Multimedia Data Types: Digital Image Representation

Lecture 03

BIL464 Multimedia Systems

Mustafa Sert
Asst. Prof.
msert@baskent.edu.tr

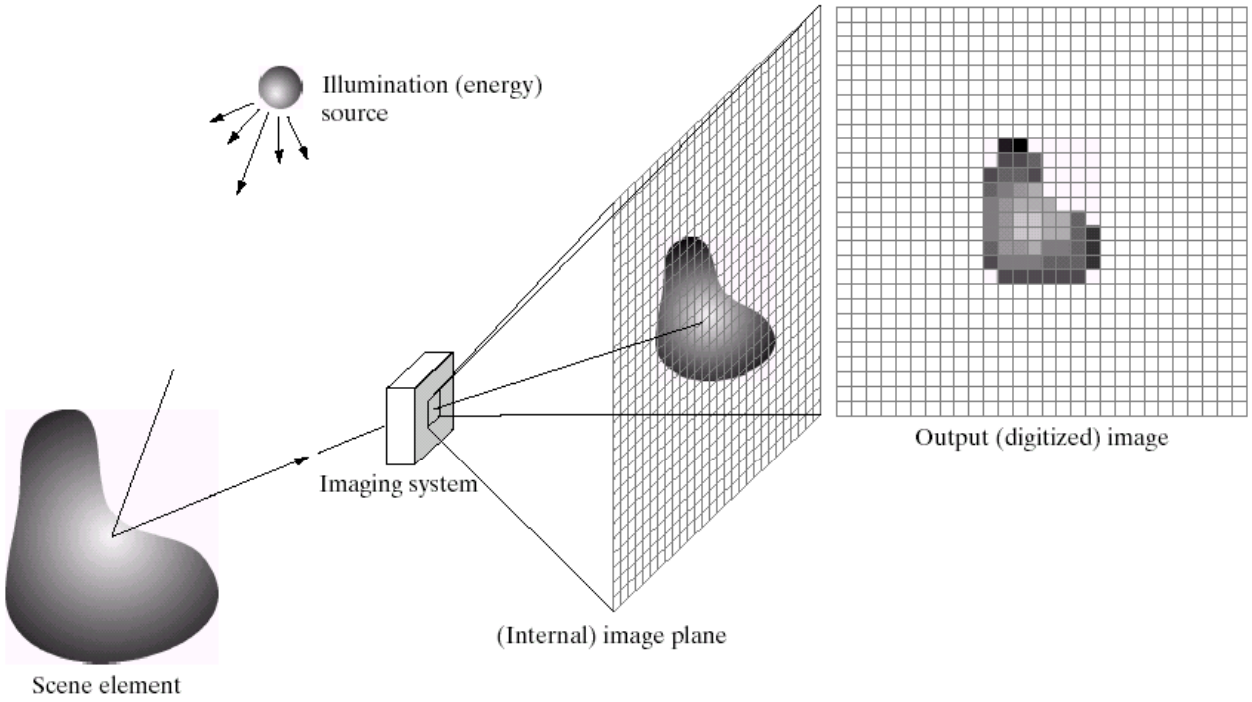
Department of Computer Engineering, Başkent University
Ankara 06810 TURKEY

Content

- What is a digital image?
- The nature of digital images
- Vector Graphics
- What is digital image processing?
- Examples of digital image processing
- Key stages in digital image processing

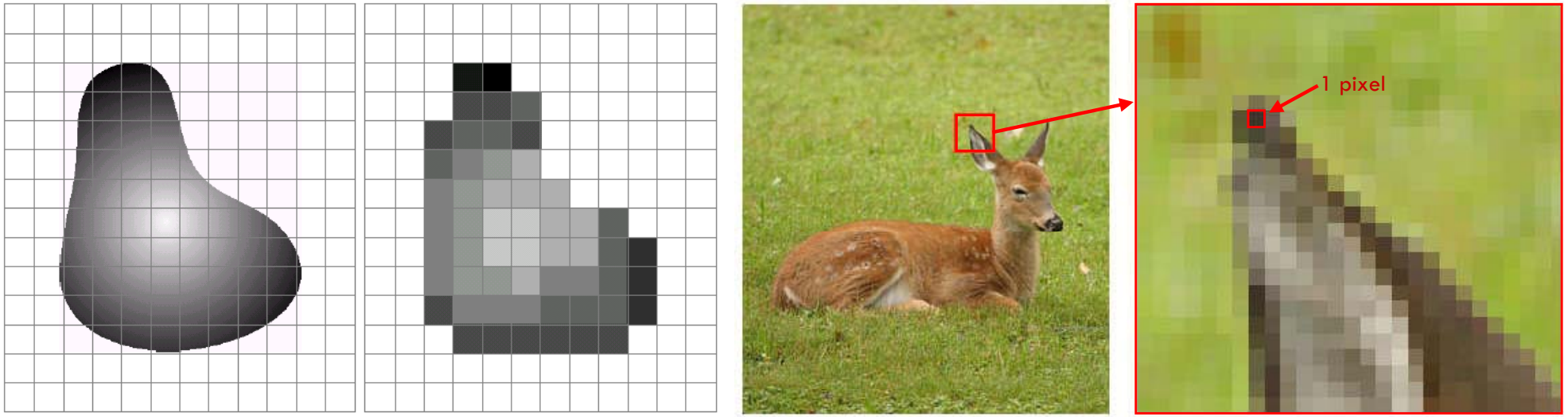
What is a digital image?

- An **image** *is a spatial representation of an object, a two-dimensional or three-dimensional scene* or another image. Often the images reflect the **intensity** *of lights*
- A **digital image** is a representation of a two-dimensional image as a finite set of digital values, called picture elements or pixels



What is a digital image? (*cont.*)

- Pixel values typically represent gray levels, colours, heights, opacities, etc.
- **Remember** *digitization* implies that a digital image is an approximation of a real scene

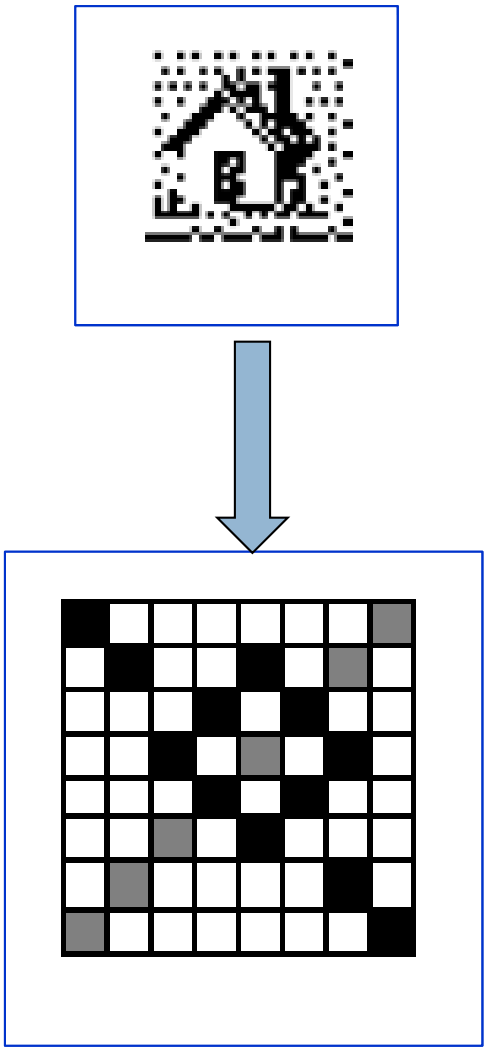


What is digital image? (*cont.*)

- More formally, the term **image** refers to a two-dimensional light intensity function **f(x,y)**
- The amplitude at spatial coordinates x,y gives the intensity (brightness) of the image at that location.
  - In black and white pictures the intensity is called gray levels.
  - Picture samples are quantized to a set of discrete, equally spaced gray level values. This is the digital picture made up of pixels

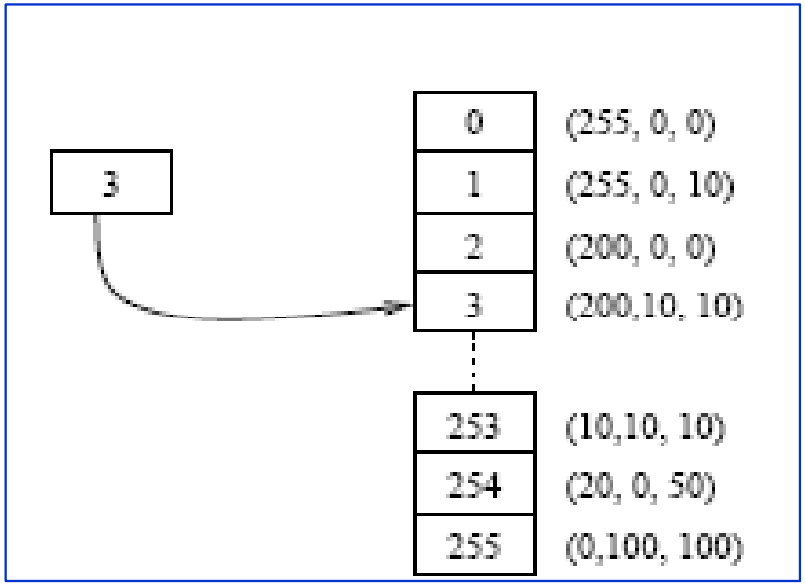
The Nature of Digital Images

- *Depth* of an image is the number of bits used to represent each pixel.
  - **1-bit** black-and-white image, also called *bitmap image*.
  - **4-bit** can represent 16 colours, used in low resolution screens(EGA/VGA)



The Nature of Digital Images – *Cont.*

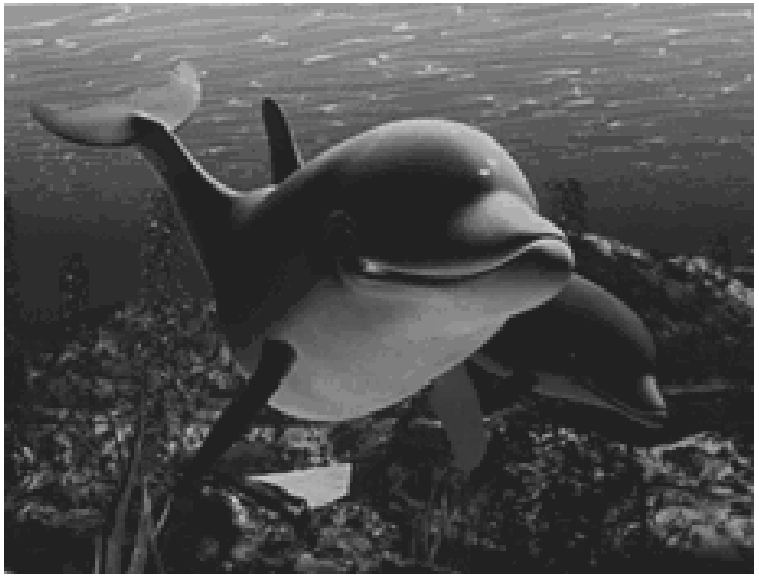
- 8-bit can have 256 colours. The 256 colour images are often known as *indexed* colour images. The values are actually indexes to a table of many more different colours. For example, Colour 3 is mapped to (200, 10, 10).



255	0	0	0	0	0	0	128
0	255	0	0	255	0	128	0
0	0	0	255	0	255	0	0
0	0	255	0	128	0	255	0
0	0	0	255	0	255	0	0
0	0	128	0	255	0	0	0
0	128	0	0	0	0	255	0
128	0	0	0	0	0	0	255

Gray-Level Images

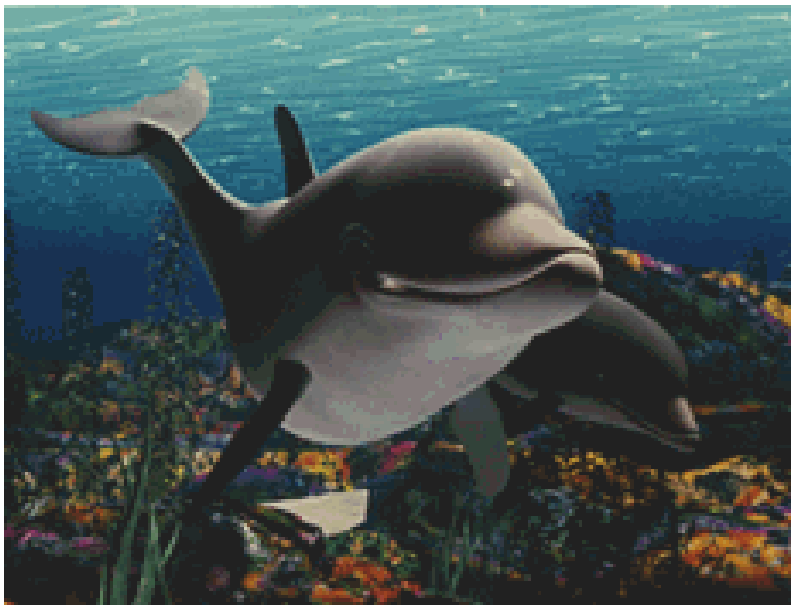
- 8-bit gray images
- 256 gray-levels
  - The image contains only brightness/intensity data without colour information.



The Nature of Digital Images – *Cont.*

- 16-bit can have 65536 colours, also known as high-colour in Windows systems. The 16 bits are divided into 5 bits for RED, 6 bits for GREEN and 5 bits for BLUE. 4-bit can represent 16 colours, used in low resolution screens(EGA/VGA)

RED	GREEN	BLUE	Colour
255	0	0	Red
0	255	0	Green
0	0	255	Blue
255	255	0	Yellow
255	0	255	Magenta
0	255	255	Cyan
127	127	127	Light gray
255	255	255	White
0	0	0	Black



The Nature of Digital Images – *Cont.*

- 24 bit $2^{24} = 16.777.216$ colours, true colour. Each byte is used to represent the intensity of a primary colour, RED, GREEN and BLUE. Each colour can have 256 different levels.

- 32 bit $2^{32} = 4.294.967.296$ (4G). Usually, 3 bytes are used to represent the three primary colours and the fourth byte is used as the *alpha channel*.

Resolution

- Resolution – measures how much detail an image can have.
- There are 3 (three) resolutions relating to images:
  - Image resolution
  - Display (monitor) resolution
  - Output resolution

Resolution – *Cont.*

- Image resolution – *is the number of pixels within an image*

  320 x 240 = 76800 pixels, 700 x 700 = 490000 pixels

- Display (Monitor) resolution – refers to number of dots per inch (dpi) on a monitor.
  - Windows systems usually have 96dpi resolution. Some high resolution video adapters/monitors support 120dpi. For instance, a 288 x 216 image displayed on a monitor with 96dpi will be 3″ x 2.25 ″
- Output resolution – refers to number of dots per inch (dpi) on a (hard copy) output device.
  - Many printers have 300dpi or 600dpi resolution. High-quality imagesetters can print at a range between 1200dpi and 2400dpi, or higher. The above image printed on a 300dpi printer will be 0.96 x 0.72 inch.

Graphics Data

- Graphic data is the most complex both to handle and to obtain because it is unnatural.
- As well as using pixels, objects can be represented by their attributes, such as size, colour, location, and so on. This type of graphics is known as **vector graphics** or **vector drawing**. This is an abstract representation of a 2D or 3D scene
- A vector graphics file contains graphics primitives, such as:
  - lines,
  - rectangles,
  - circles,
  - text,
  - strings,
  - 2 or 3 dimensional objects etc

Vector Graphics (*cont.*)

- Three types of languages for describing vector graphics are:
  - PostScript
  - VRML (Virtual Reality Markup Language)
  - SVG (Scalable Vector Graphic)
- **PostScript** was developed by Adobe as a page description language
- **SVG (Scalable Vector Graphic)** stands for Scalable Vector Graphic. It is a language for describing two-dimensional graphics in XML. It allows three types of graphics objects: vector graphic shapes, images and text.

Vector Graphics (*cont.*)

- **VRML** stands for Virtual Reality Markup Language. It is for describing a scene in a virtual world

```
Cube {
  Width 30 Depth 30 Height 30}
Material {
  ambientColor 0.2 0.2 0.2
  diffuseColor 0.8 0.8 0.8
  specularColor 0 0 0
  emissiveColor 0 0 0
  shininess 0.2
  transparency 0
  }
```

Vector vs. Bitmap Images

Bitmap Images

- A bitmap contains an exact pixel-by-pixel value of an image
- A bitmap file is fixed in resolution
- The file size of a bitmap is completely determined by the image resolution and its depth
- A bitmap image is easier to render

Vector Graphics

- a vector graphic contains mathematical description of objects
- a vector graphic is resolution independent
- the file size of a vector graphic depends on the number of graphic elements it contains
- displaying a vector graphic usually involves a large amount of processing

What is Digital Image Processing?

- Digital image processing focuses on two major tasks
  - Improvement of pictorial information for human interpretation
  - Processing of image data for storage, transmission and representation for autonomous machine perception
- Some argument about where image processing ends and fields such as image analysis and computer vision start

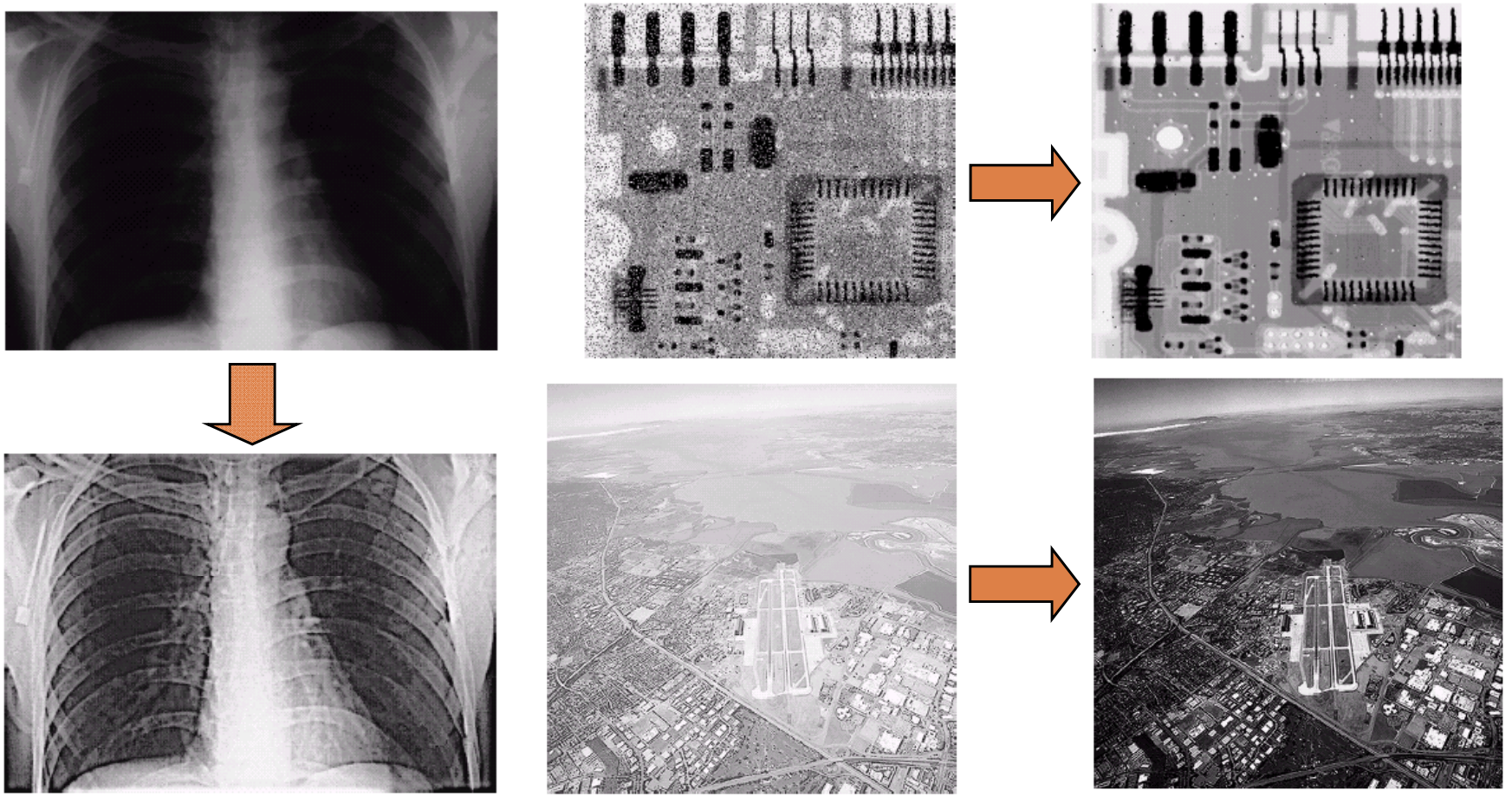
What is DIP? (*cont.*)

- The continuum from image processing to computer vision can be broken up into low-, mid- and high-level processes

Low Level Process	**Mid Level Process**	**High Level Process**
Input: Image **Output:** Image **Examples:** Noise removal, image sharpening	**Input:** Image **Output:** Attributes **Examples:** Object recognition, segmentation	**Input:** Attributes **Output:** Understanding **Examples:** Scene understanding, autonomous navigation

Examples – Image Enhancement

- One of the most common uses of DIP techniques: improve quality, remove noise etc

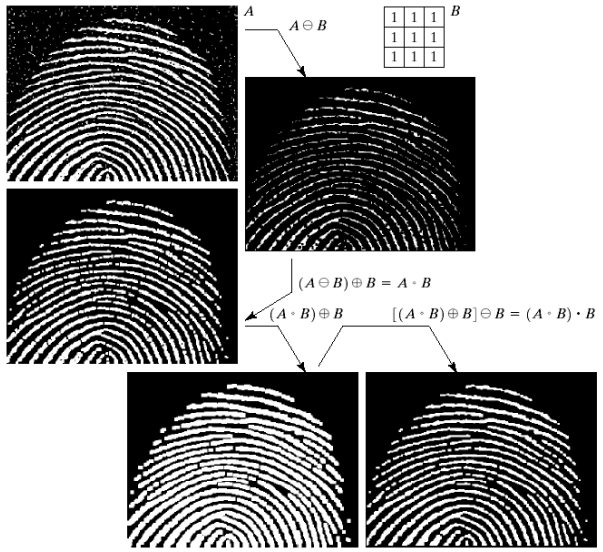


Examples – Artistic Effects

- Artistic effects are used to make images more visually appealing, to add special effects and to make composite images

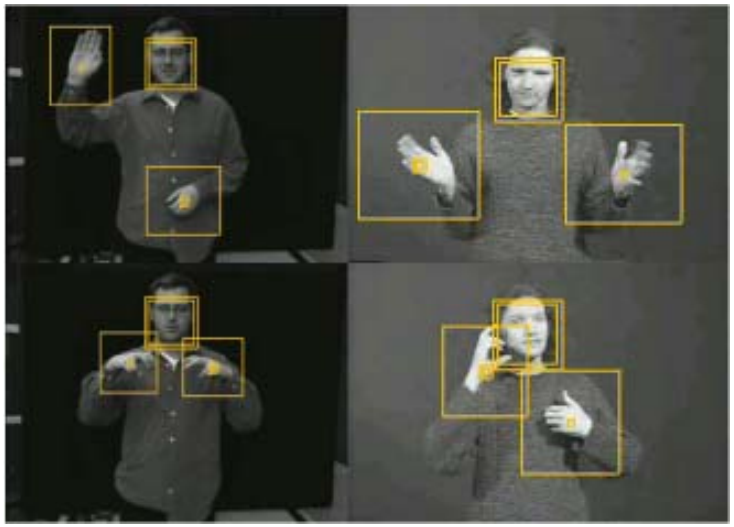
Examples – Law Enforcement

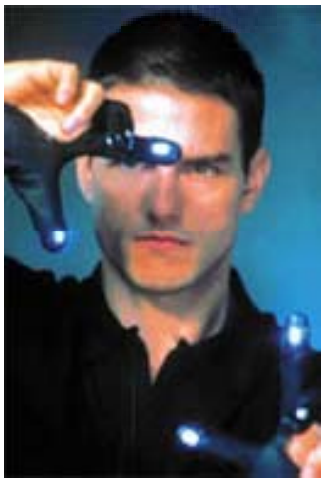
- Image processing techniques are used extensively by law enforcers
  - Number plate recognition for speed cameras/automated toll systems
  - Fingerprint recognition
  - Enhancement of

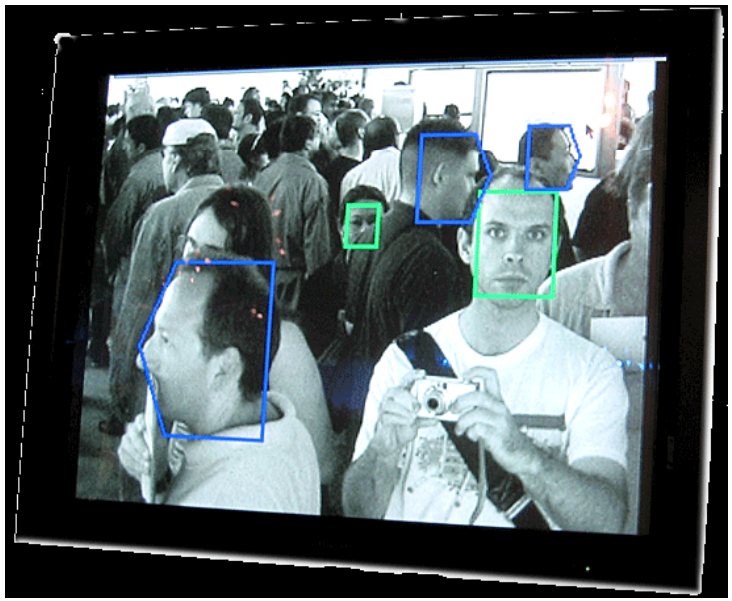


Examples – HCI

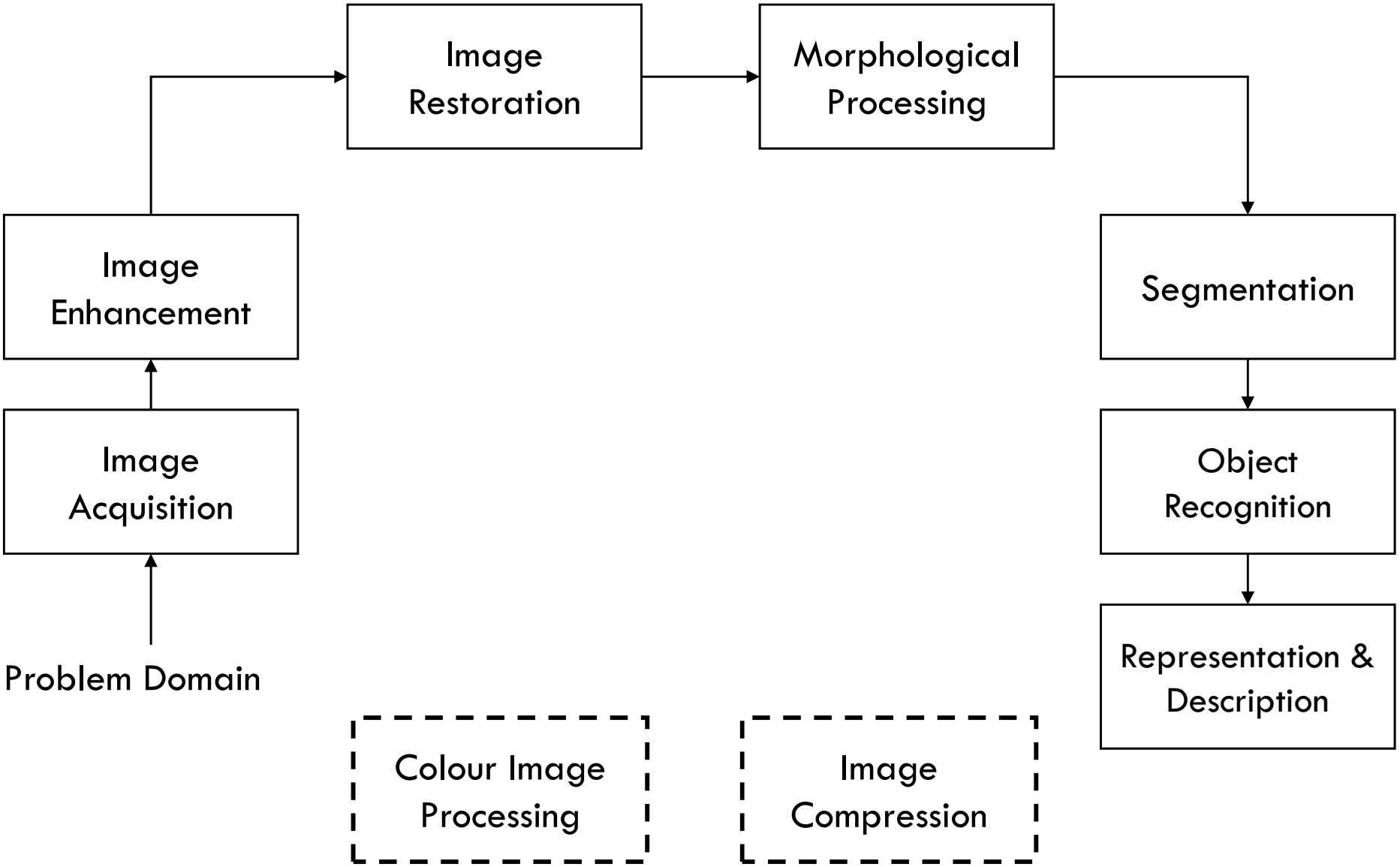
- Try to make human computer interfaces more natural
  - Face recognition
  - Gesture recognition
- Does anyone remember the user interface from "Minority Report"?
- These tasks can be extremely difficult



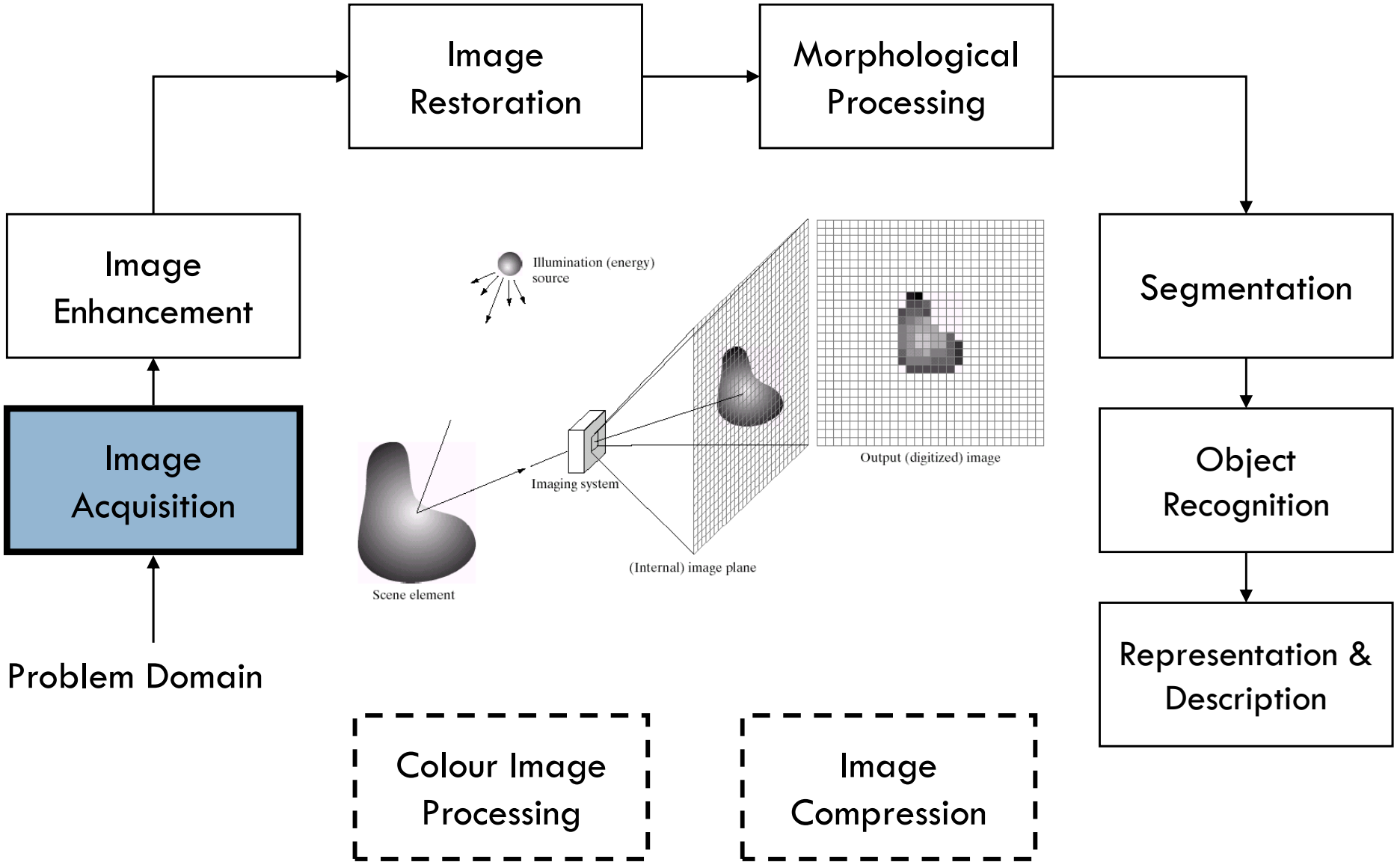




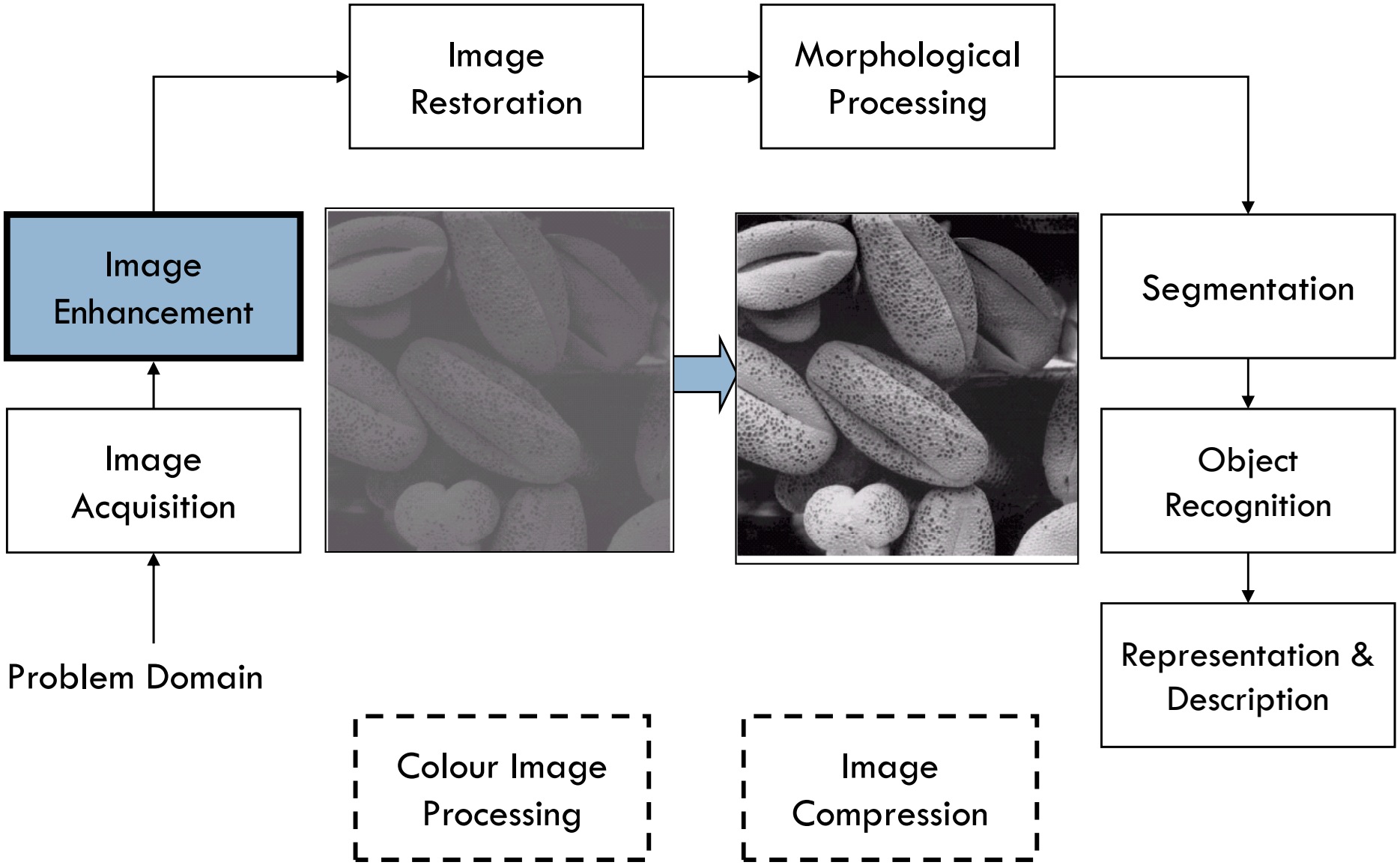
Key Stages in Digital Image Processing



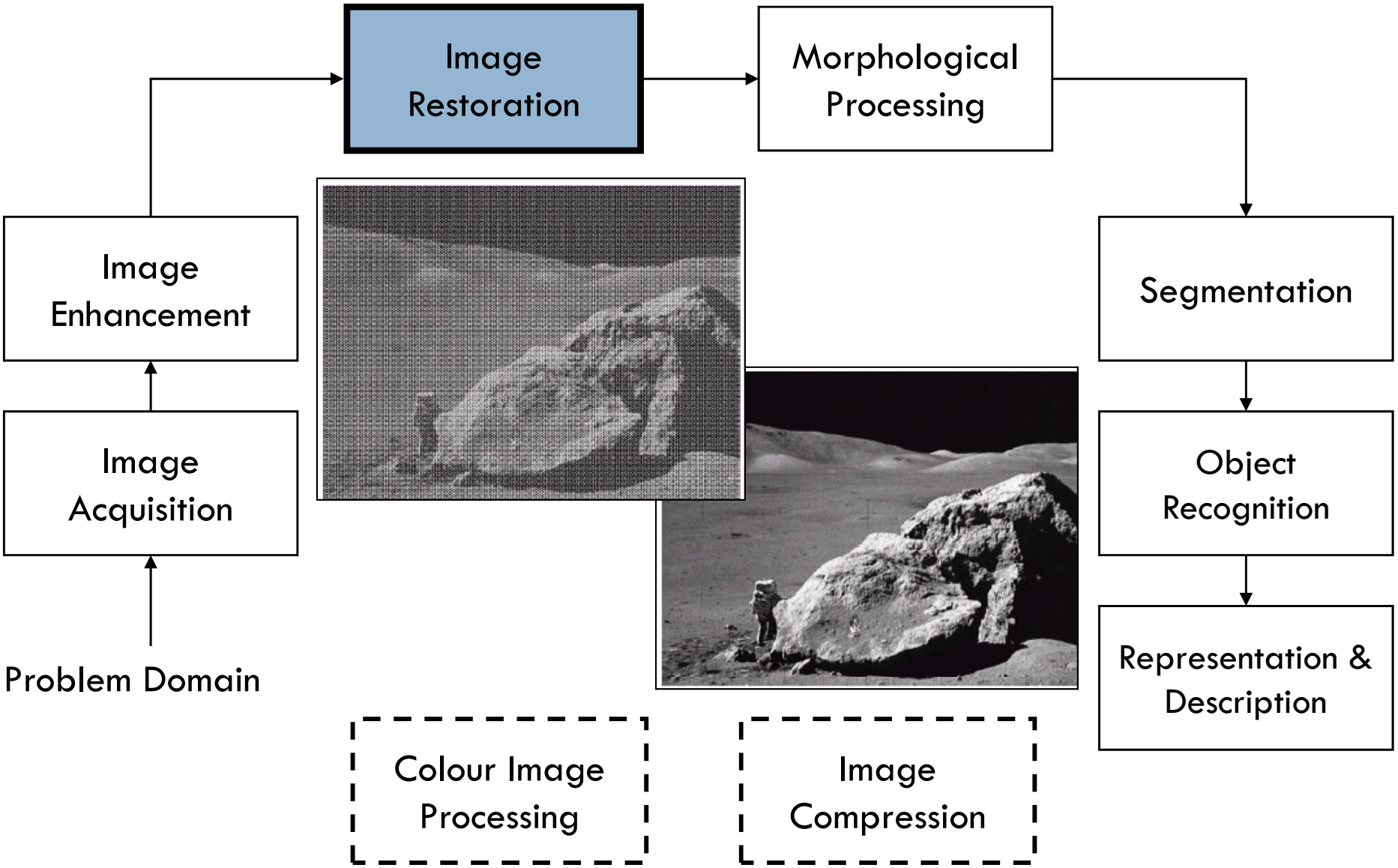
Key Stages in Digital Image Processing: Image Acquisition



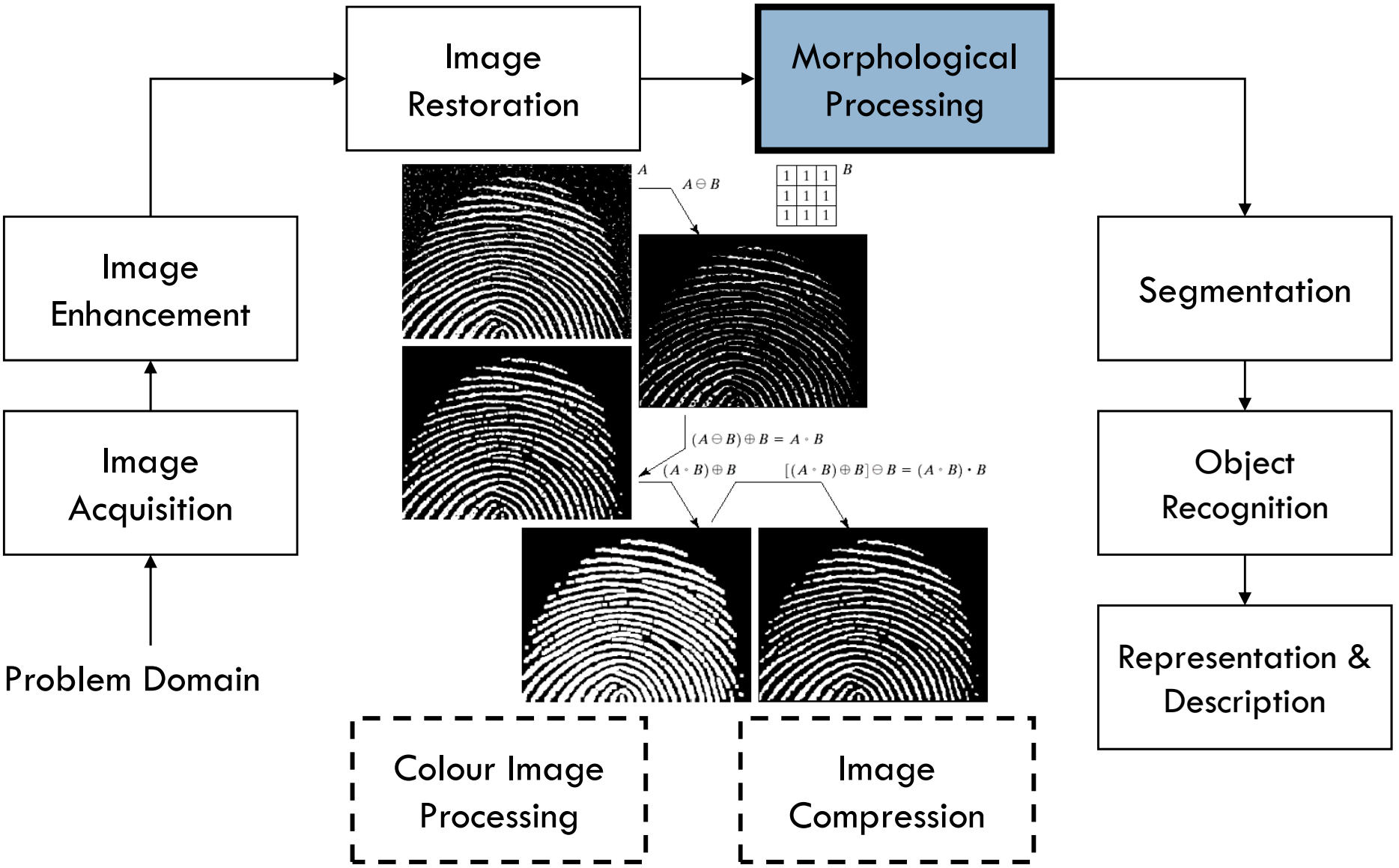
Key Stages in Digital Image Processing: Image Enhancement



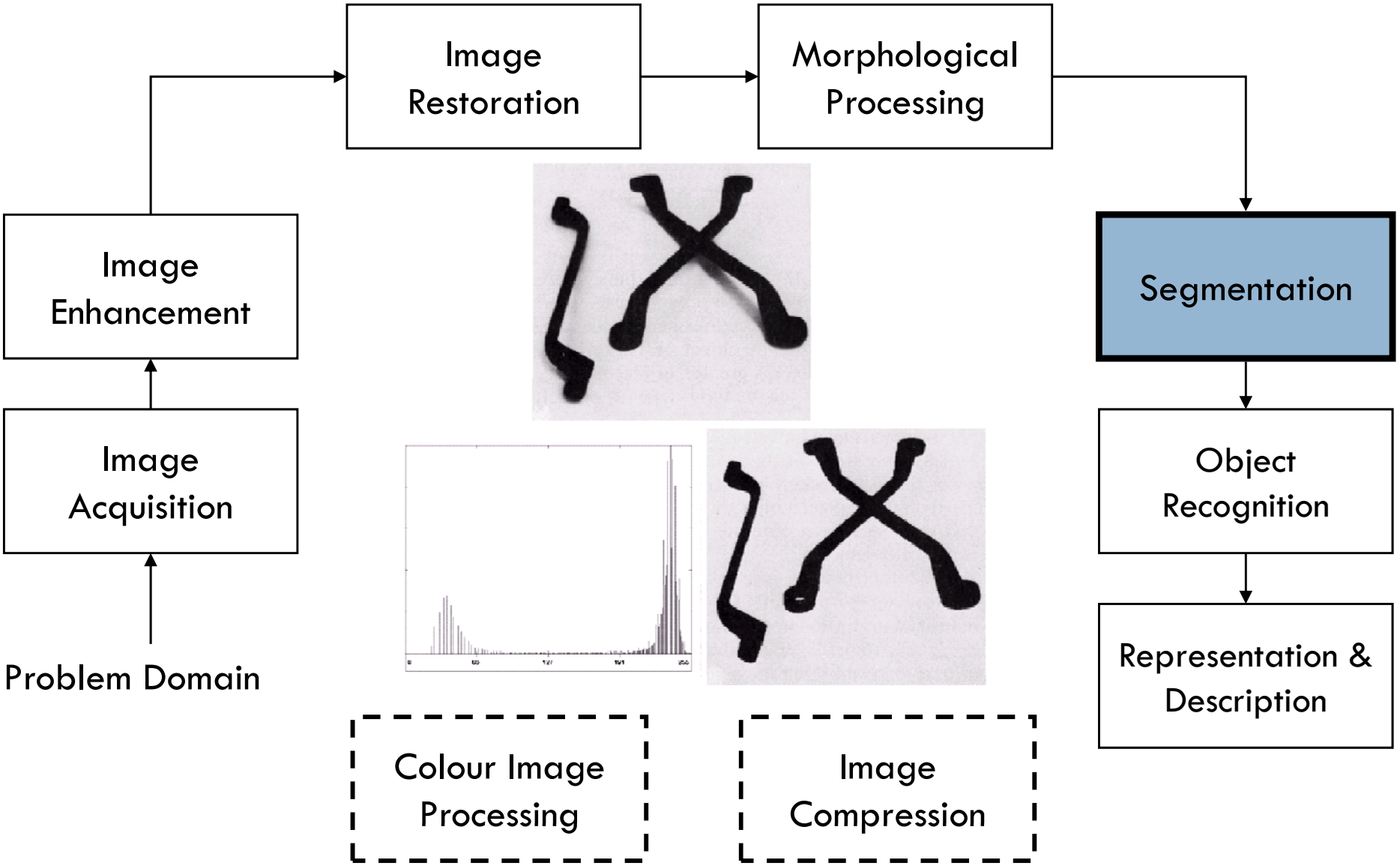
Key Stages in Digital Image Processing: Image Restoration



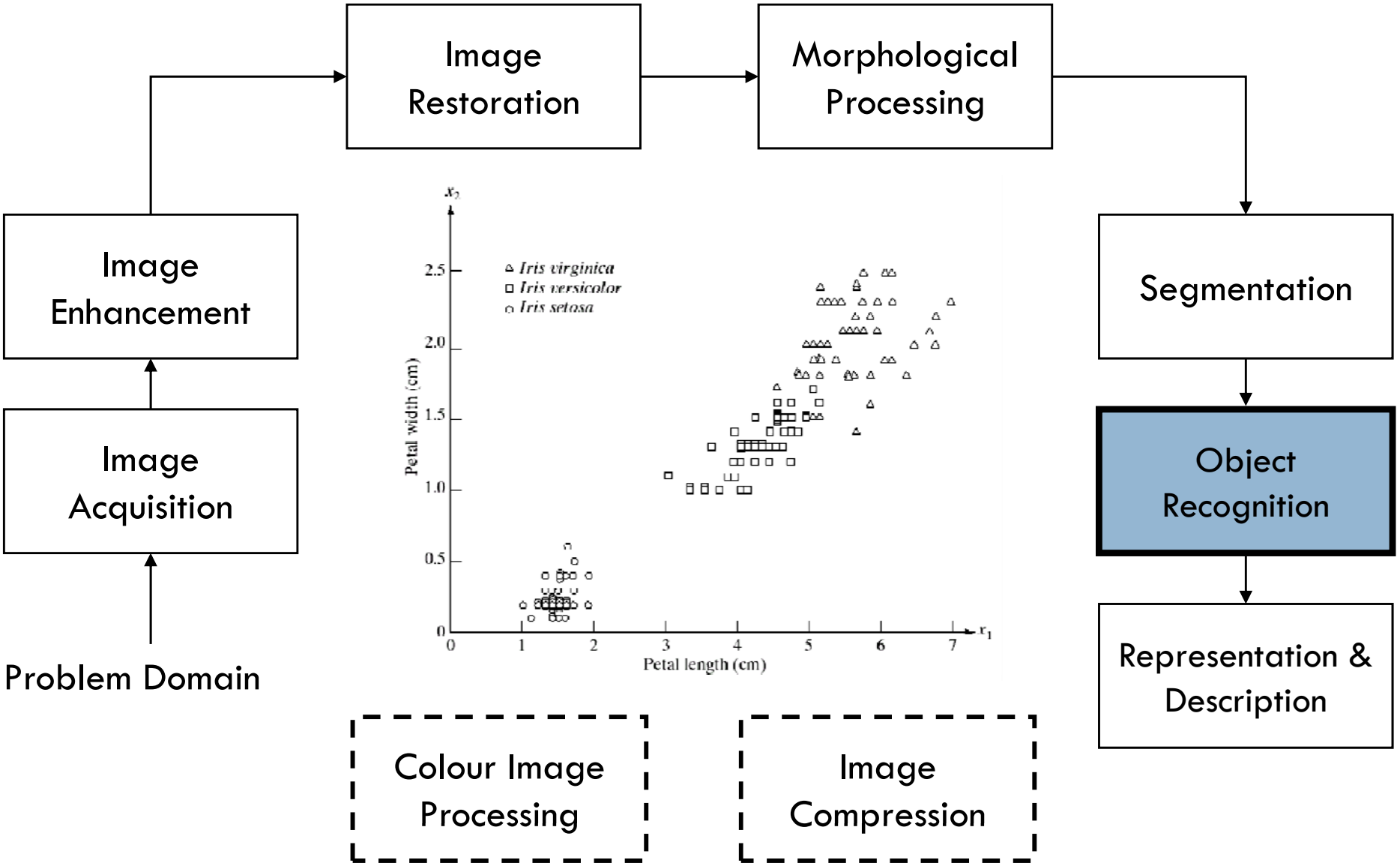
Key Stages in Digital Image Processing: Morphological Processing



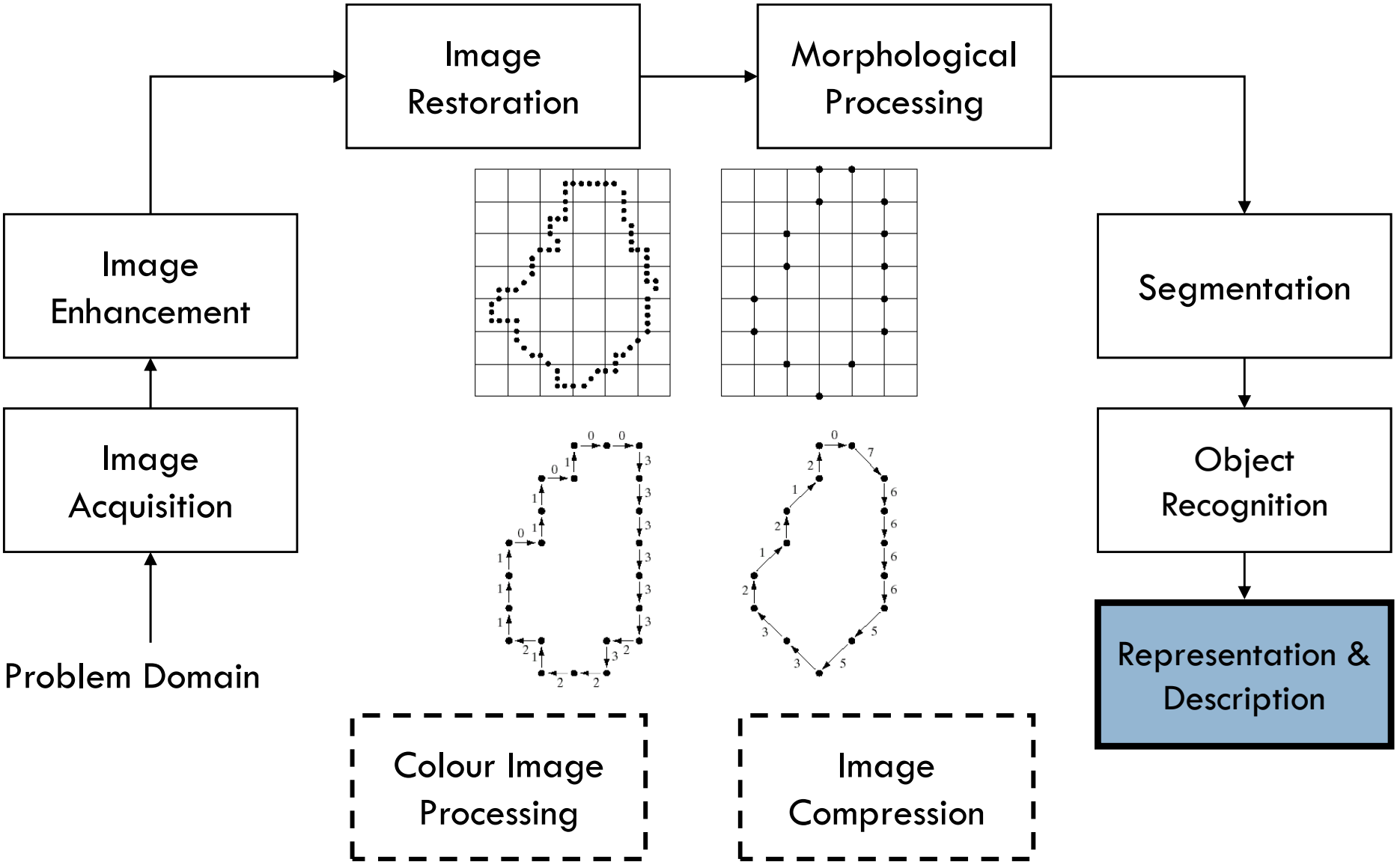
Key Stages in Digital Image Processing: Segmentation



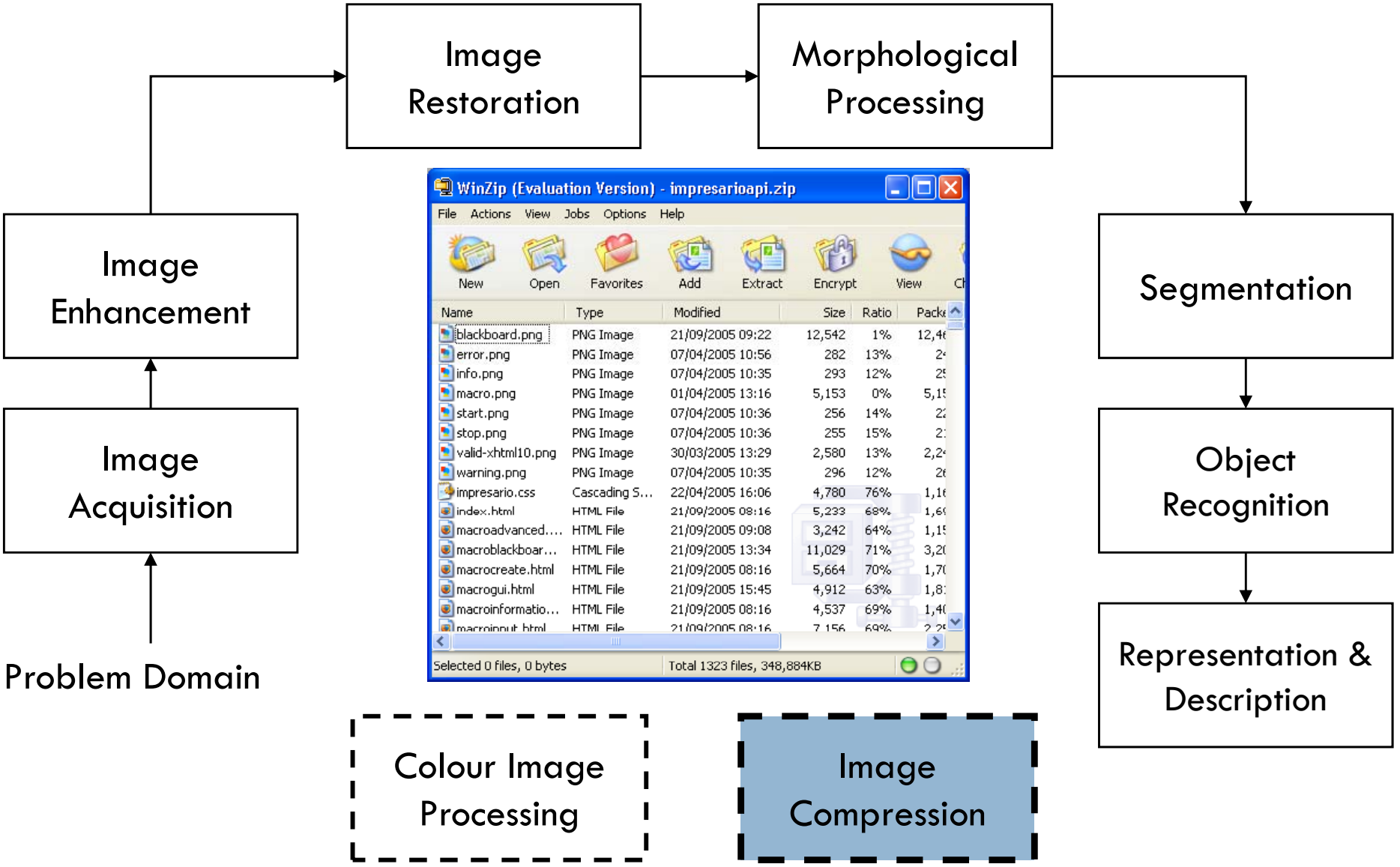
Key Stages in Digital Image Processing: Object Recognition



Key Stages in Digital Image Processing: Representation & Description



Key Stages in Digital Image Processing: Image Compression



Key Stages in Digital Image Processing: Colour Image Processing