qualitative/quantitative conclusion—that is characteristic of image understanding and computer vision problems. each of these phases.

# COMPUTER VISION:

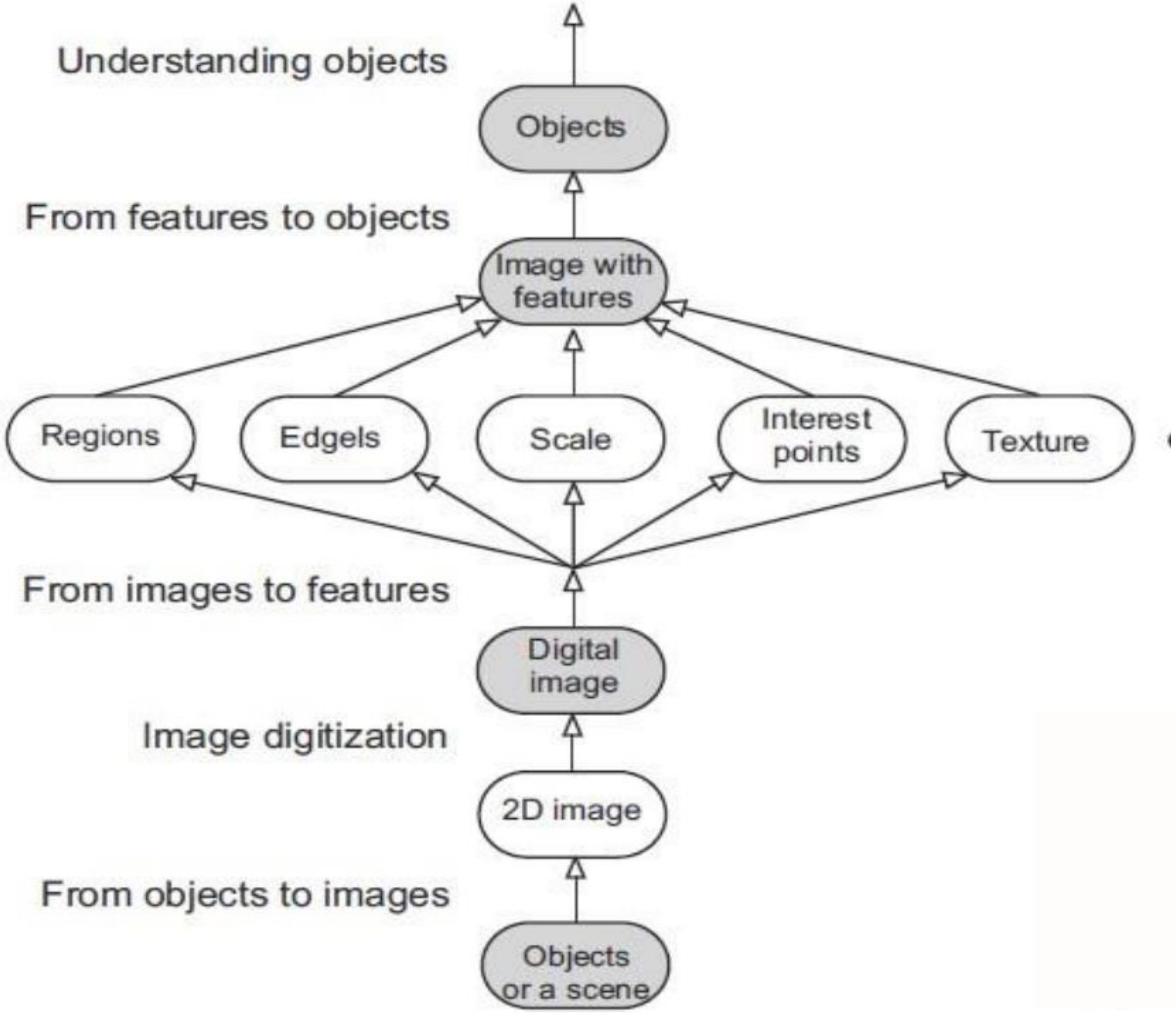
- Computer vision is a field of artificial intelligence (AI) enabling computers to derive information from images, videos and other inputs.
  - ❑Loss of information in 3D→ 2D
  - ❑Noise
  - ❑Too much data.
  - ❑Brightness measured
  - ❑Local window vs. need for global view

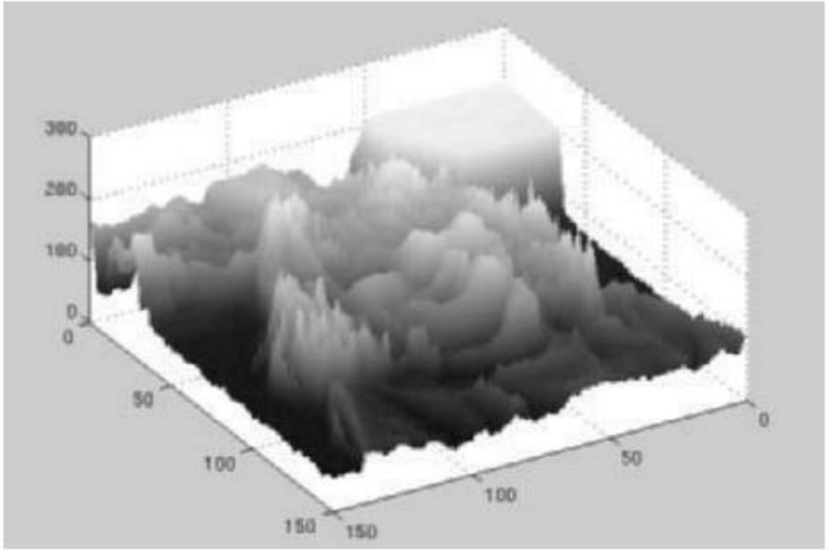


The pinhole model of imaging geometry does not distinguish size of objects.

# IMAGE REPRESENTATION AND IMAGE ANALYSIS TASKS:

- Low-level image processing
  - Low- level methods may include image compression, pre-processing methods for noise filtering, edge extraction, and image sharpening.
  - Low- level image processing uses data which resemble the input image; for example, an input image captured by a TV camera is 2D in nature, being described by an image function f (x, y) whose value is usually brightness depending on the co-ordinates x, y of the location in the image.
- High-level image understanding
  - High-level vision begins with some form of formal model of the world, and then the ‘reality’ perceived in the form of digitized images is compared to the model.
  - A match is attempted, and when differences emerge, partial matches (or subgoals) are sought that overcome them; the computer switches to low-level image processing to find information needed to update the model

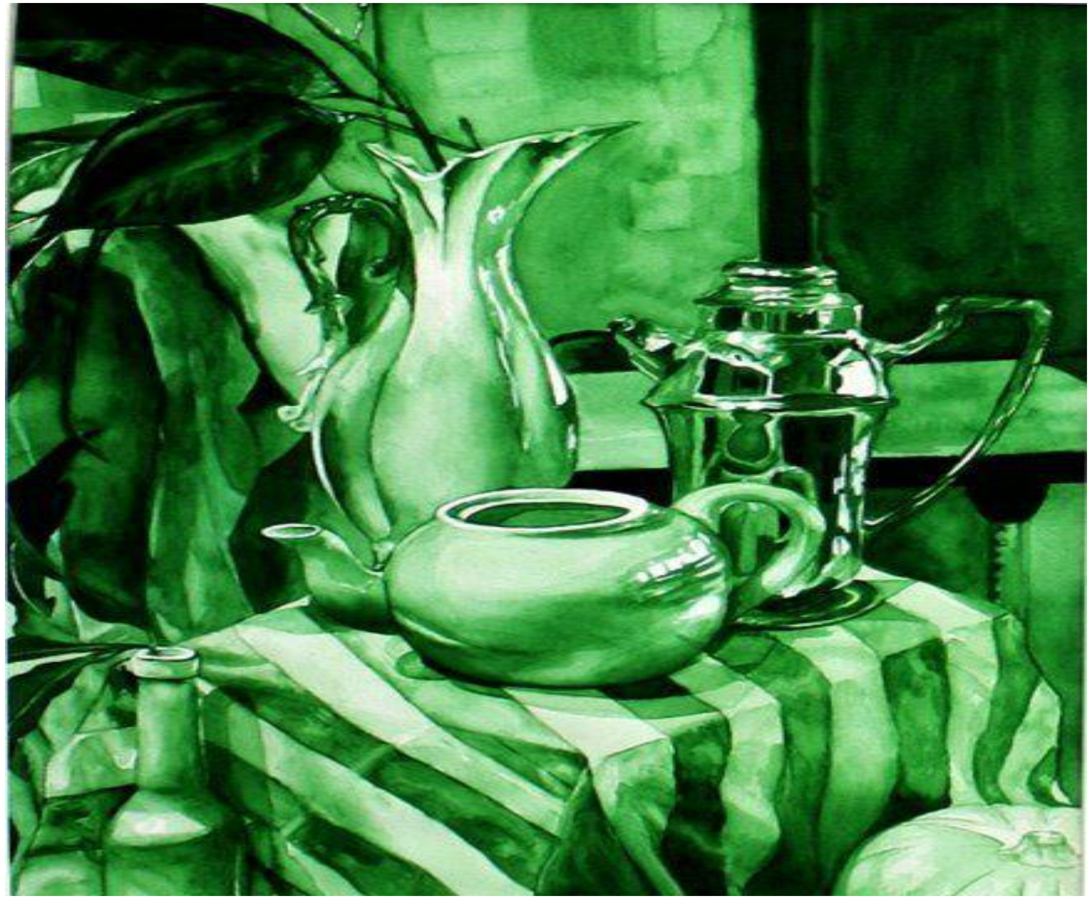

Understanding objects
Objects
From features to objects
Image with features
Regions
Edgels
Scale
Interest points
Texture
From images to features
Digital image
Image digitization
2D image
From objects to images
Objects or a scene

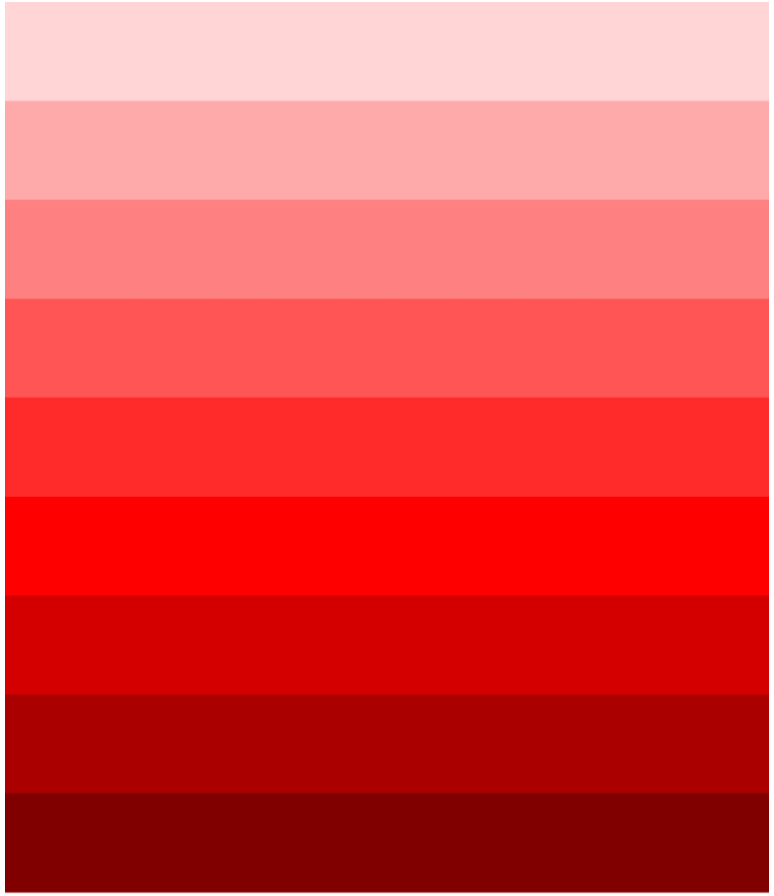


# IMAGE, ITS REPRESENTATIONS AND PROPERTIES

- Mathematical models are often used to describe images. A monochrome or monochromatic image, object or palette is composed of one color (or values of one color). Images using only shades of grey are called grayscale (typically digital) or black-and-white (typically analog).
- A scalar function might be sufficient to describe a monochromatic image, while vector functions may be used to represent color images consisting of three component colors. Functions are categorized as
  - ✓ Continuous
  - ✓ Discrete

# MONOCHROME IMAGE

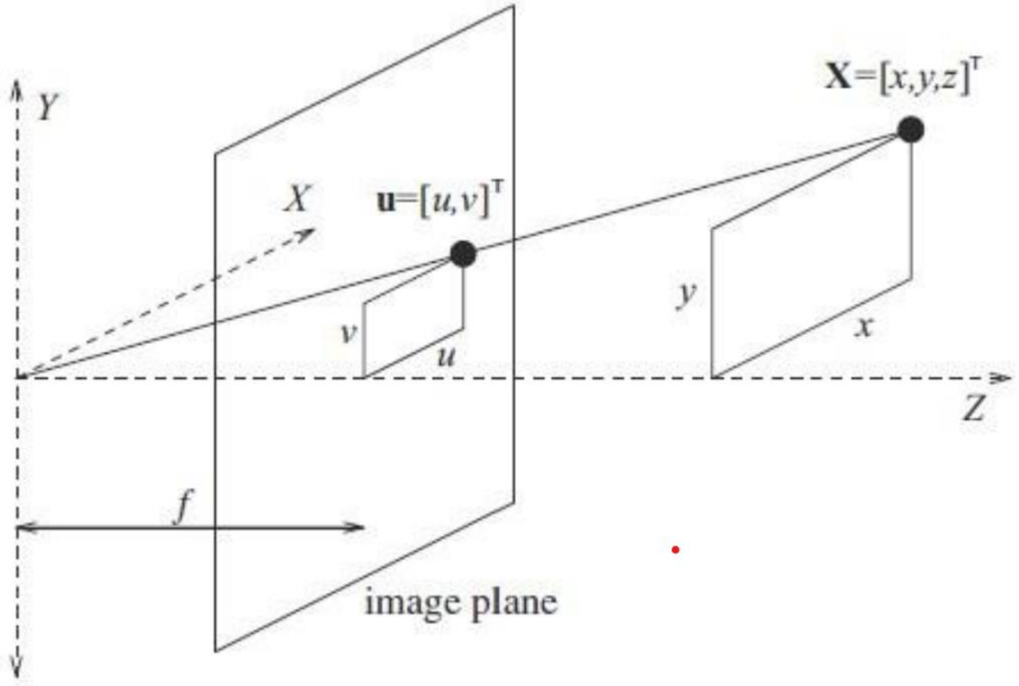




# IMAGE

- Image can be modeled by a continuous function of two variables f (x, y) where (x, y) are co-ordinates in a plane, or perhaps three variables f (x, y, t), where t is time.
- This model is reasonable in the great majority of applications.
- Infra-red cameras are now very common (for example, for night-time surveillance).
- Further, image acquisition outside the EM spectrum is also common: in the medical domain, datasets are generated via magnetic resonance (MR), X-ray computed tomography (CT), ultrasound etc.
- All of these approaches generate large arrays of data requiring analysis and understanding and with increasing frequency these arrays are of 3 or more dimensions.

# The continuous image function




- Brightness integrates different optical quantities—using brightness as a basic quantity allows us to avoid the complicated process of image formation.
- The image on the retina or on a camera sensor is intrinsically two-dimensional (2D).
- The 2D image on the imaging sensor is commonly the result of projection of a three-dimensional (3D) scene.
- The simplest mathematical model for this is a pin-hole camera.

- The quantities x, y, and z are coordinates of the point X in a 3D scene, and f is the distance from the pinhole to the image plane. f is commonly called the focal length because in lenses it has a similar meaning.
- The projected point u has co-ordinates (u, v) in the 2D image plane, which can easily be derived from similar triangles.
- A non-linear perspective projection is often approximated by a linear parallel (or orthographic) projection,

- Many basic and useful methods used in digital image analysis do not therefore depend on whether the object was originally 2D or 3D.
- Image processing often deals with static images, in which time is constant. A monochromatic static image is represented by a continuous image function f (x, y) whose arguments are coordinates in the plane.
- The spatial resolution is given by the proximity of image samples in the image plane; spectral resolution is given by the bandwidth of the light frequencies captured by the sensor; radiometric resolution corresponds to the number of distinguishable gray-levels; and time resolution is given by the interval between time samples at which images are captured.

# Image digitization

- Image digitization means that the function f (x, y) is sampled into a matrix with M rows and N columns. Image quantization assigns to each continuous sample an integer value—the continuous range of the image function f (x, y) is split into K intervals.
- The finer the sampling (i.e., the larger M and N ) and quantization (the larger K), the better the approximation of the continuous image function f (x, y) achieved. Image function sampling poses two questions.
- First, the sampling period should be determined—this is the distance between two neighboring sampling points in the image.
- Second, the geometric arrangement of sampling points (sampling grid) should be set.

# DIGITAL IMAGE PROPERTIES

- Metric
- Topological

A digital image consists of picture elements with finite size

# DATA STRUCTURES FOR IMAGE ANALYSIS

- Data and an algorithm are the two essentials of any program.
- Data organization often considerably affects the simplicity of the selection and the implementation of an algorithm, and the choice of data structures.
- Several levels of visual information representation are defined on the way between the input image and the model
  - Intermediate representations (data structures).
  - Algorithms

# Levels

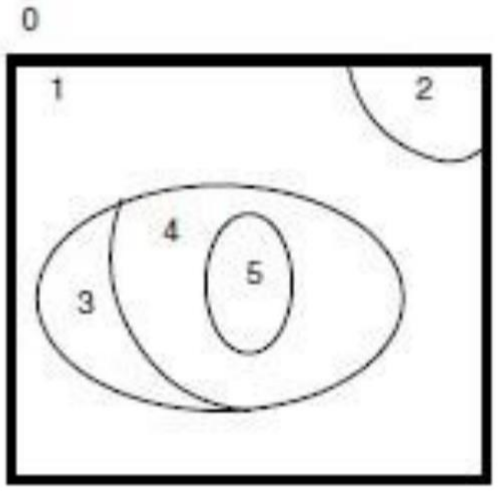
- Iconic Images
- Segmented Images
- Geometric Representations
- Relational Models

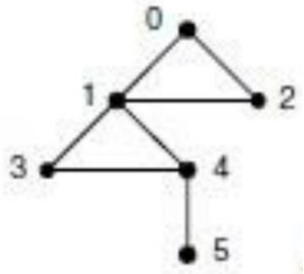
# TRADITIONAL IMAGE DATA STRUCTURES

- Matrices
- Chains
- Graphs
- Relational Databases

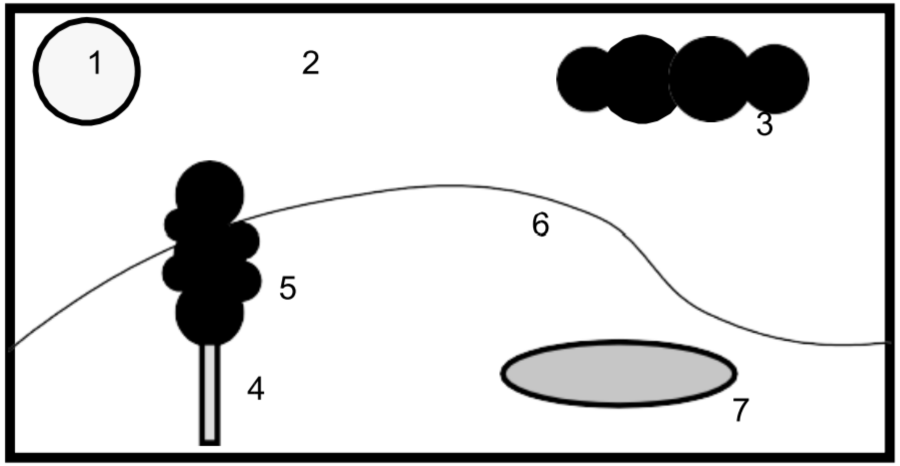
# Topological data structures

- Topological data structures describe the image as a set of elements and their relations; these relations are often represented using graphs. A graph $G = (V, E)$ is an algebraic structure which consists of a set of nodes and a set of arcs $E = \{ e_1, e_2, \ldots, e_m \}$.
- Each arc $e_k$ is incident to an unordered (or ordered) pair of nodes $\{v_i, v_j\}$ which are not necessarily distinct. The degree of a node is equal to the number of incident arcs of the node.



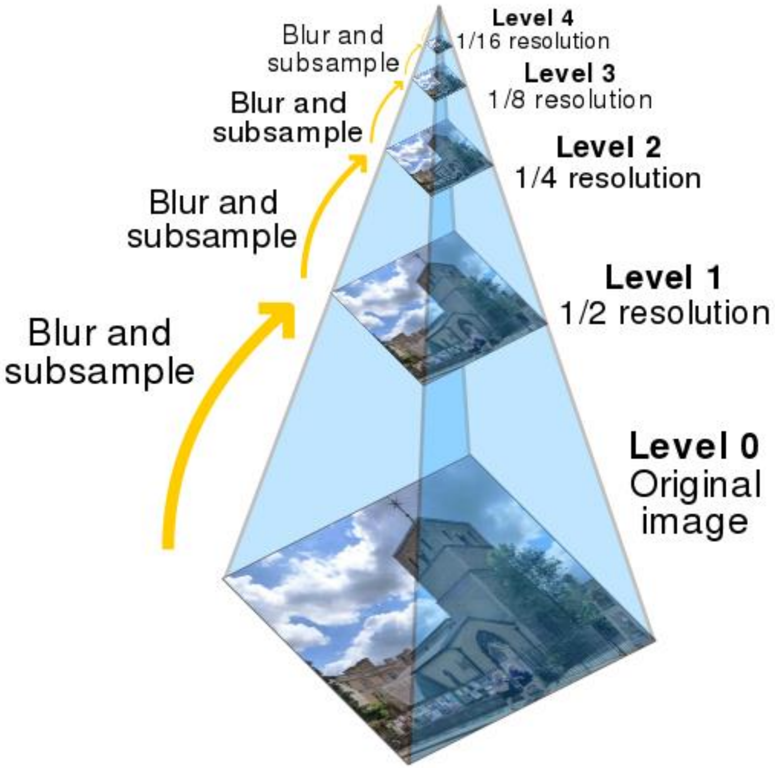




# Relational Data structure

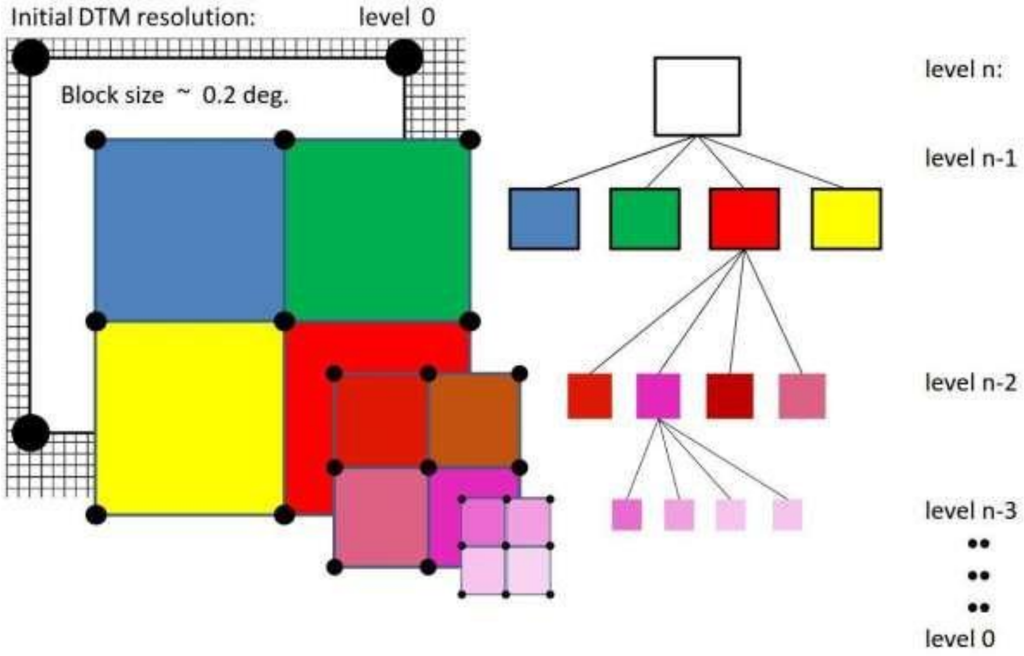



| No. | Object name | Color | Min. row | Min. col. | Inside |
|---|---|---|---|---|---|
| 1 | sun | white | 5 | 40 | 2 |
| 2 | sky | blue | 0 | 0 | – |
| 3 | cloud | gray | 20 | 180 | 2 |
| 4 | tree trunk | brown | 95 | 75 | 6 |
| 5 | tree crown | green | 53 | 63 | – |
| 6 | hill | light green | 97 | 0 | – |
| 7 | pond | blue | 100 | 160 | 6 |

# HIERARCHICAL DATA STRUCTURES




**Pyramids**




**Quadtrees**