# DIGITAL IMAGE PROCESSING

The images used in this presentation can be found here:

https://github.com/dphi-official/Deep_Learning_Bootcamp/tree/master/Digital%20Image%20Processing/images

# What is Digital Image Processing?

**Digital Image:**

A representation of a two-dimensional image as a finite set of digital values, called picture elements or pixels. *f(x, y)*

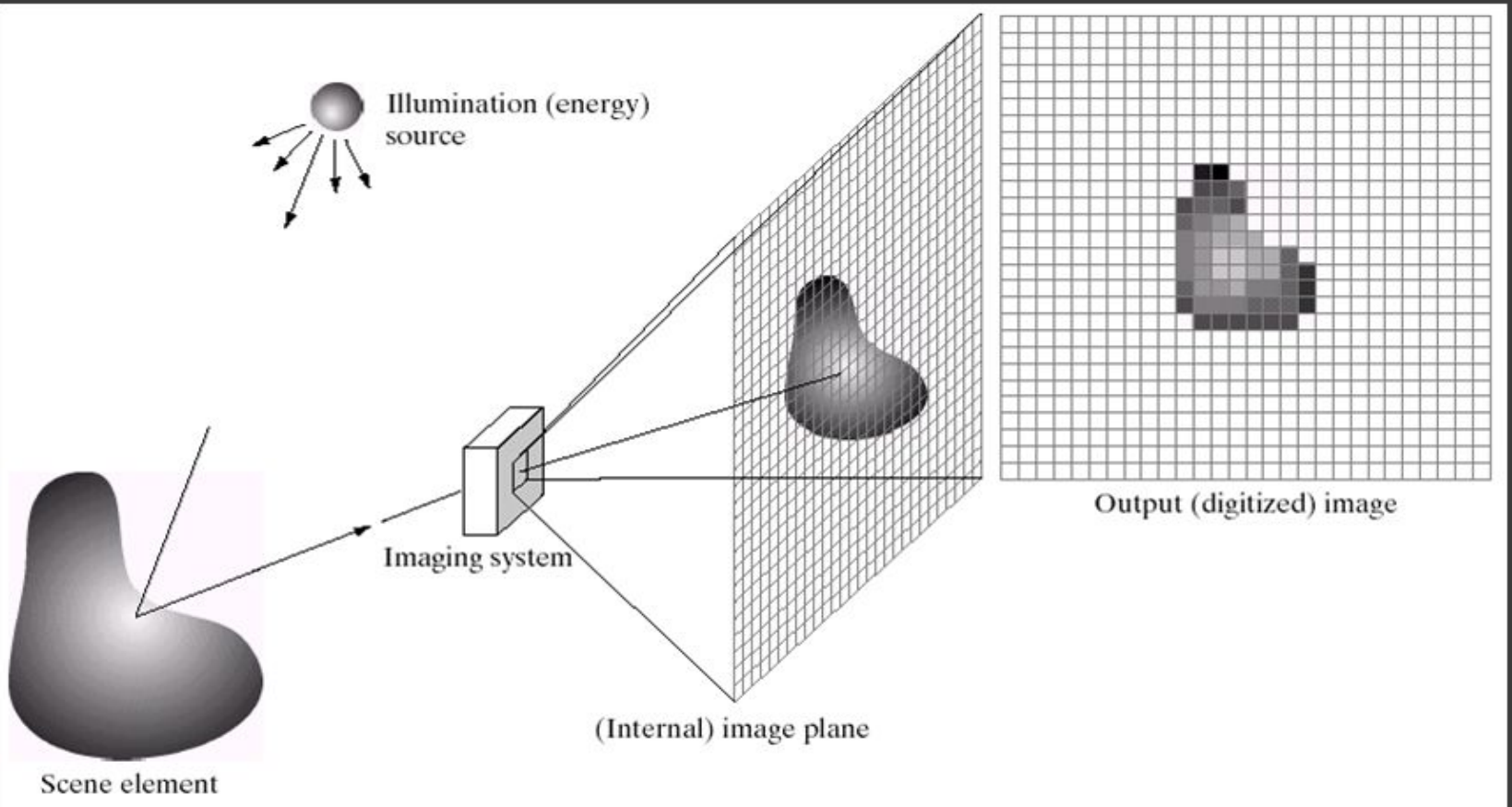
Where x, y are spatial coordinates
**f(x, y) = i(x,y) * r(x,y)**

f(x, y): Intensity at given point (x, y)
i(x, y): Illumination at (x, y)
r(x, y): Reflectance/ Transmissivity at (x, y)

M XN representation of *f*

$$f(x,y) = \begin{bmatrix} f(0,0) & f(0,1) & \dots & f(0,N-1) \\ f(1,0) & f(1,1) & \dots & f(1,N-1) \\ \dots & \dots & \dots & \dots \\ f(M-1,0) & f(M-1,1) & \dots & f(M-1,N-1) \end{bmatrix}$$

# Image Acquisition Process



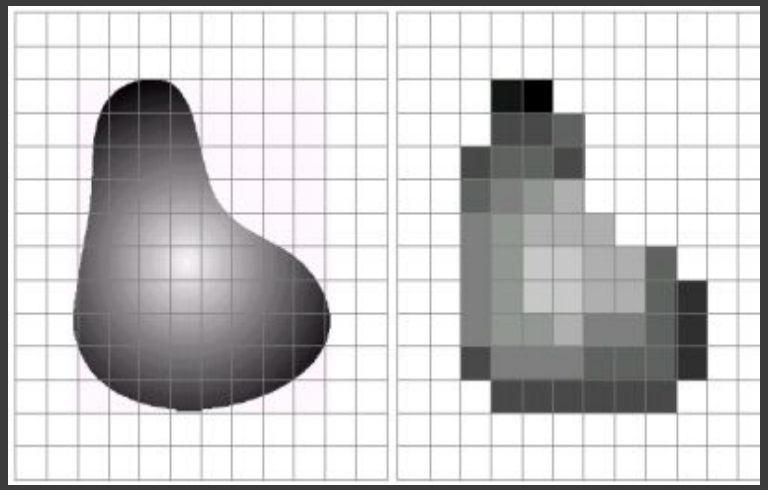

a b c d e

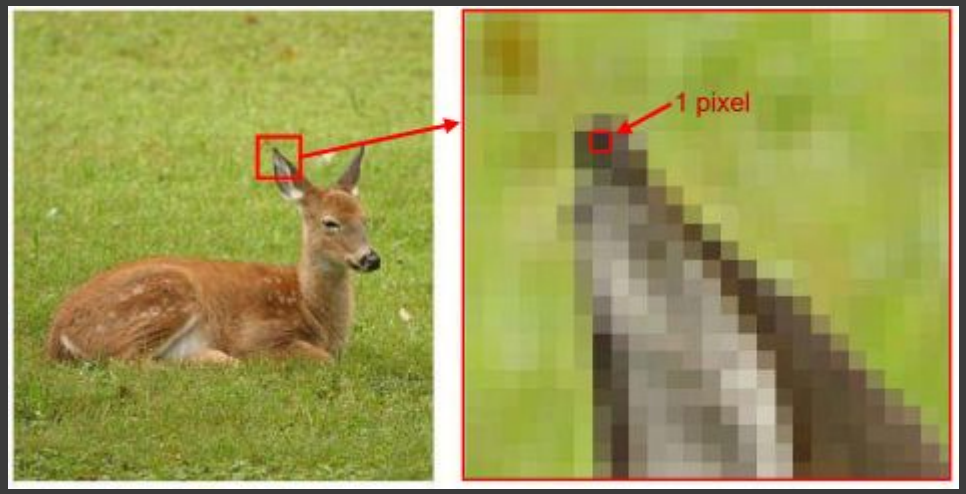
**FIGURE 2.15** An example of the digital image acquisition process. (a) Energy ("illumination") source. (b) An element of a scene. (c) Imaging system. (d) Projection of the scene onto the image plane. (e) Digitized image.

# Pixel & Digitization

Pixels are the elements of a digital image that typically represent gray levels, colours, heights, opacities.

Digitization implies that a digital image is an approximation of a real scene in the numerical matrices form

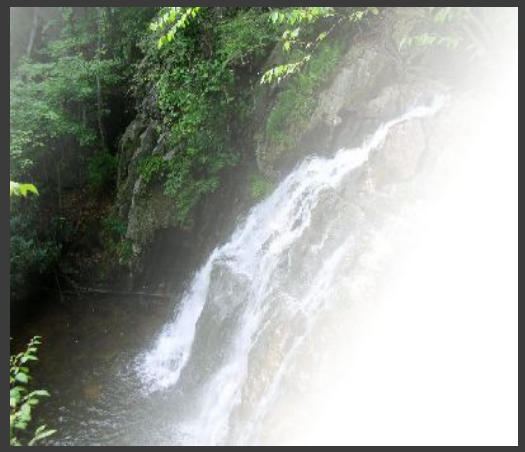




# Digital Image

Common digital image formats include

- 1 sample per point (B&W / Grayscale)
- 3 samples per point ( Red, Green and Blue)
- 4 samples per point (Red, Green, Blue and Alpha / opacity)



# What is Digital Image Processing?

**Digital Image Processing:**

Processing digital images by means of a computer.

An **image processing** operation typically defines a new image *g* in terms of an existing image *f*.

We can transform either the range of *f*.

$$g(x,y) = t(f(x,y))$$

Or the domain of *f*:

$$g(x,y) = f(t_x(x,y), t_y(x,y))$$

# Why Digital Image Processing?

- Improvement of pictorial information for human interpretation
- Processing of image data for storage, transmission and representation for autonomous machine perception

Where image processing ends, fields such as image analysis and computer vision start.

The continuum from image processing to computer vision is broken down into:

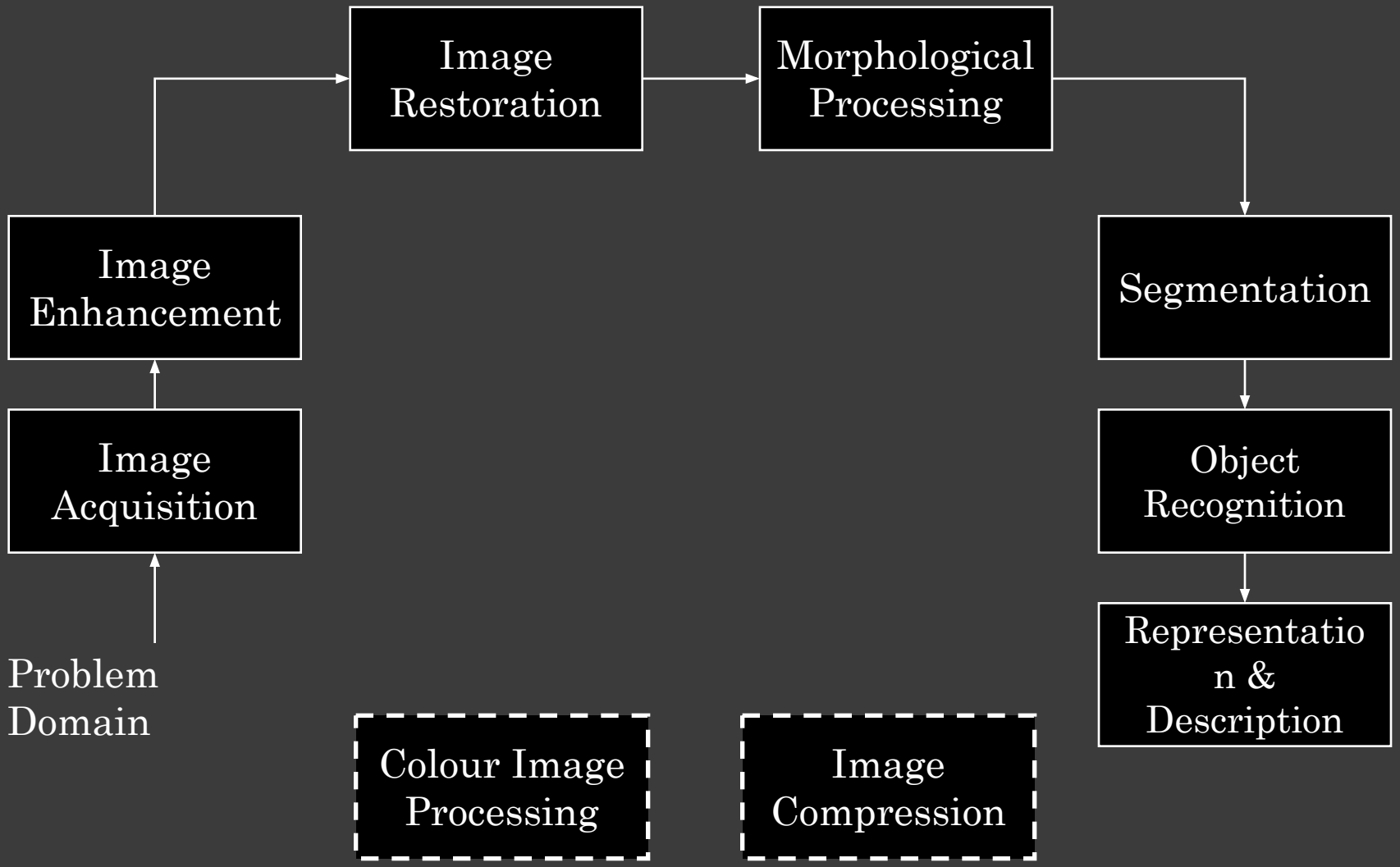
Low – Level:
Inputs and outputs are images
Ex: Noise Removal, Image Sharpening

Mid – Level:
Outputs are the attributes extracted from input images
Ex: Object Recognition, Image Segmentation

High – Level:
An ensemble of recognition of individual objects
Ex: Scene Understanding, Autonomous Navigation

For more details about each of the steps in the next set of slides refer this article: https://medium.com/futframe-ai/fundamental-steps-of-digital-image-processing-d7518d6bb23c

# Key Stages in Digital Image Processing



# KEY STAGES IN DIGITAL IMAGE PROCESSING: IMAGE ACQUISITION

Problem Domain

Image Acquisition

Image Enhancement

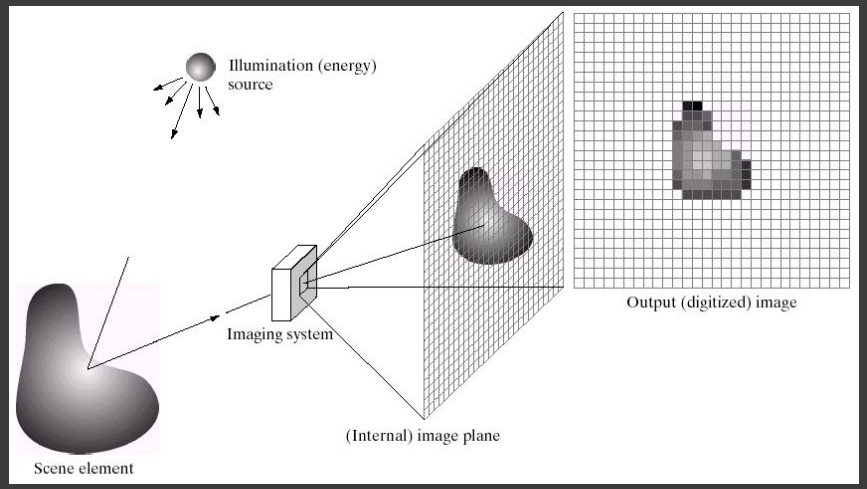
Image Restoration

Morphological Processing

Segmentation

Object Recognition

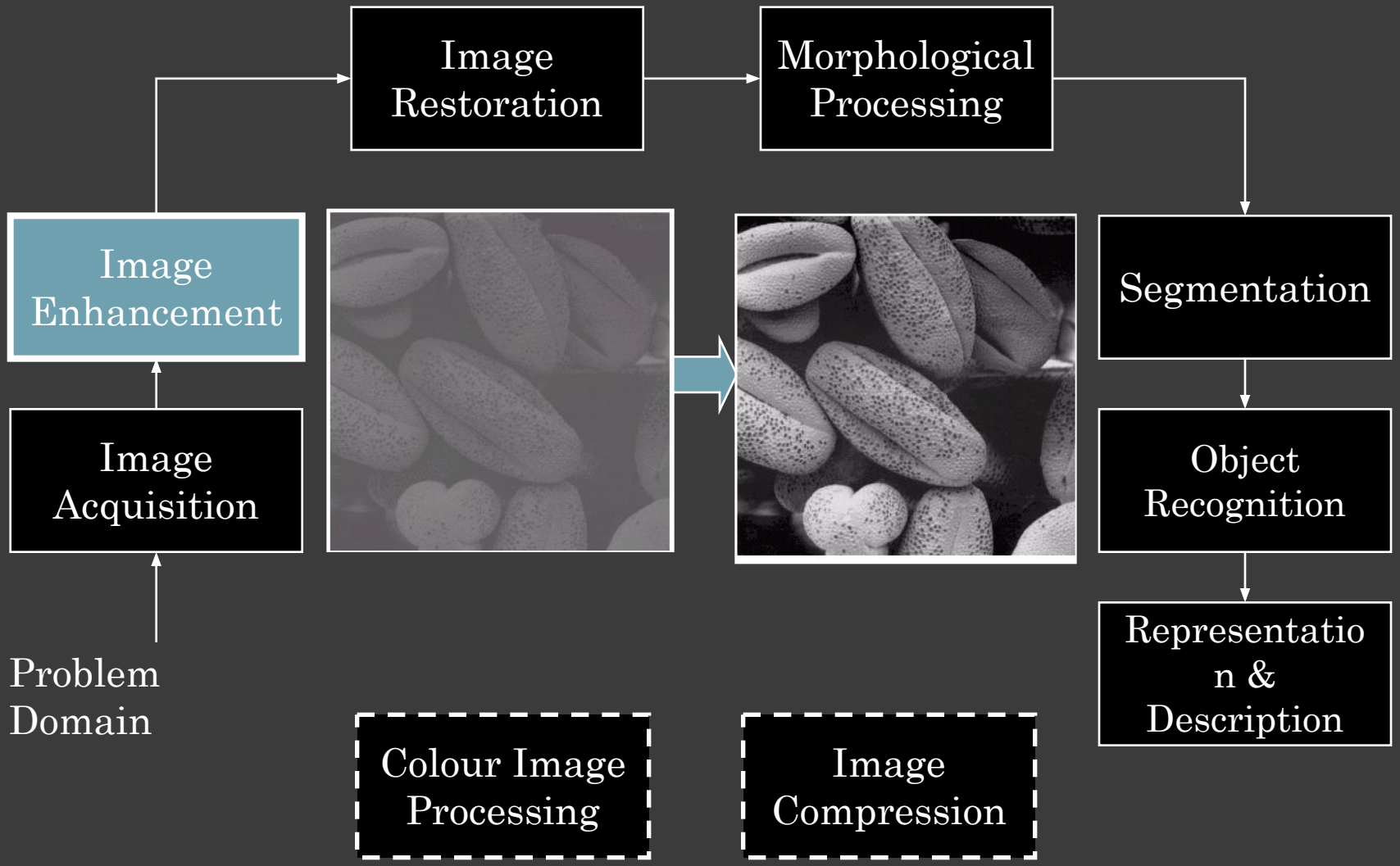
Representation & Description



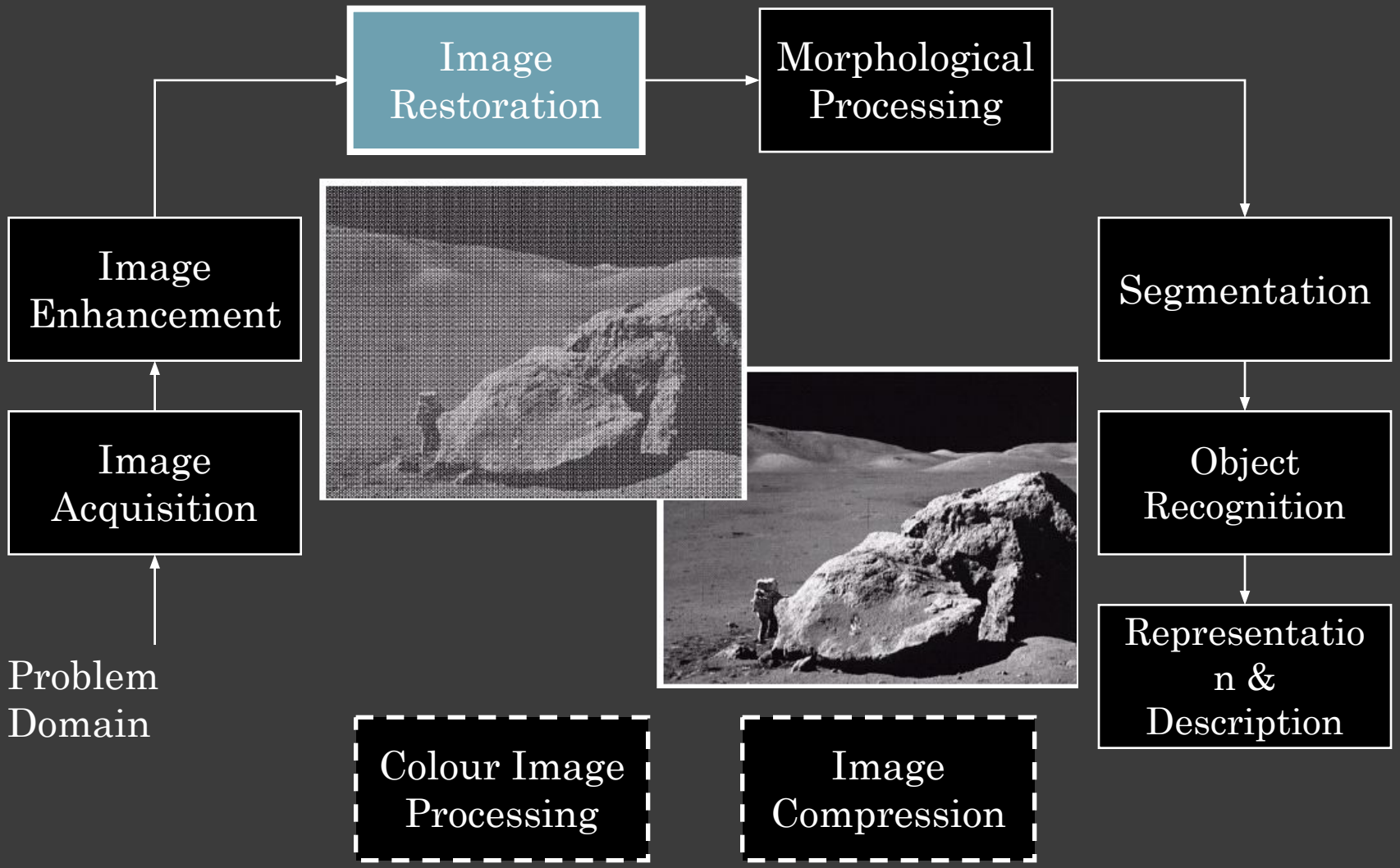

Colour Image Processing

Image Compression

# KEY STAGES IN DIGITAL IMAGE PROCESSING: IMAGE ENHANCEMENT



# KEY STAGES IN DIGITAL IMAGE PROCESSING: IMAGE RESTORATION



# KEY STAGES IN DIGITAL IMAGE PROCESSING: MORPHOLOGICAL PROCESSING

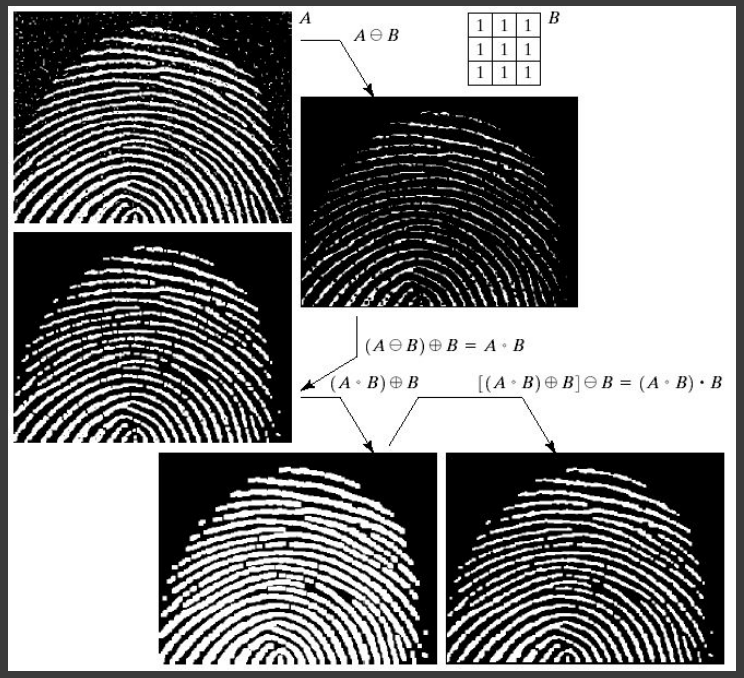
Problem Domain

Image Acquisition

Image Enhancement

Image Restoration

Morphological Processing




Segmentation

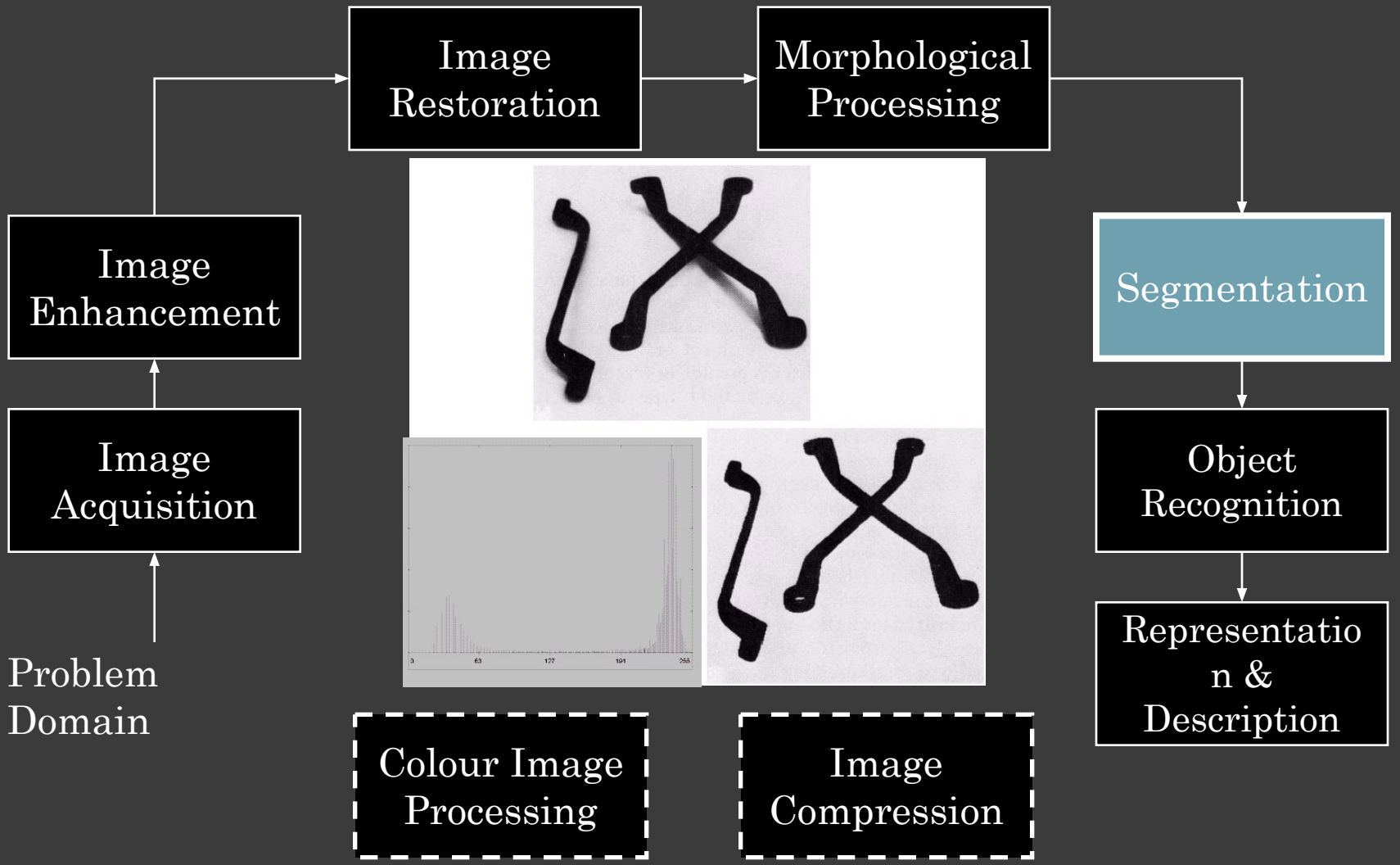
Object Recognition

Representation & Description

Colour Image Processing

Image Compression

# KEY STAGES IN DIGITAL IMAGE PROCESSING: SEGMENTATION



# KEY STAGES IN DIGITAL IMAGE PROCESSING: OBJECT RECOGNITION

Problem Domain

Image Acquisition

Image Enhancement

Image Restoration

Morphological Processing

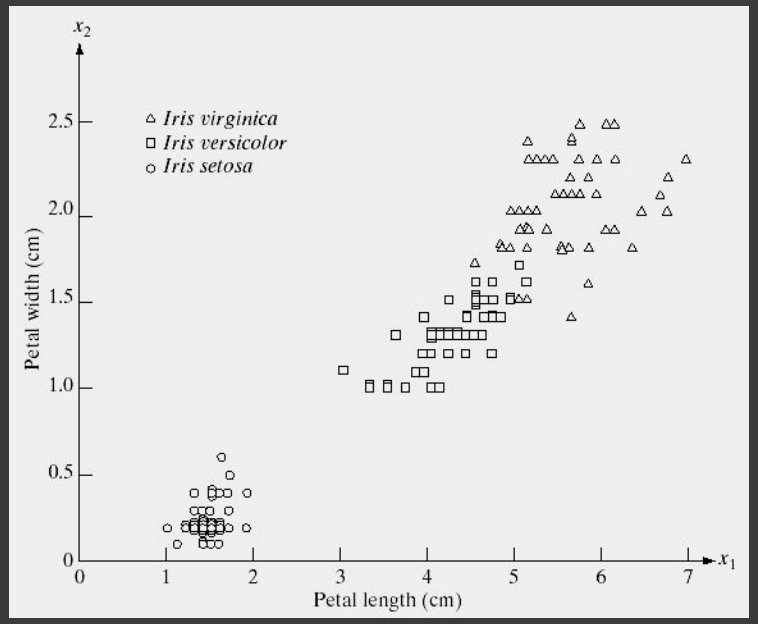
Segmentation

Object Recognition

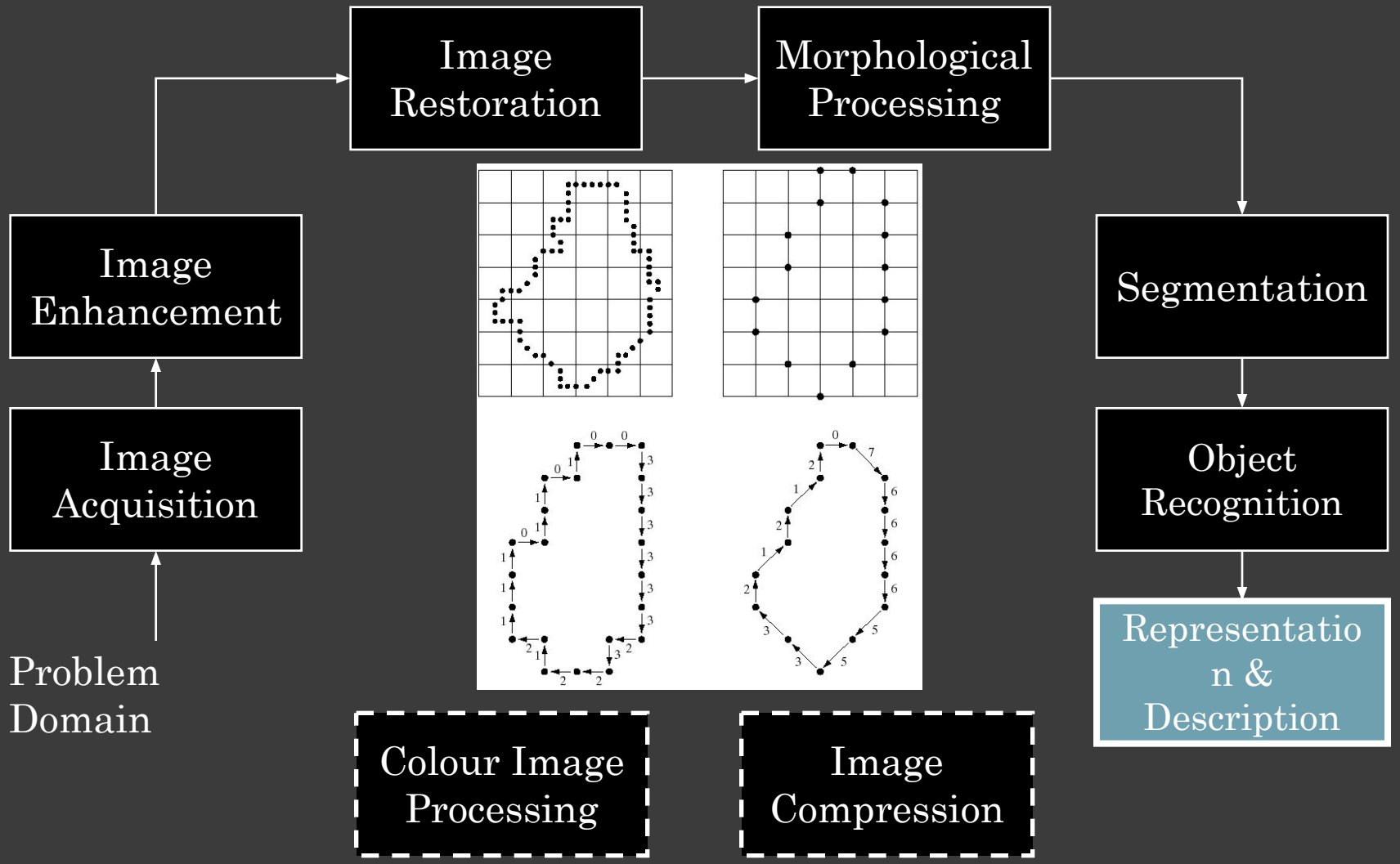
Representation & Description

Colour Image Processing

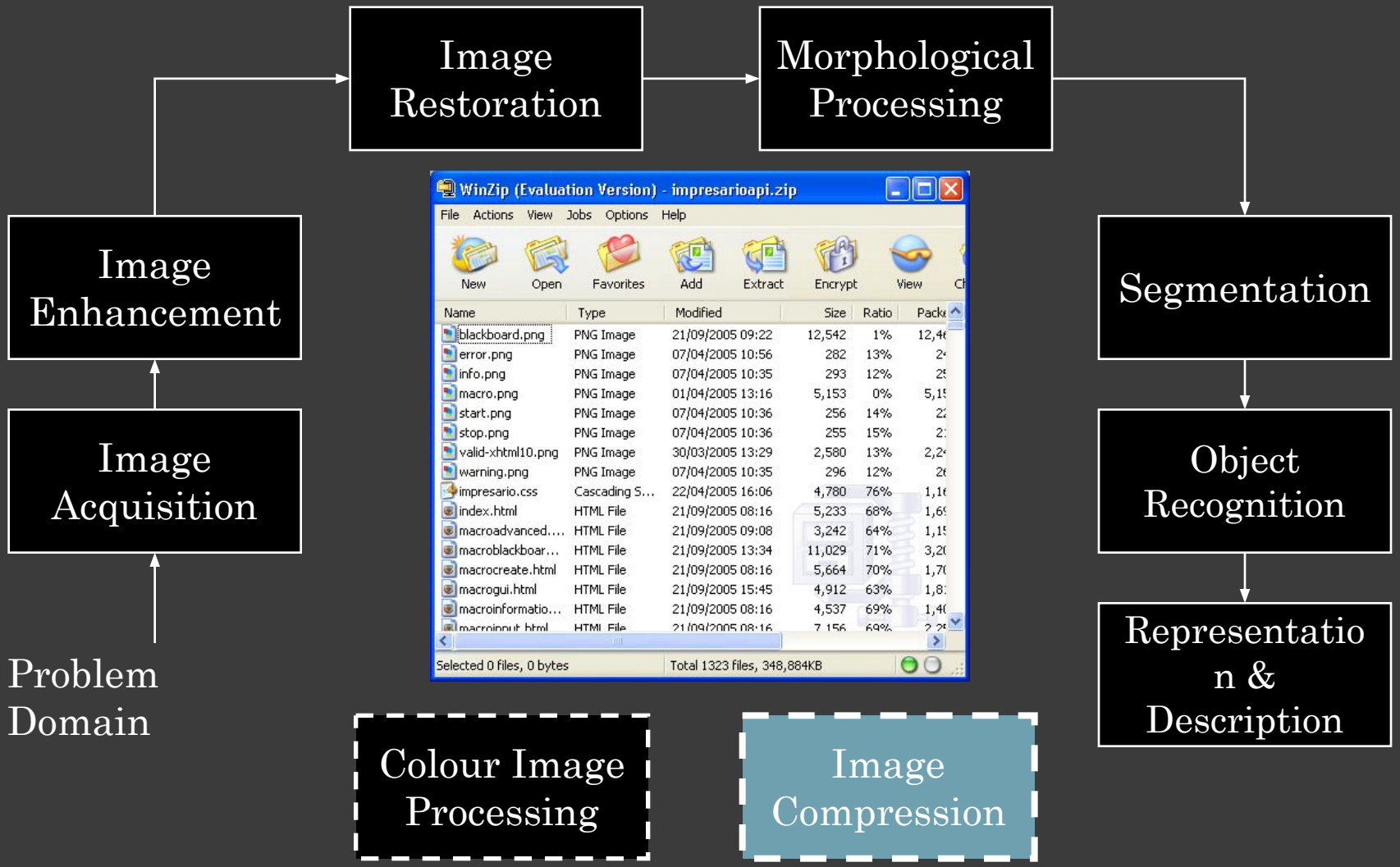
Image Compression



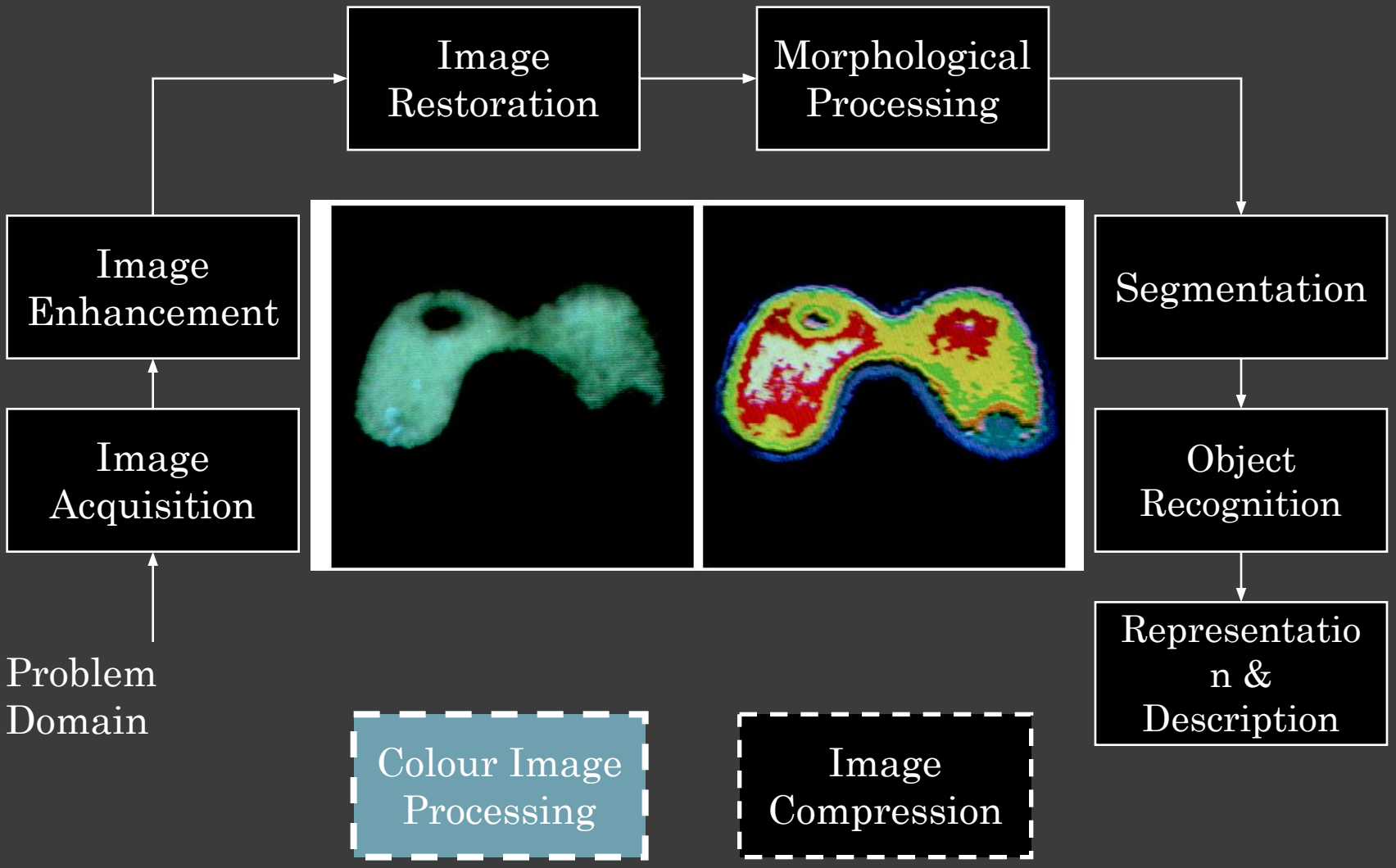
# KEY STAGES IN DIGITAL IMAGE PROCESSING: REPRESENTATION



# KEY STAGES IN DIGITAL IMAGE PROCESSING: COMPRESSION

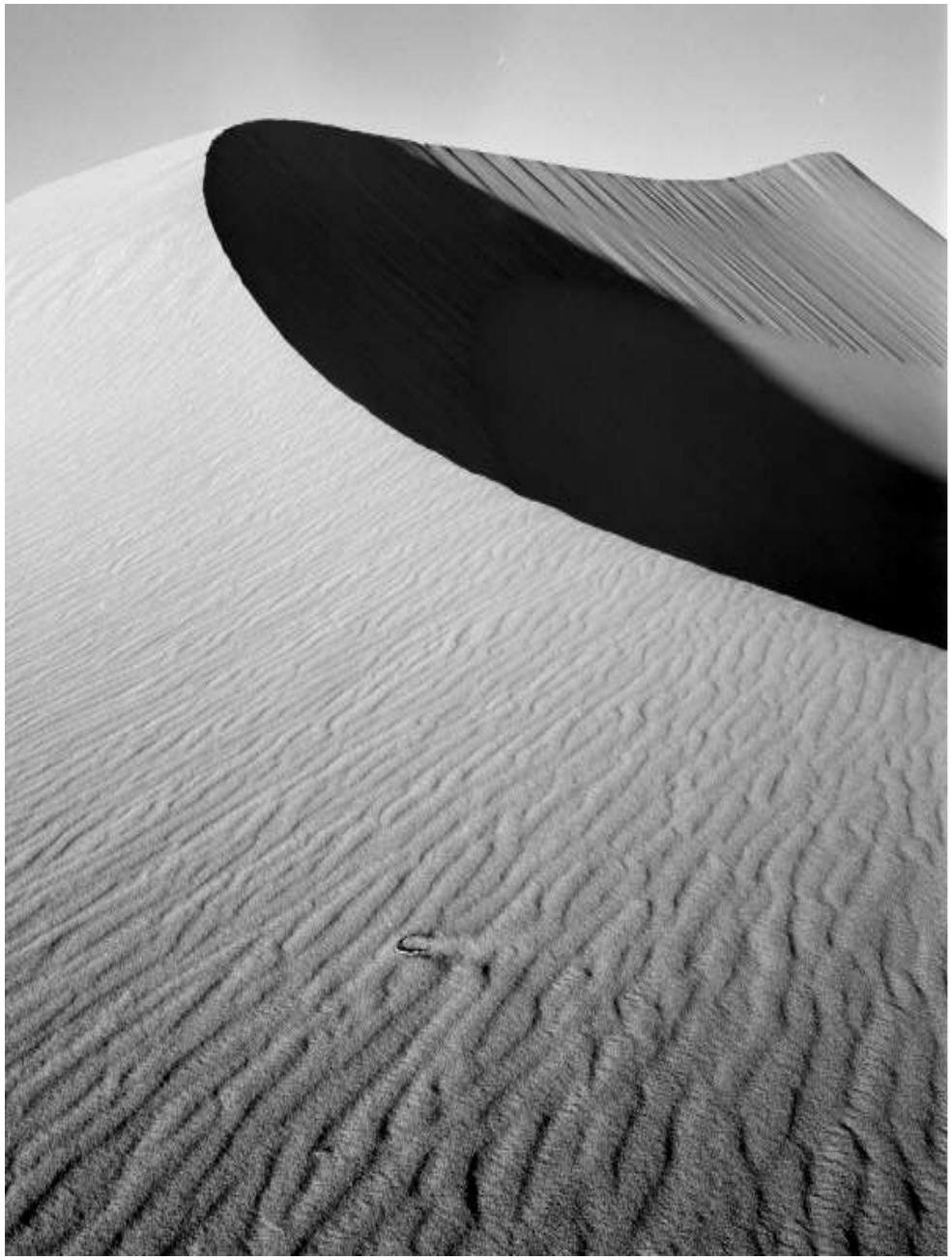


# KEY STAGES IN DIGITAL IMAGE PROCESSING: COLOUR PROCESSING



# APPLICATIONS

- Document Handling
- Signature Verification
- Biometric Verification
- Object Recognition Research
- Target Recognition
- Interpretation of aerial photography
- Autonomous Vehicle
- Traffic Monitoring
- Face Recognition and Tracking
- Medical Applications -> Tumor detection
- Image generations
- Image styling



THANK YOU
Banu Prakash