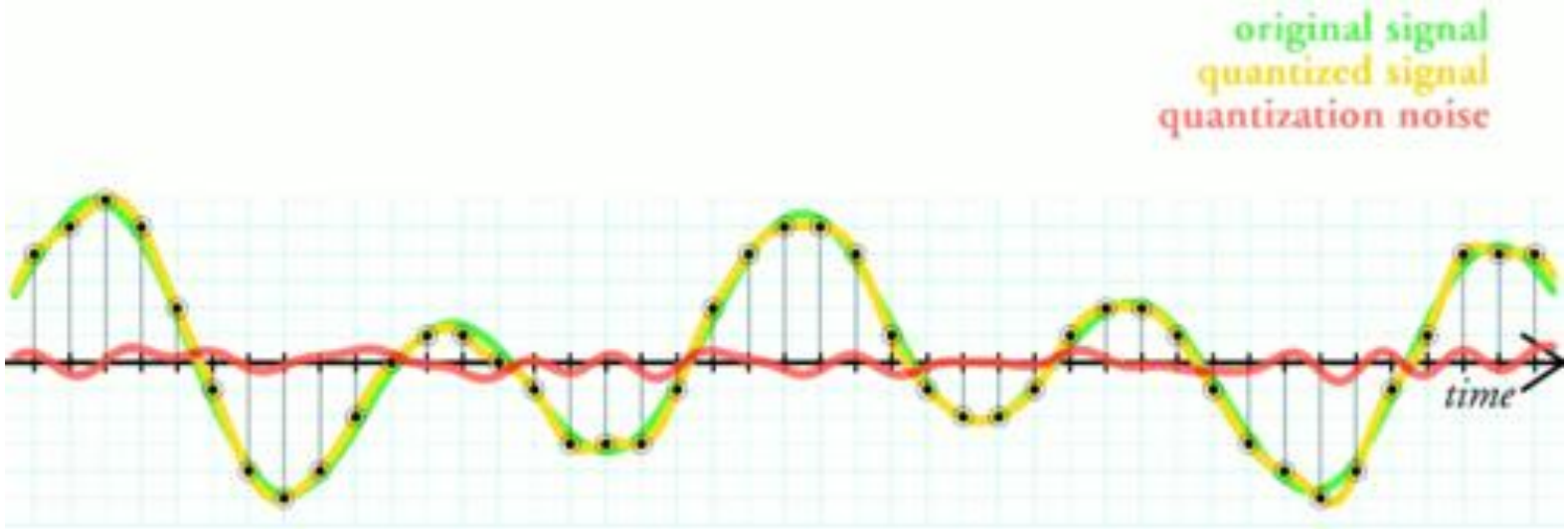
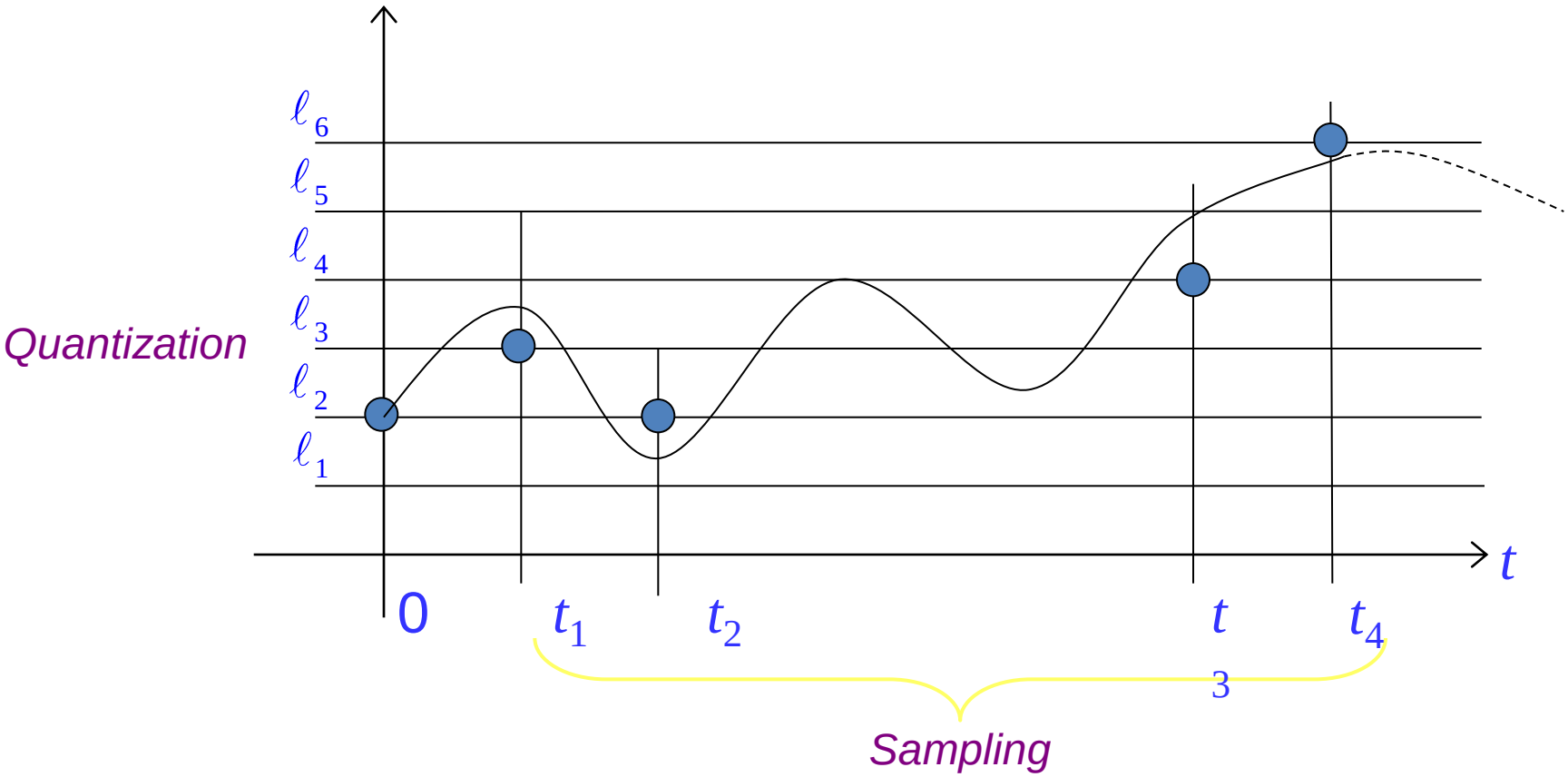
Sampling and Quantization

Quantization, in mathematics and digital signal processing, is the process of mapping a large set of input values to a (countable) smaller set – such as rounding values to some unit of precision. A device or algorithmic function that performs quantization is called a quantizer. The round-off error introduced by quantization is referred to as quantization error.


original signal
quantized signal
quantization noise
time


Quantization
ℓ_6
ℓ_5
ℓ_4
ℓ_3
ℓ_2
ℓ_1
0
t_1
t_2
t_3
t_4
t
Sampling

Sampling

- In signal processing, **sampling** is the reduction of a continuous signal to a discrete signal.

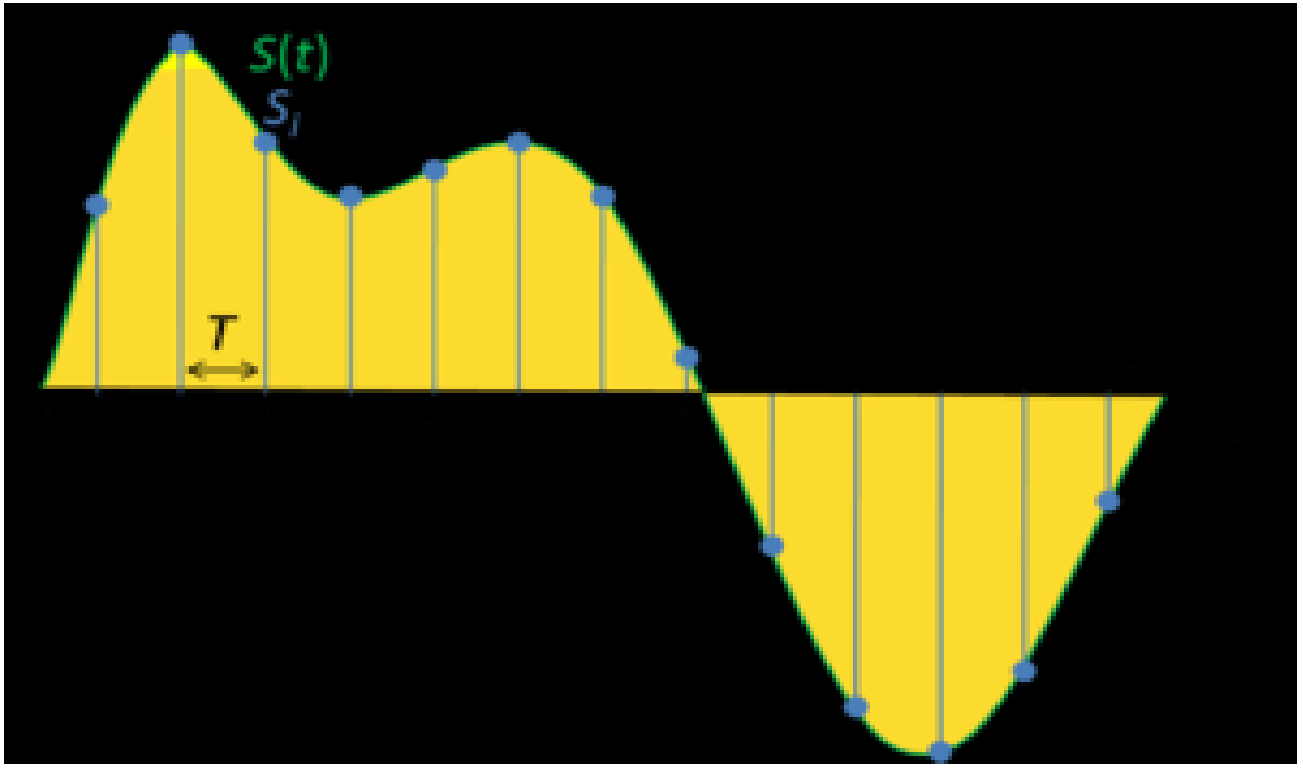
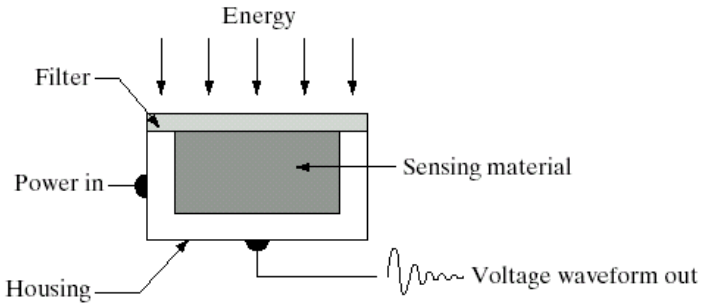


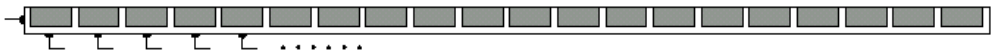
Image Sensing

Incoming energy lands on a sensor material responsive to that type of energy and this generates a voltage

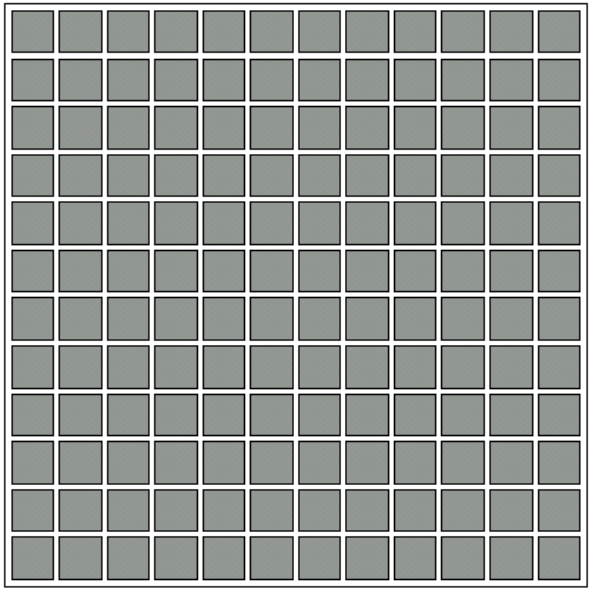
Collections of sensors are arranged to capture images



Imaging Sensor



Line of Image Sensors



Array of Image Sensors

Image Sampling And Quantisation

A digital sensor can only measure a limited number of **samples** at a **discrete** set of energy levels

Quantisation is the process of converting a continuous **analogue** signal into a digital representation of this signal

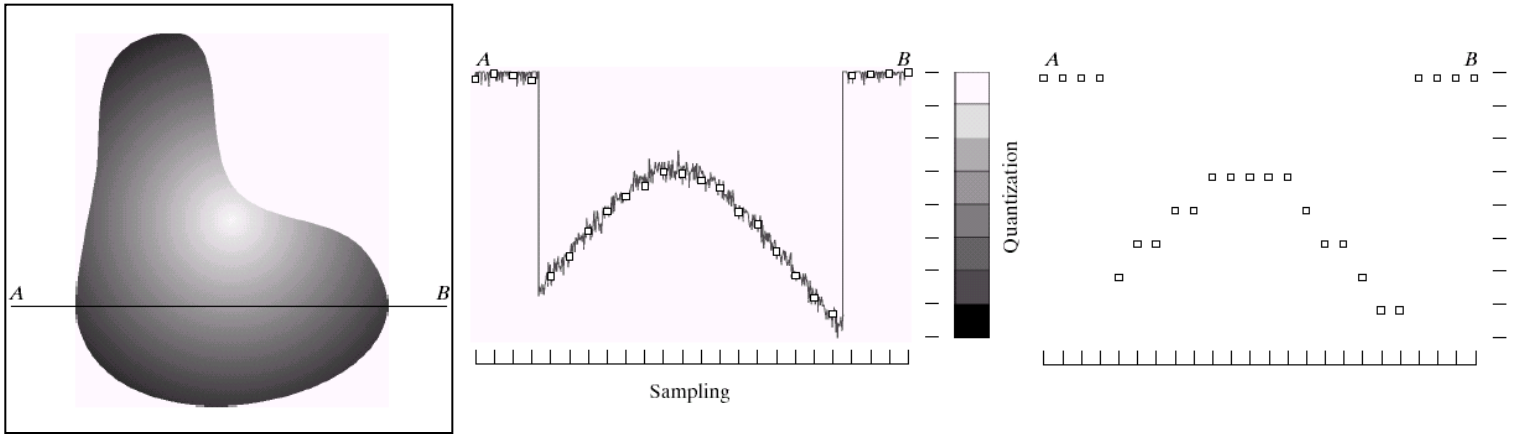


Image Sampling And Quantisation

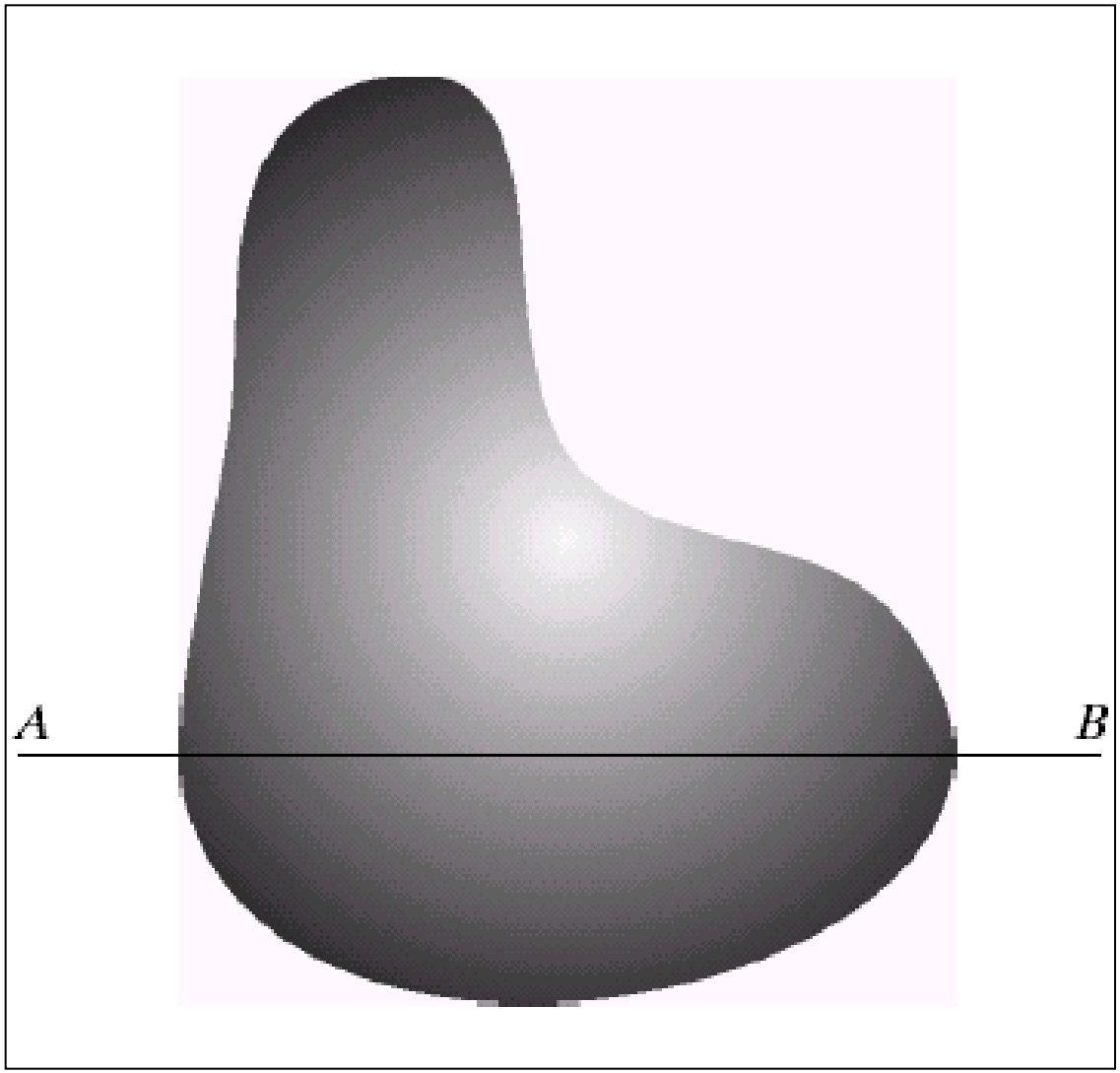
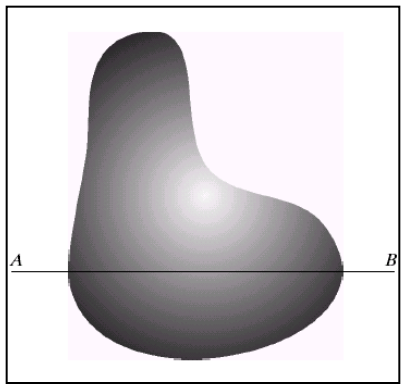


Image Sampling And Quantisation



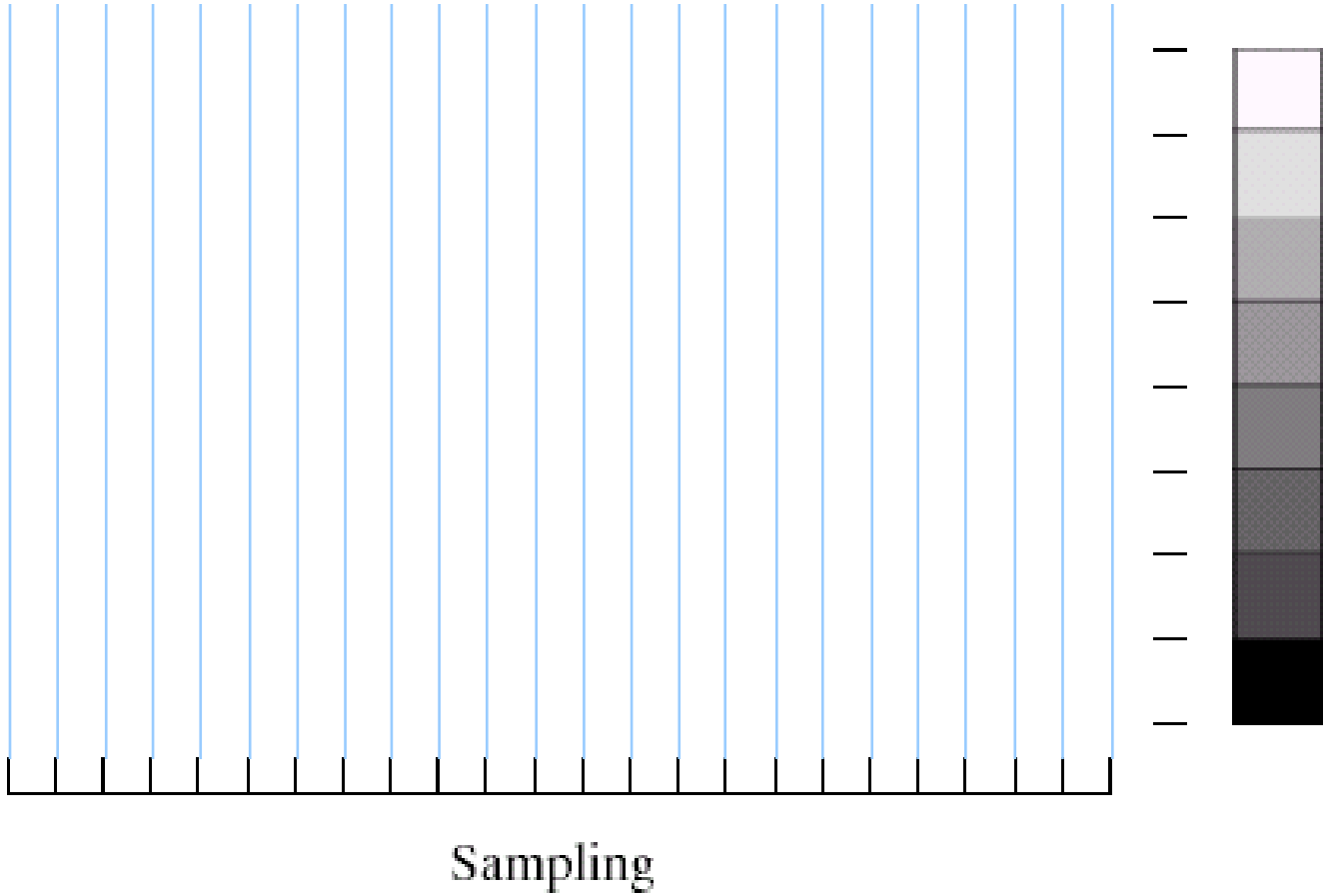
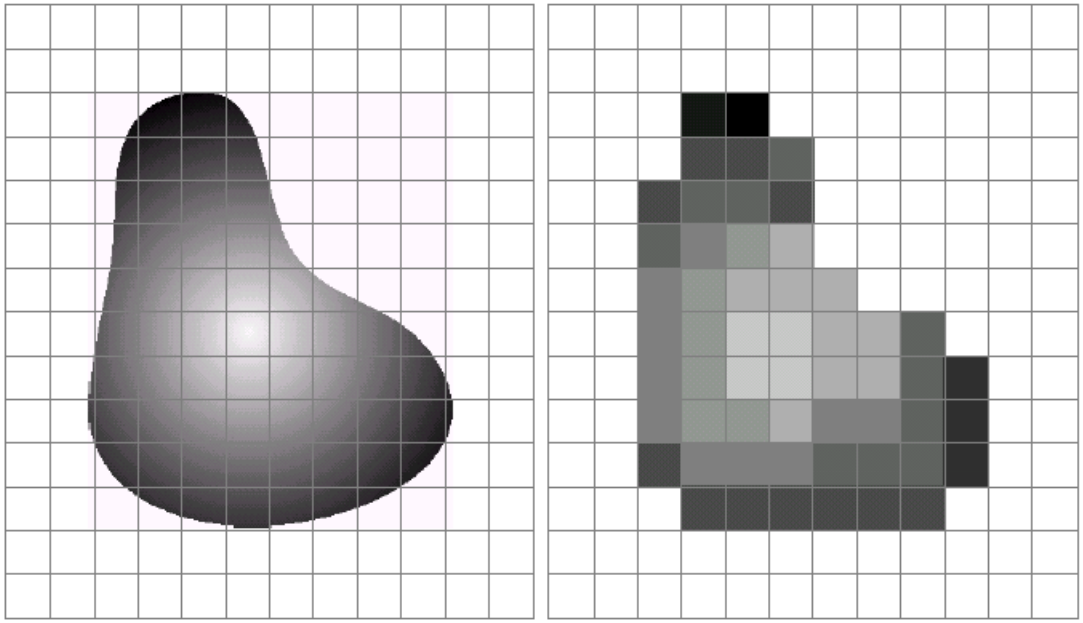


Image Sampling And Quantisation (cont…)

Remember that a digital image is always only an **approximation** of a real world scene



Spatial Resolution

The spatial resolution of an image is determined by how sampling was carried out

Spatial resolution simply refers to the smallest discernable detail in an image

- Vision specialists will often talk about pixel size
- Graphic designers will talk about *dots per inch* (DPI)

Spatial Resolution (cont…)

Spatial Resolution (cont…)

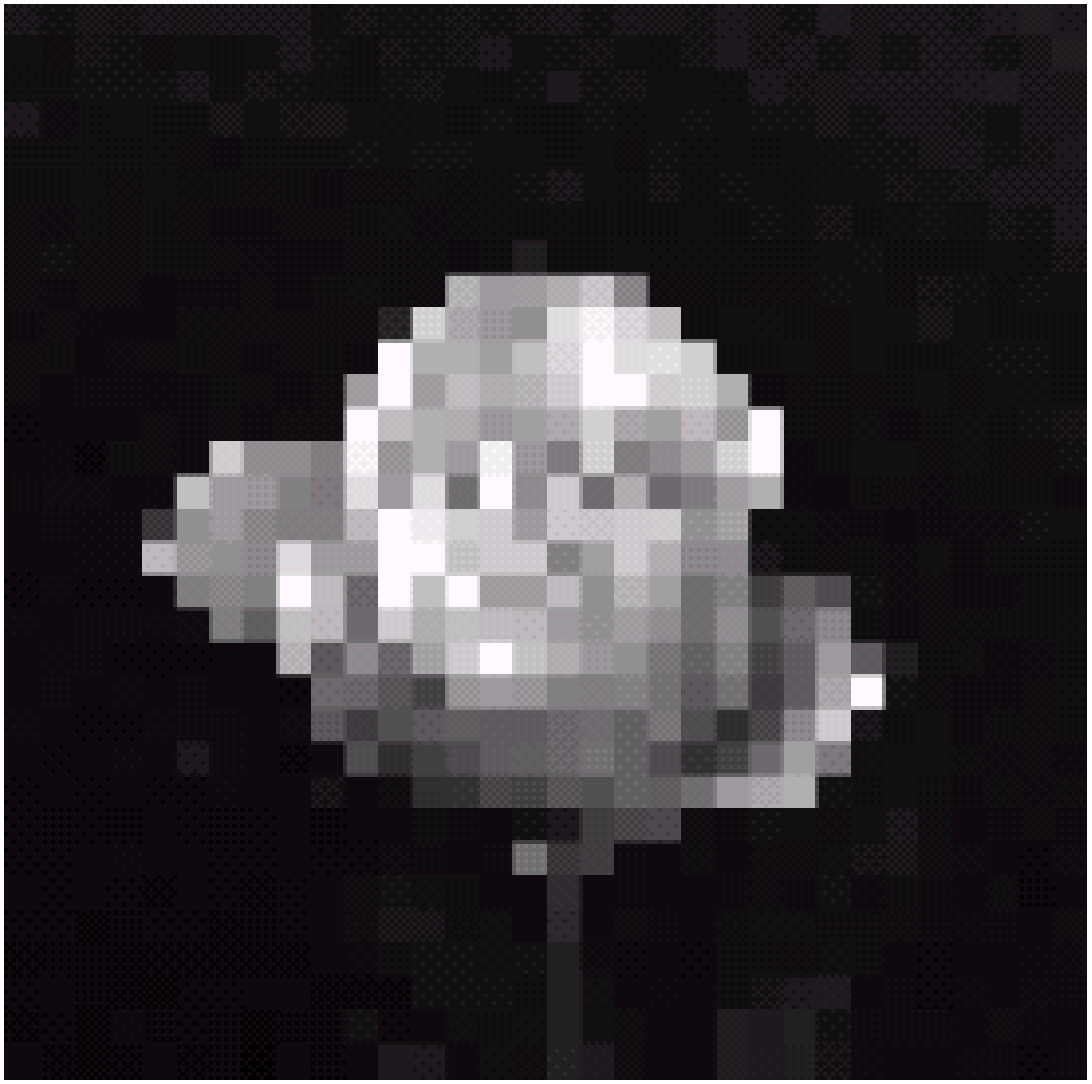
Spatial Resolution (cont…)

Spatial Resolution (cont…)

Spatial Resolution (cont…)

Spatial Resolution (cont…)

Spatial Resolution (cont…)



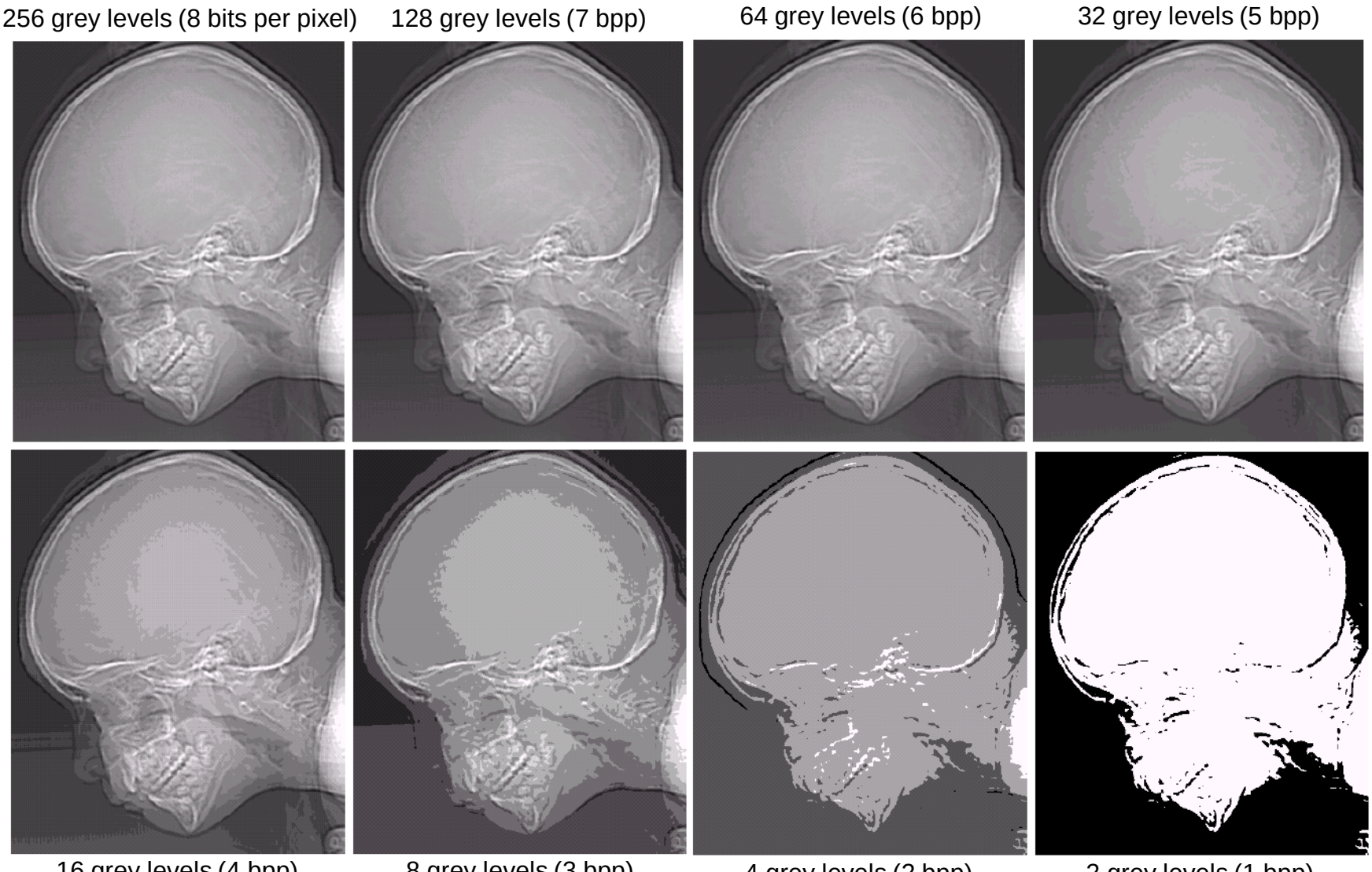
Intensity Level Resolution

Intensity level resolution refers to the number of intensity levels used to represent the image

- The more intensity levels used, the finer the level of detail discernable in an image
- Intensity level resolution is usually given in terms of the number of bits used to store each intensity level

Number of Bits	Number of Intensity Levels	Examples
1	2	0, 1
2	4	00, 01, 10, 11
4	16	0000, 0101, 1111
8	256	00110011, 01010101
16	65,536	1010101010101010

Intensity Level Resolution (cont…)



Intensity Level Resolution (cont…)

Intensity Level Resolution (cont…)

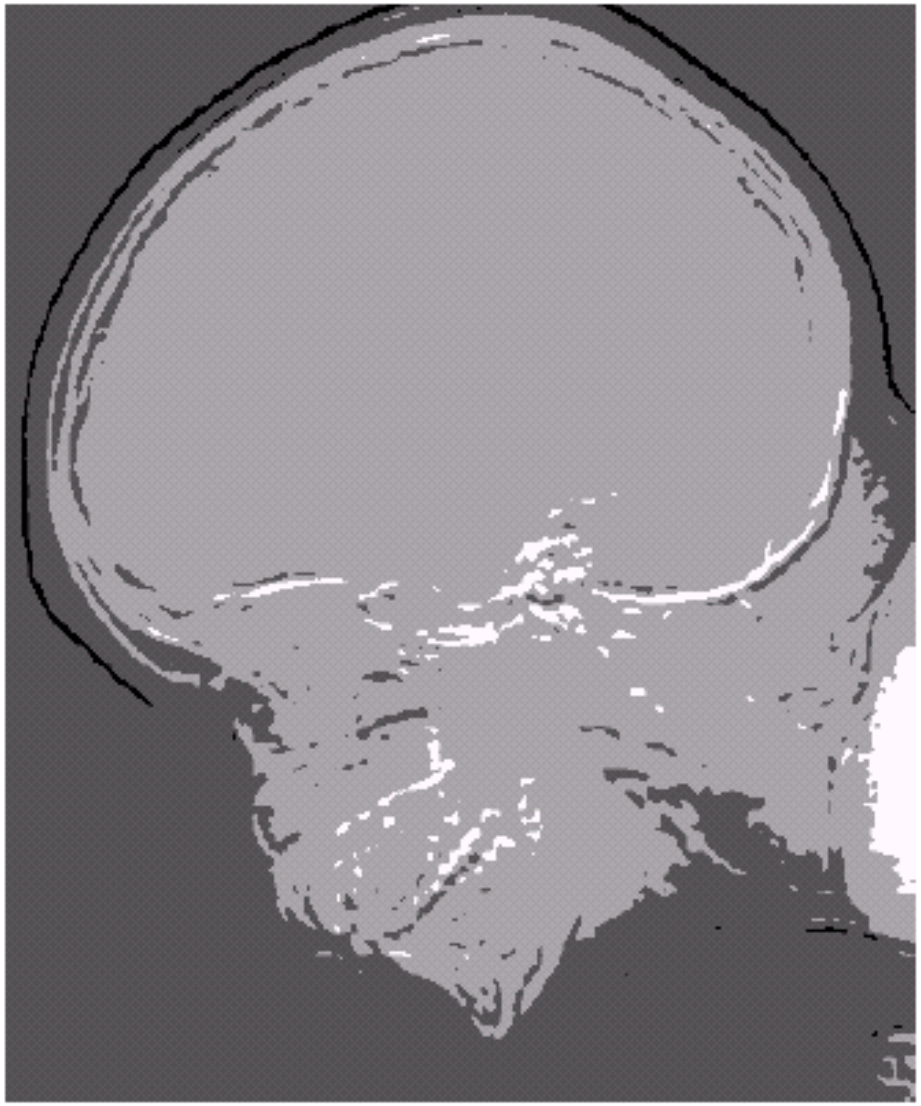
Intensity Level Resolution (cont…)

Intensity Level Resolution (cont…)

Intensity Level Resolution (cont…)

Intensity Level Resolution (cont…)

Intensity Level Resolution (cont…)



Intensity Level Resolution (cont…)

Resolution: How Much Is Enough?

The big question with resolution is always *how much is enough*?

- This all depends on what is in the image and what you would like to do with it
- Key questions include
  - Does the image look aesthetically pleasing?
  - Can you see what you need to see within the image?

Resolution: How Much Is Enough? (cont…)

The picture on the right is fine for counting the number of cars, but not for reading the number plate