Machine Vision

Lecture 4 Part 2

Image Enhancement

Based on lectures of

Brian Mac Namee

Contents

- What is image enhancement?
- Different kinds of image enhancement
- Histogram processing
- Point processing
- Neighbourhood operations

A Note About Grey Levels

So far when we have spoken about image grey level values we have said they are in the range [0, 255]

- Where 0 is black and 255 is white

There is no reason why we have to use this range

- The range [0,255] stems from display

For many of the image processing operations in this lecture grey levels are assumed to be given in the range [0.0, 1.0]

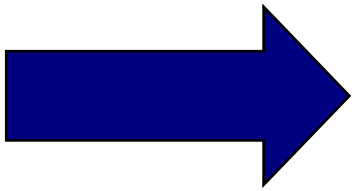
What Is Image Enhancement?

Image enhancement is the process of making images more useful

The reasons for doing this include:

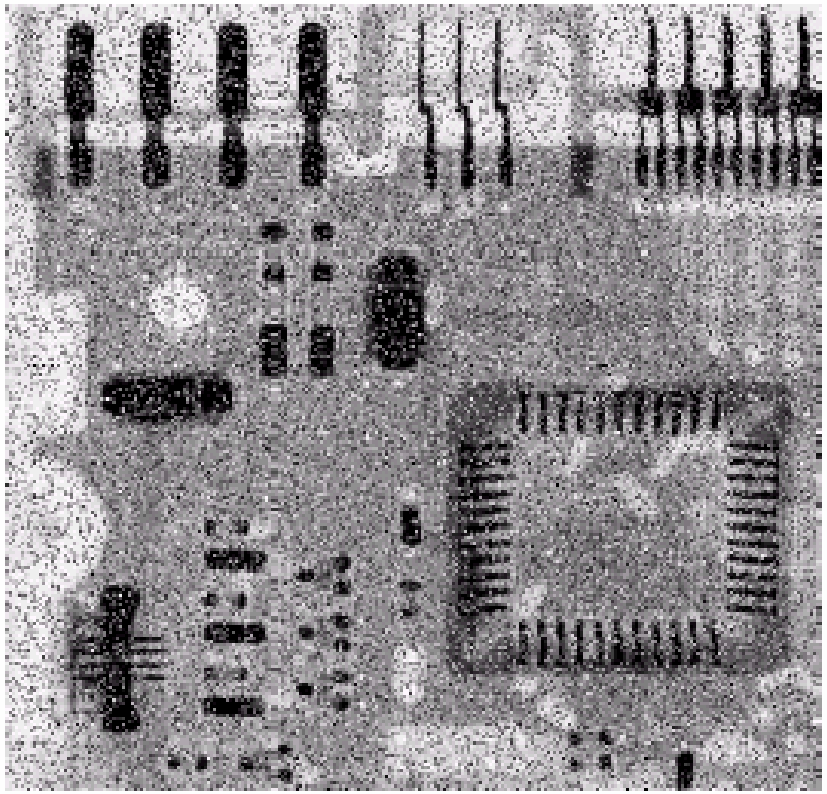
- Highlighting interesting detail in images
- Removing noise from images
- Making images more visually appealing

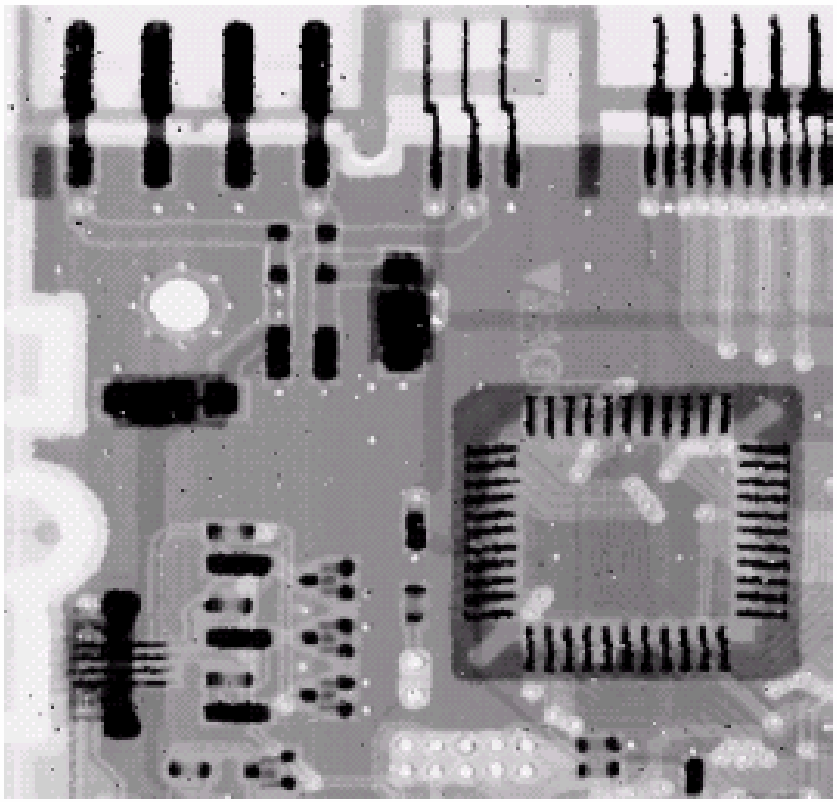
Image Enhancement Examples



Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Image Enhancement Examples (cont…)





Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Image Enhancement Examples (cont…)

Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Spatial & Frequency Domains

There are two broad categories of image enhancement techniques

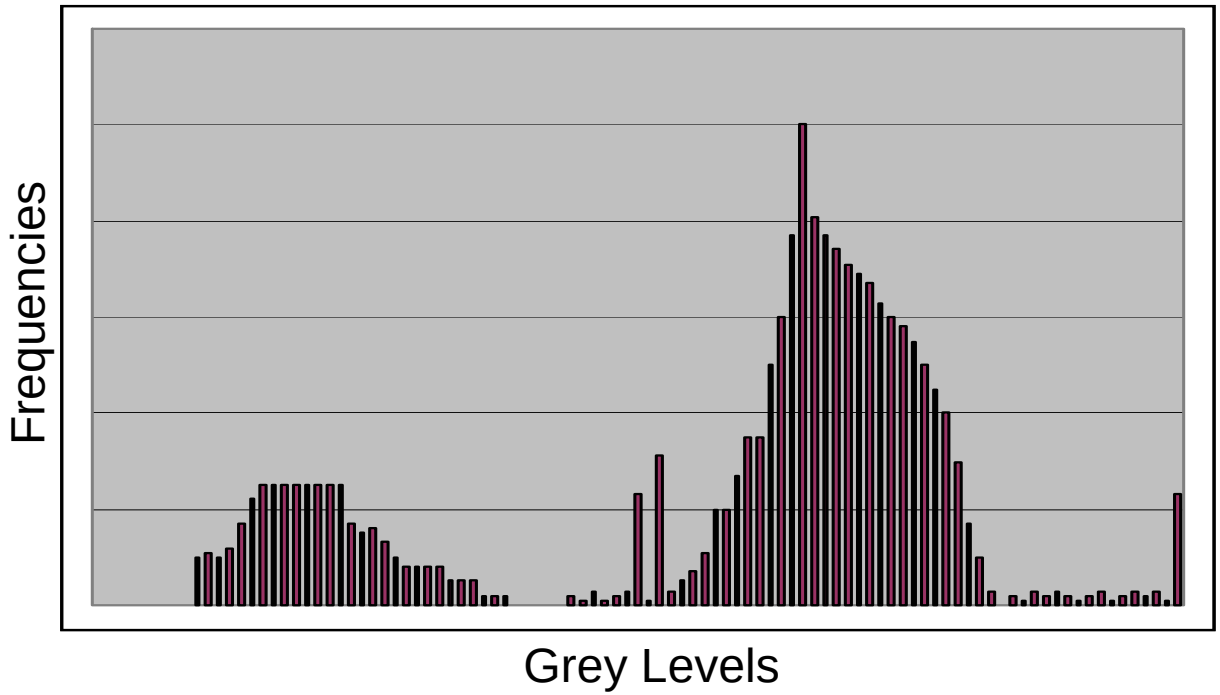
- Spatial domain techniques
  - Direct manipulation of image pixels
- Frequency domain techniques
  - Manipulation of Fourier transform or wavelet transform of an image

For the moment we will concentrate on techniques that operate in the spatial domain

Image Histograms

The histogram of an image shows us the distribution of grey levels in the image

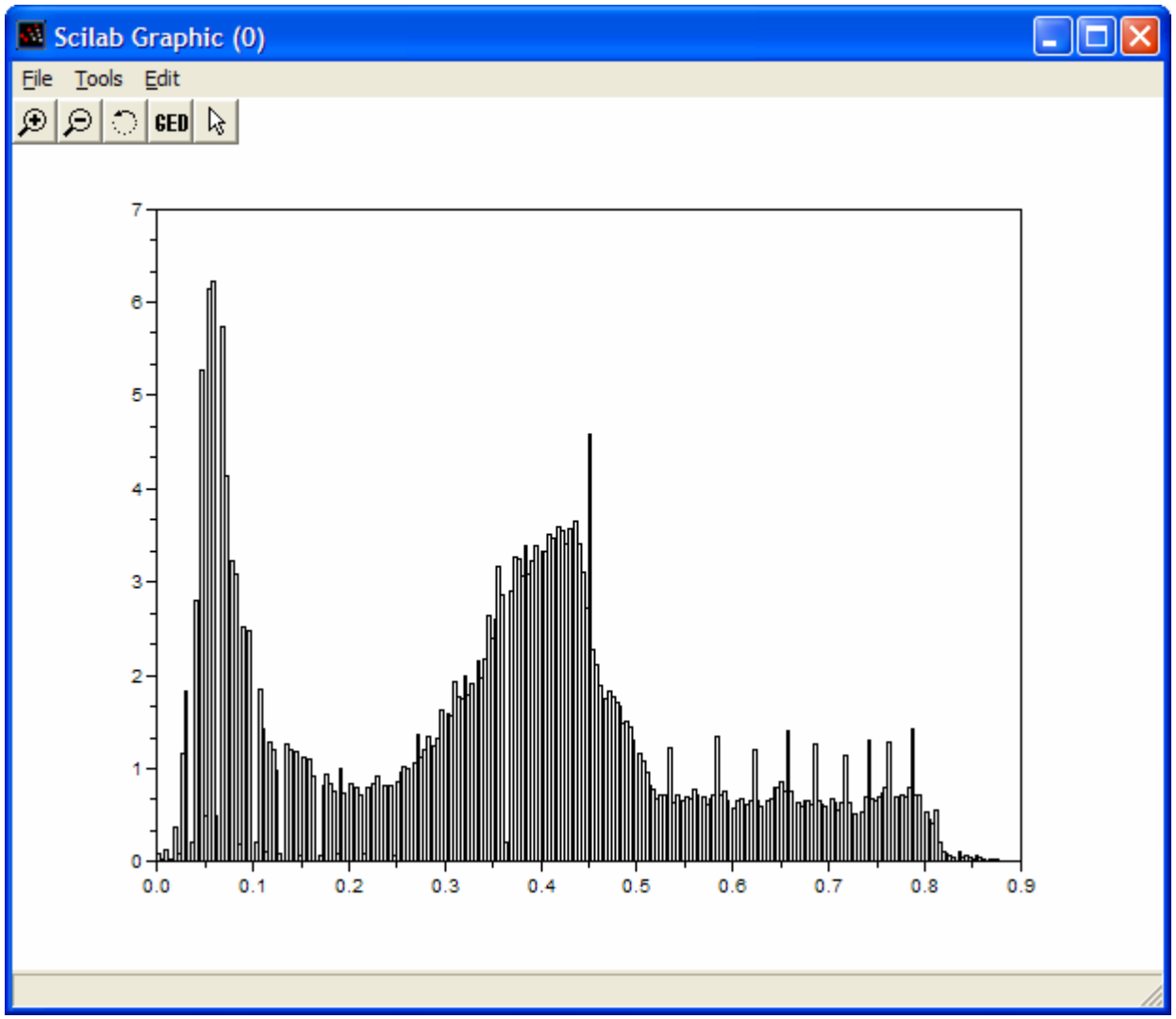
Massively useful in image processing, especially in segmentation



Histogram Examples

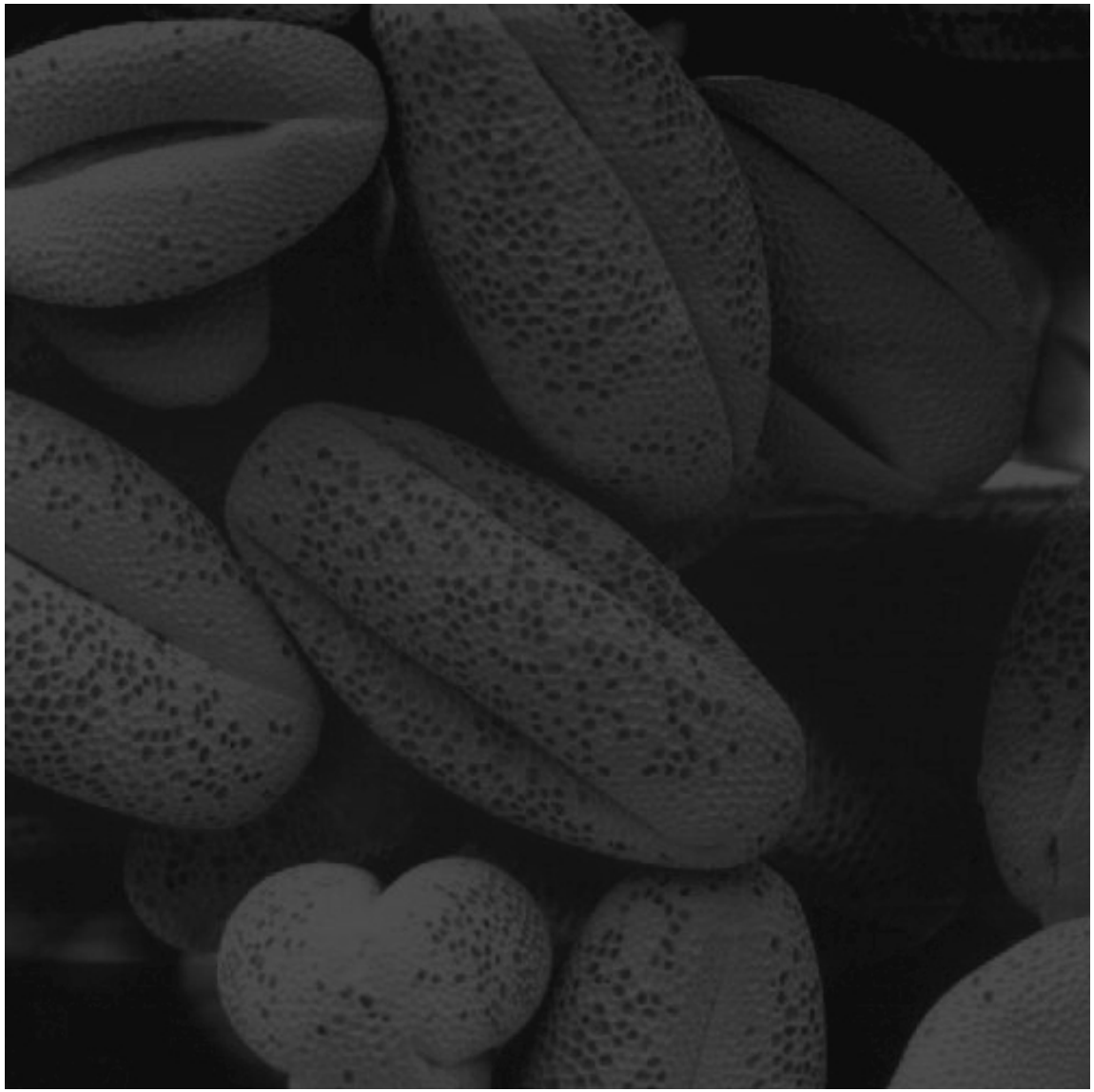
Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Histogram Examples (cont…)



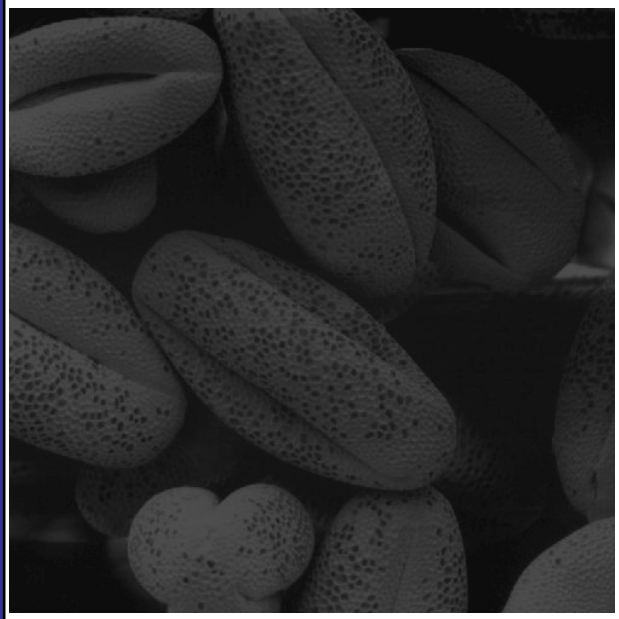
Images taken from Gonzalez & Woods, Digital Image Processing (2002)

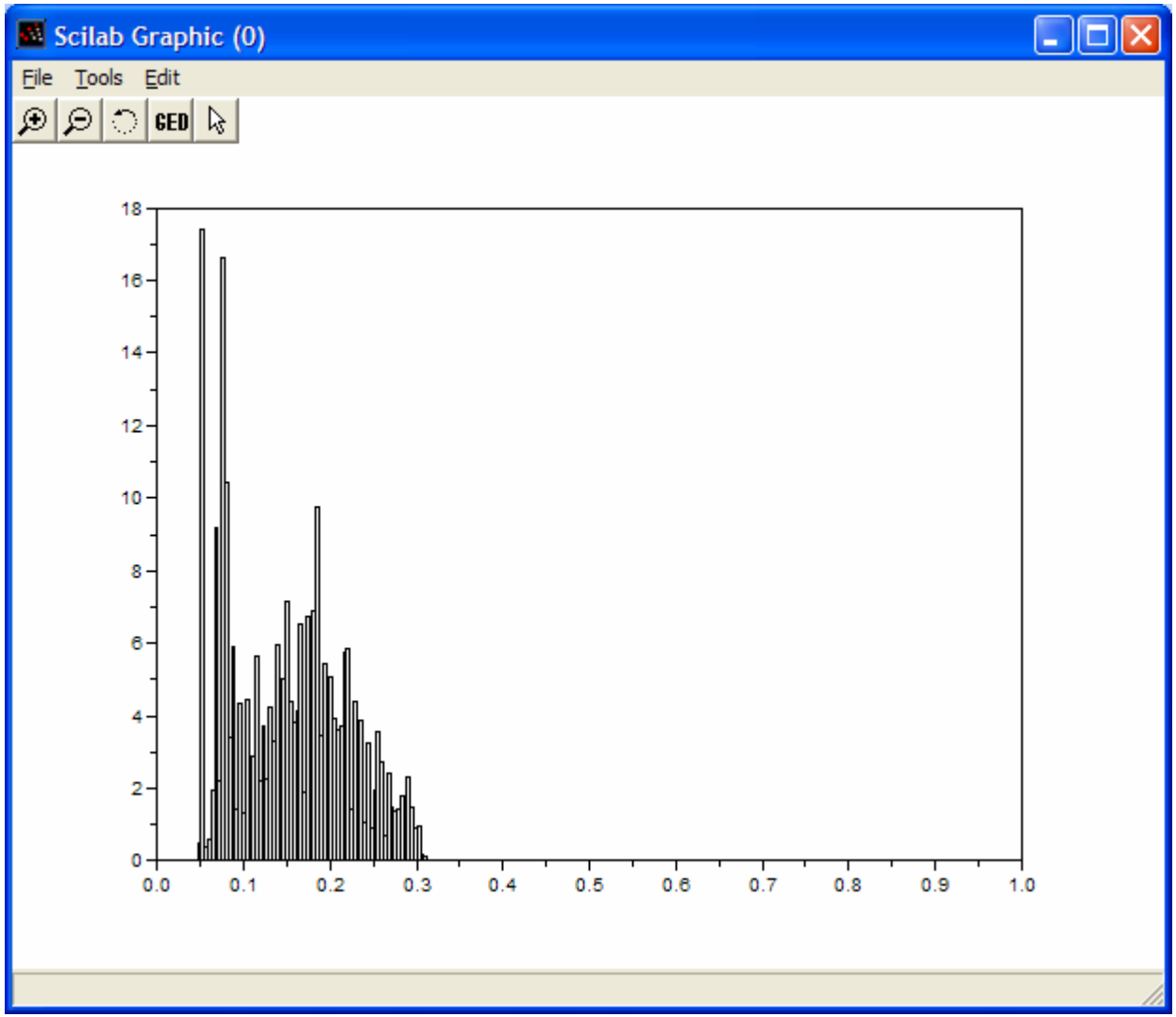
Histogram Examples (cont…)



Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Histogram Examples (cont…)



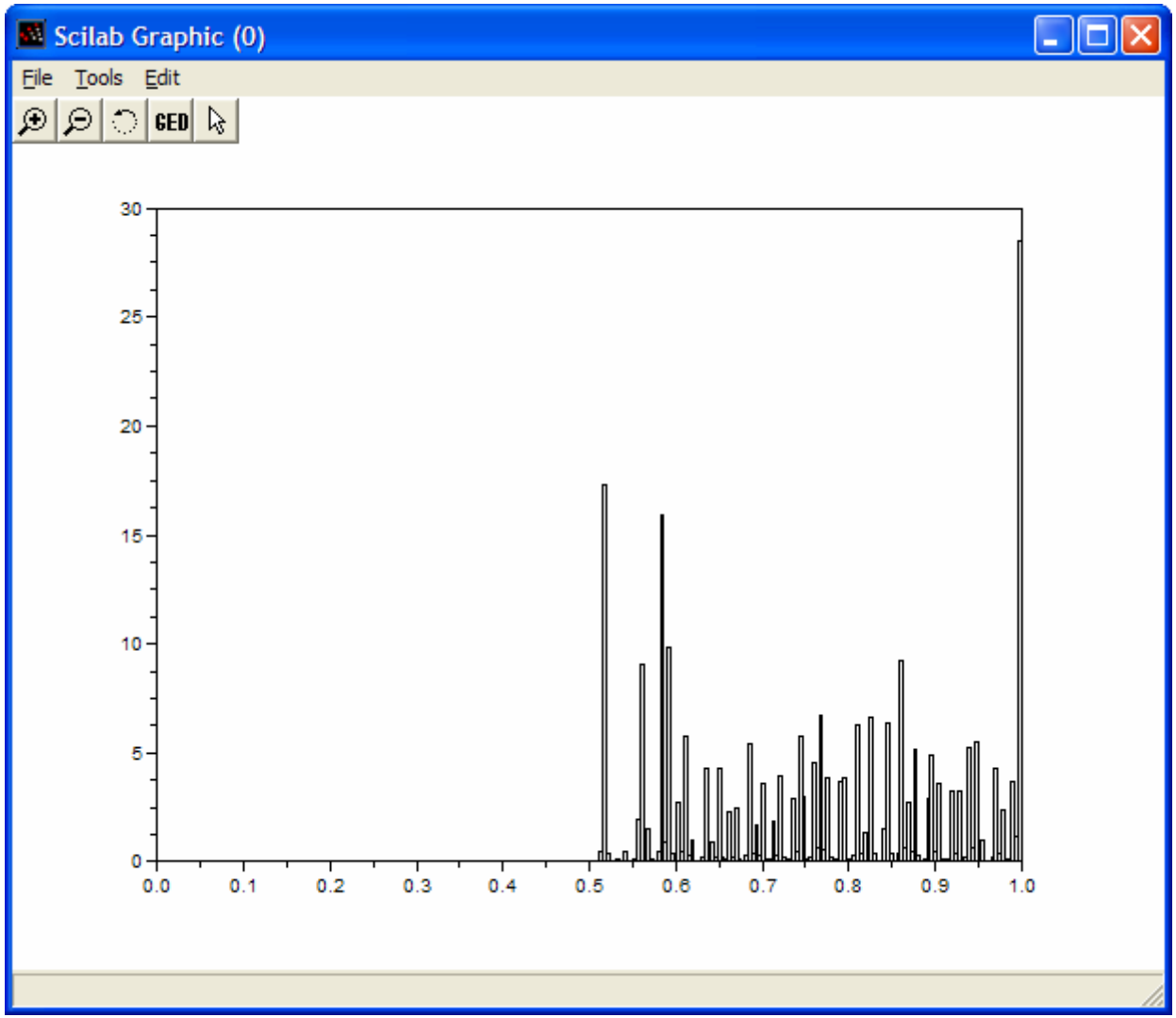


Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Histogram Examples (cont…)

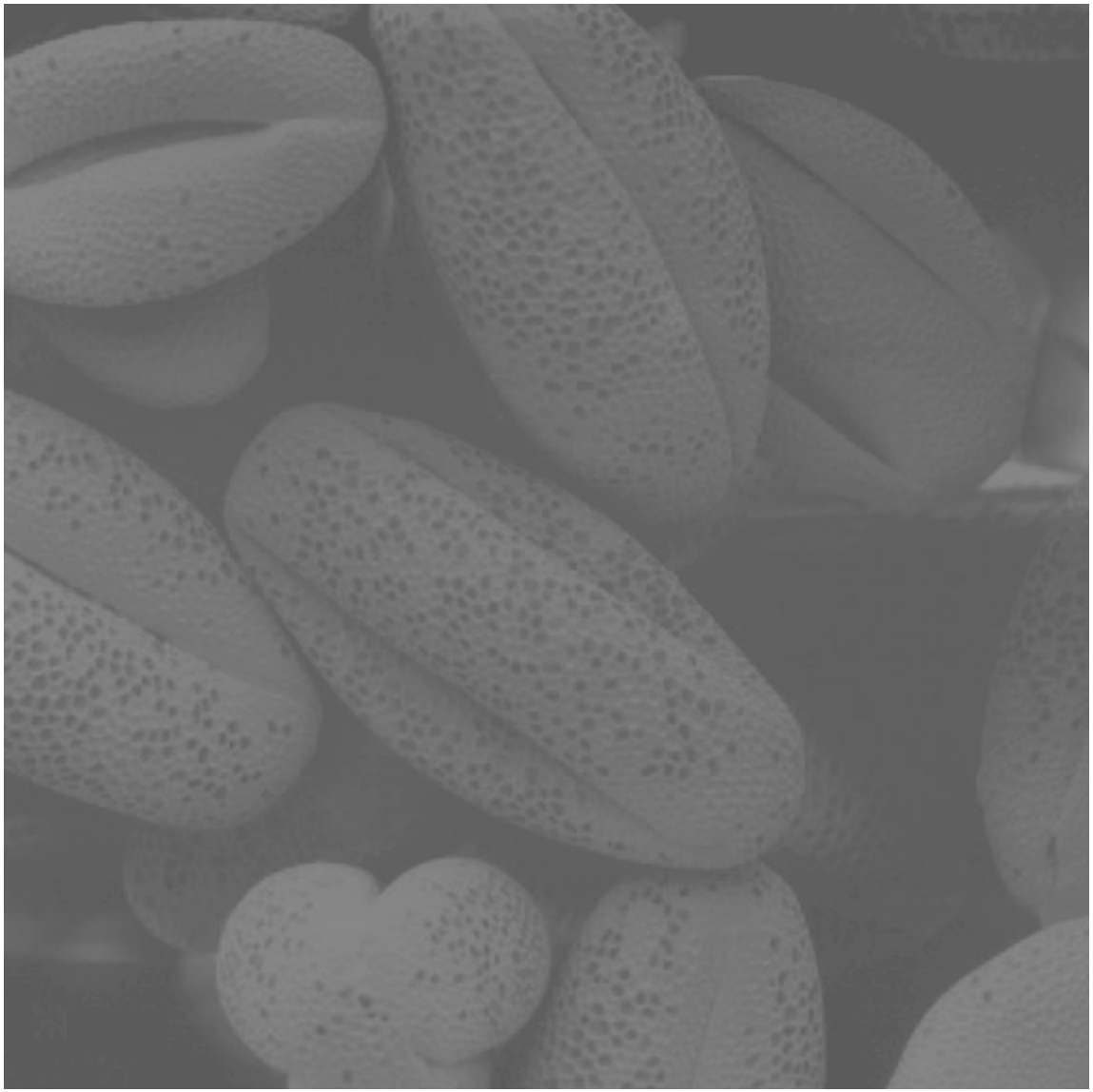
Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Histogram Examples (cont…)



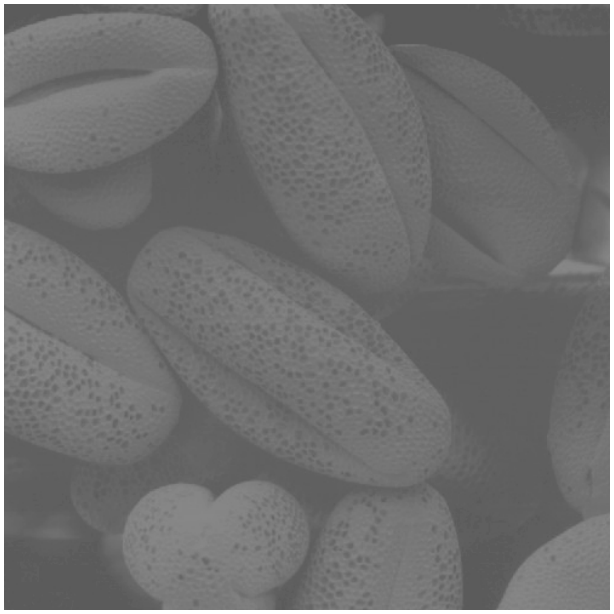
Images taken from Gonzalez & Woods, Digital Image Processing (2002)

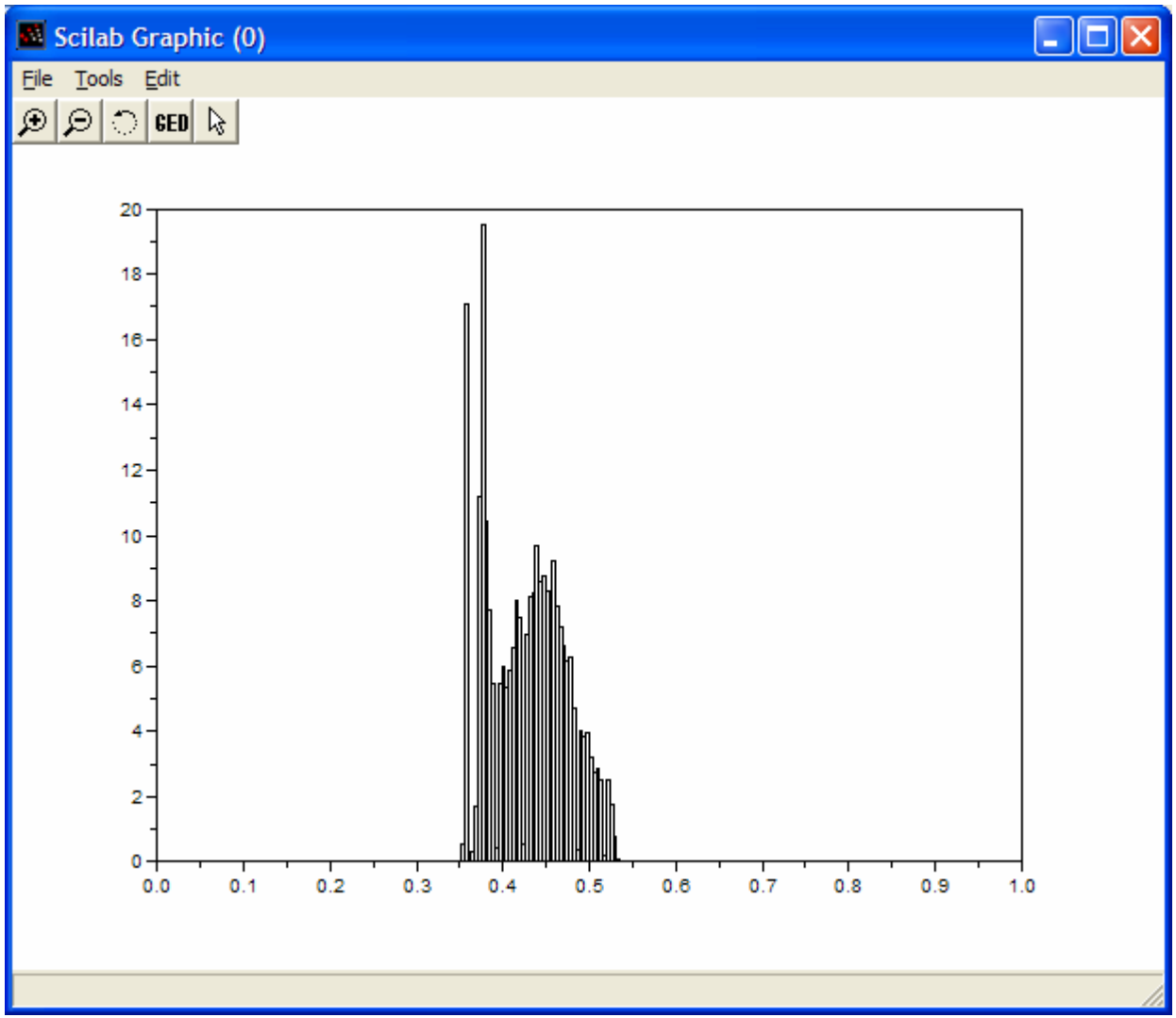
Histogram Examples (cont…)



Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Histogram Examples (cont…)



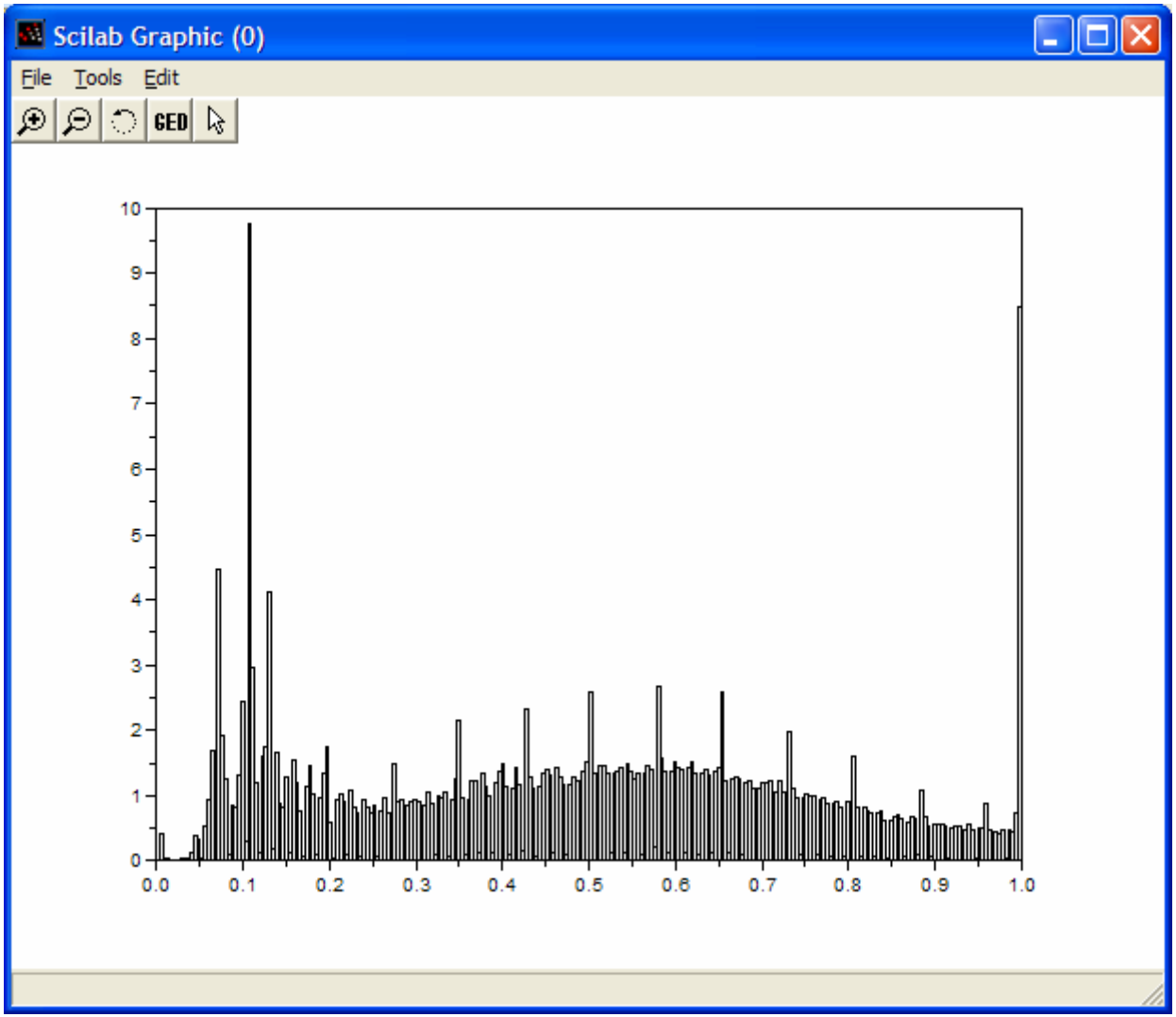


Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Histogram Examples (cont…)

Images taken from Gonzalez & Woods, Digital Image Processing (2002)

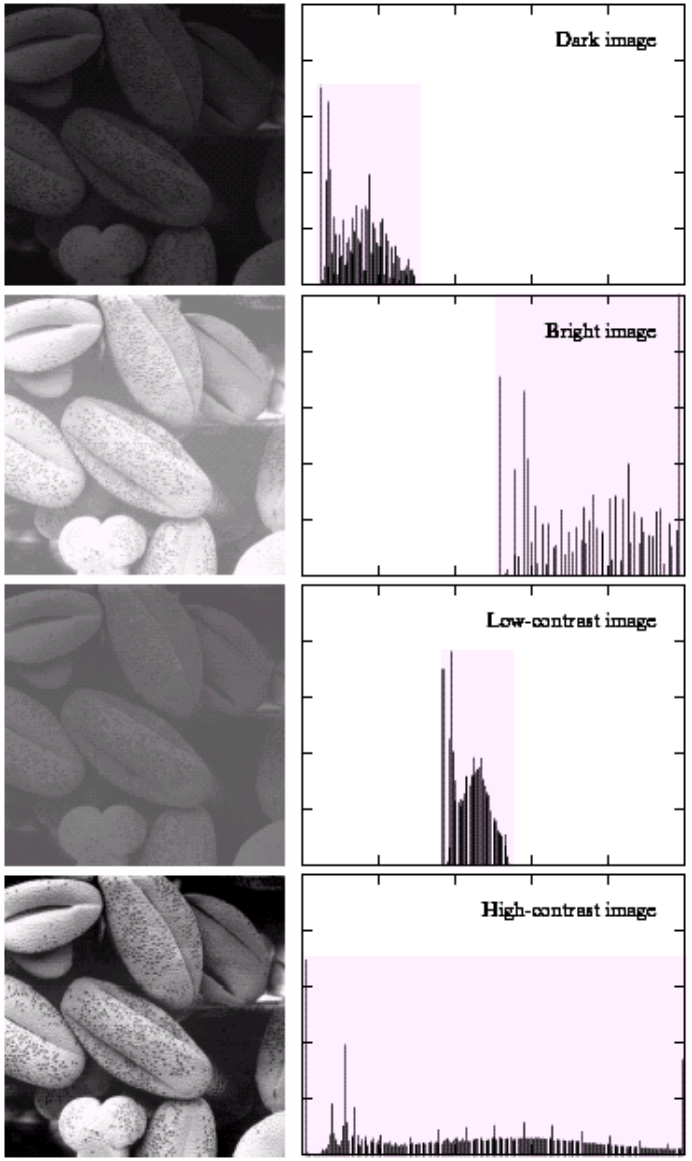
Histogram Examples (cont…)



Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Histogram Examples (cont…)

- A selection of images and their histograms
- Notice the relationships between the images and their histograms
- Note that the high contrast image has the most evenly spaced histogram



Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Histogram Equalisation

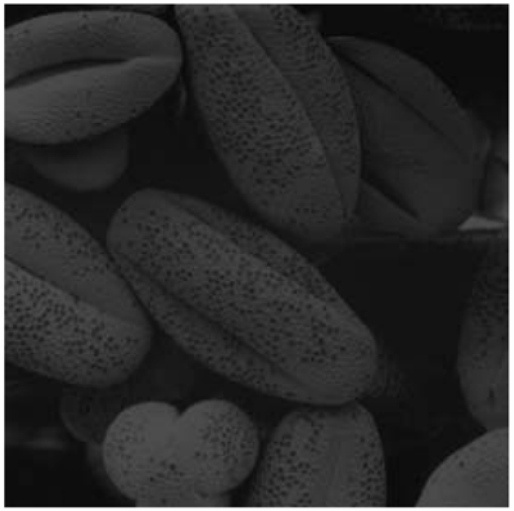
Spreading out the frequencies in an image (or equalising the image) is a simple way to improve dark or washed out images

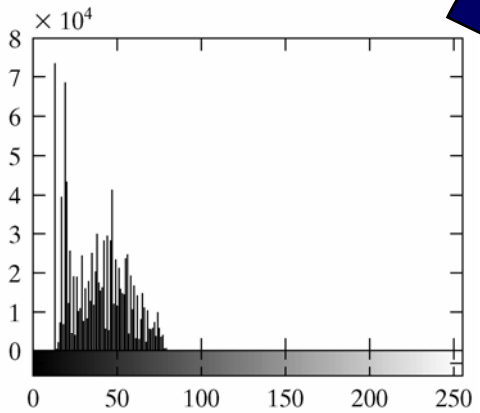
The formula for histogram equalisation is given where

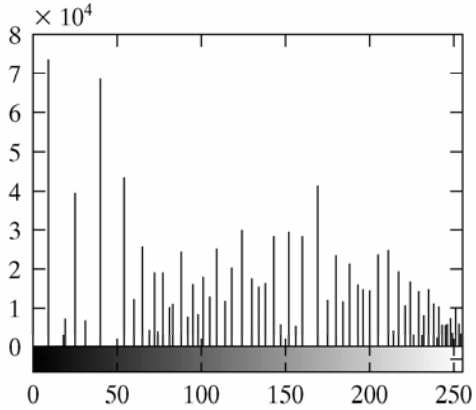
- r_k: input intensity (0.0-1.0)
- s_k: processed intensity
- k: the intensity range
  n_j: the number of intensity j
- n: the total number of pixels

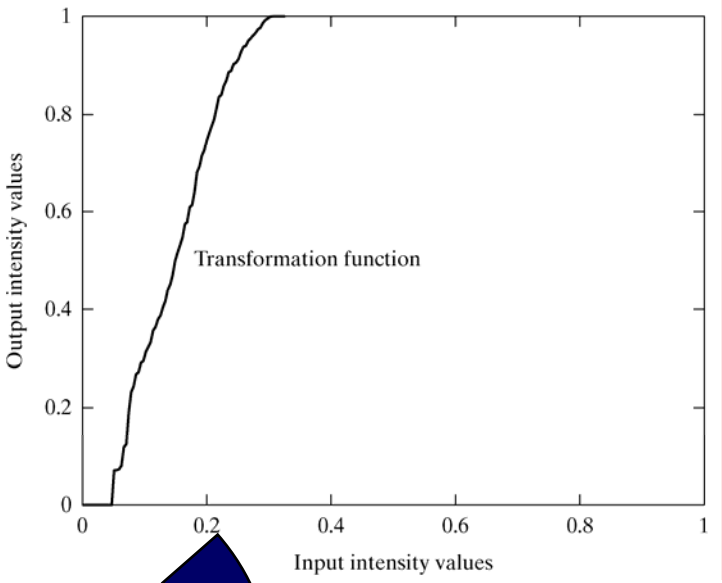
$$s_k = T(r_k)$$
$$= \sum_{j=1}^{k} p_r(r_j)$$
$$= \sum_{j=1}^{k} \frac{n_j}{n}$$

Equalisation Transformation Function



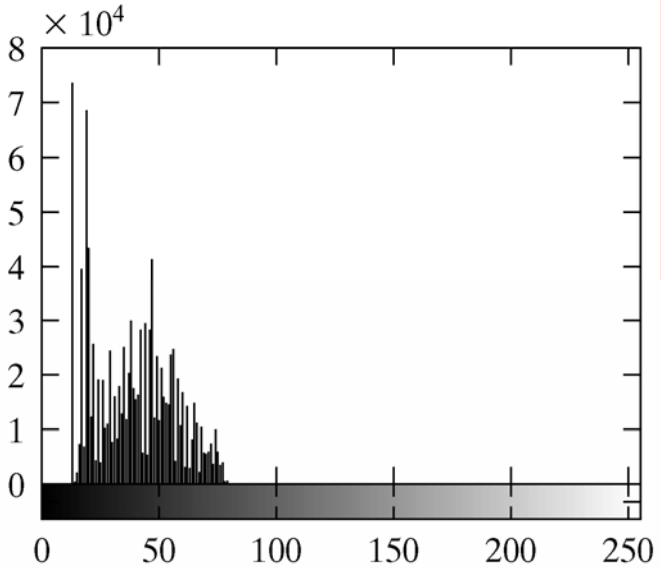


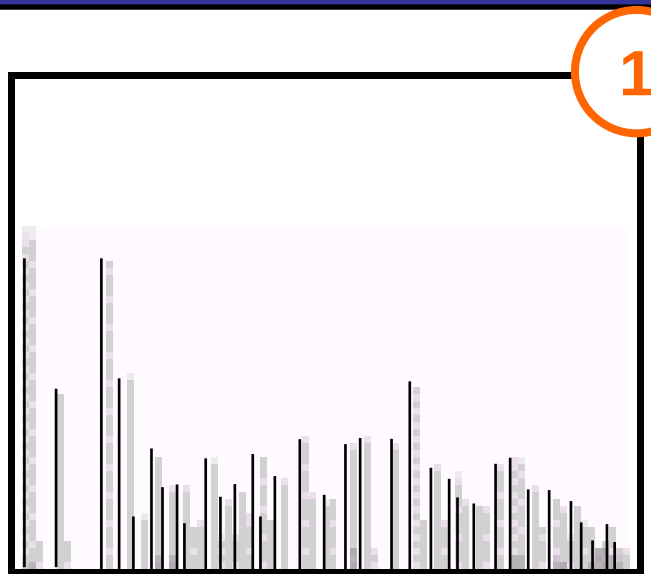


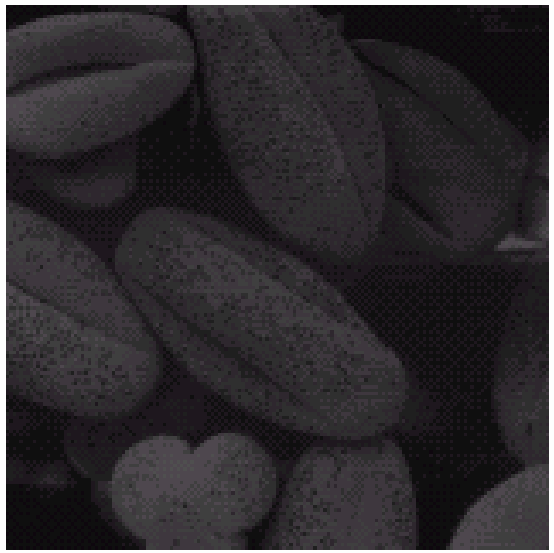


Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Equalisation Examples



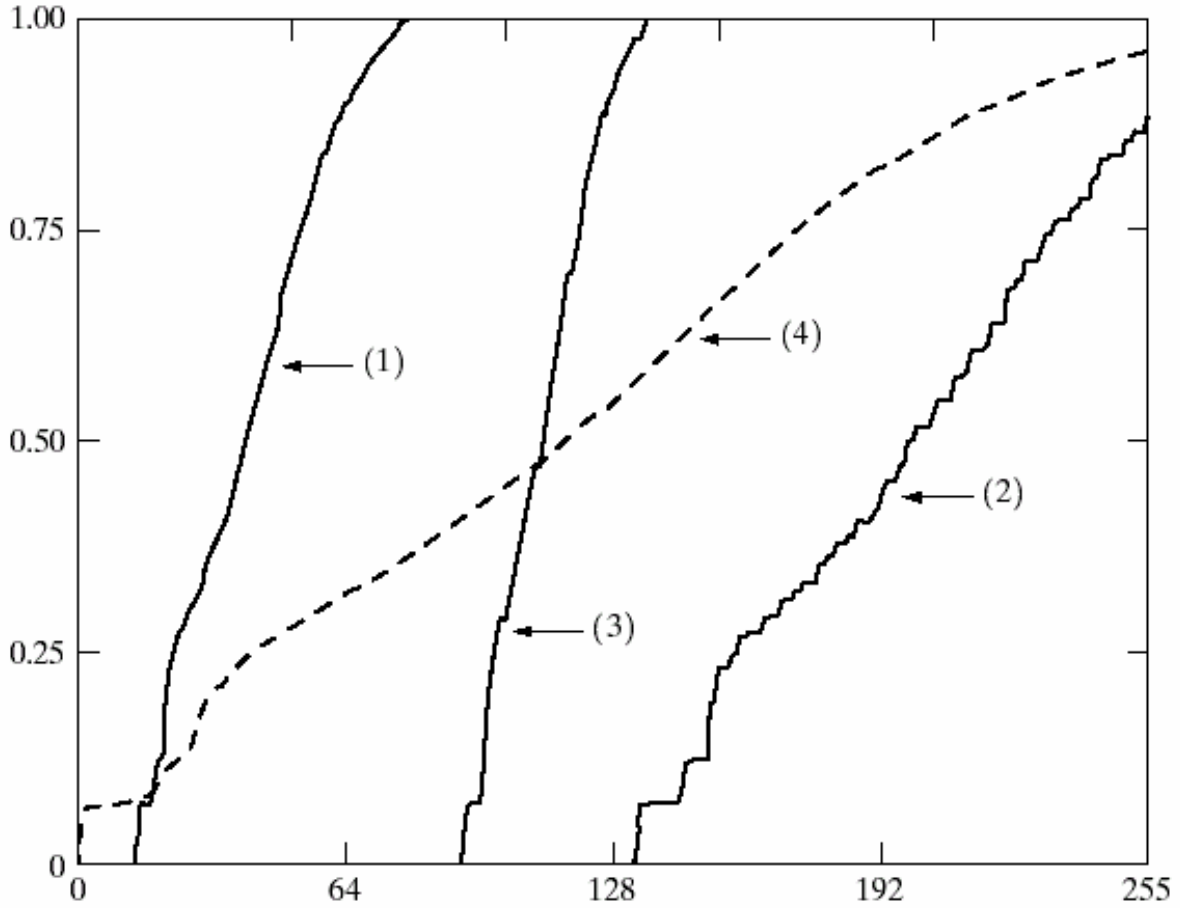




Images taken from Gonzalez & Woods, Digital Image Processing (2002)

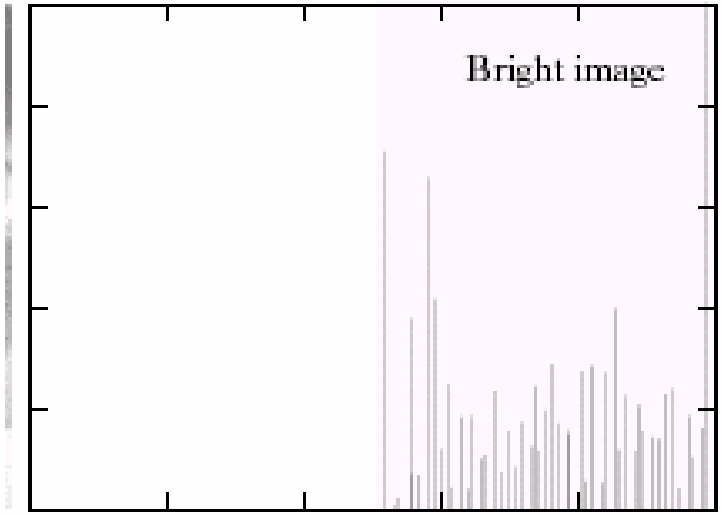
Equalisation Transformation Functions

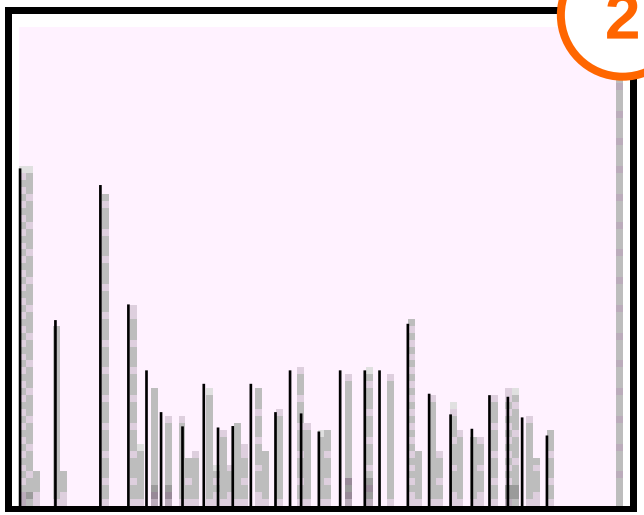
The functions used to equalise the images in the previous example



Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Equalisation Examples





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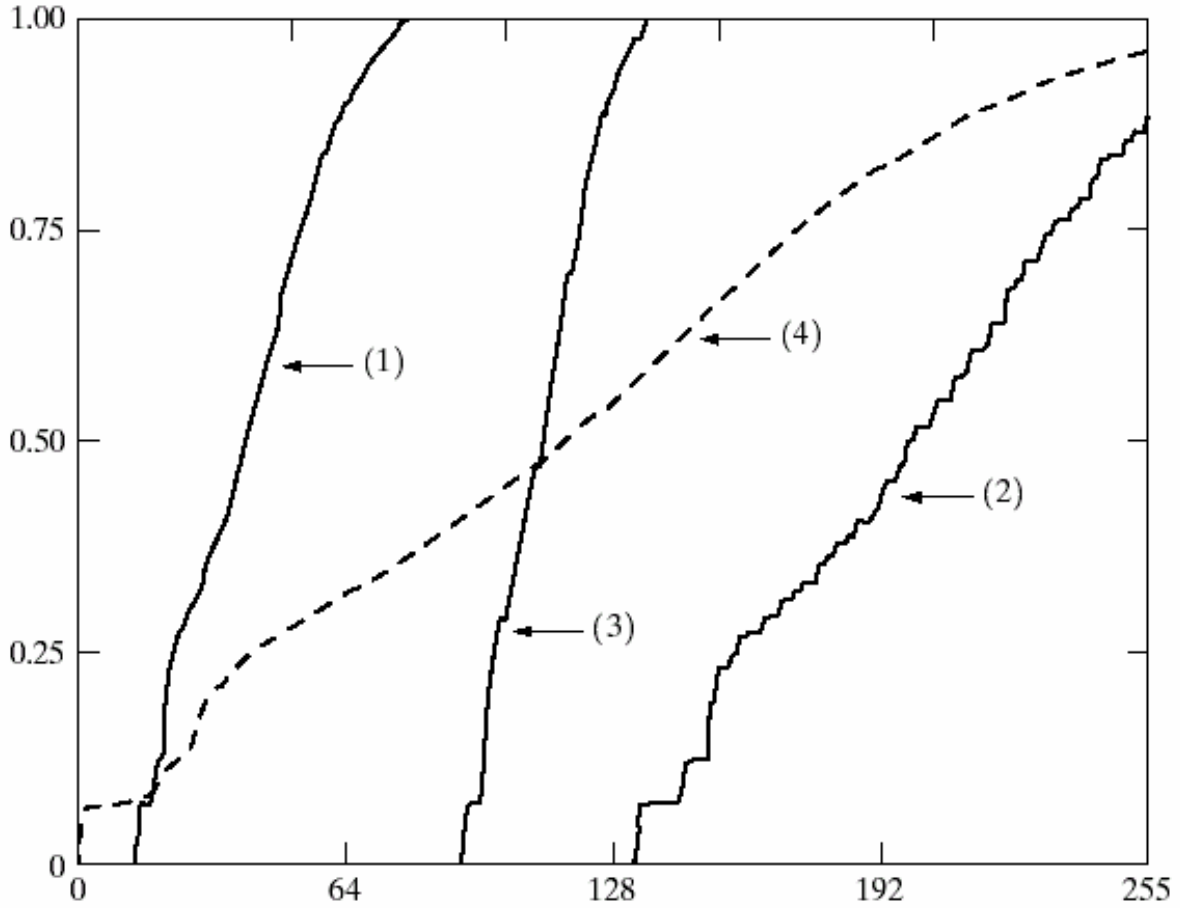

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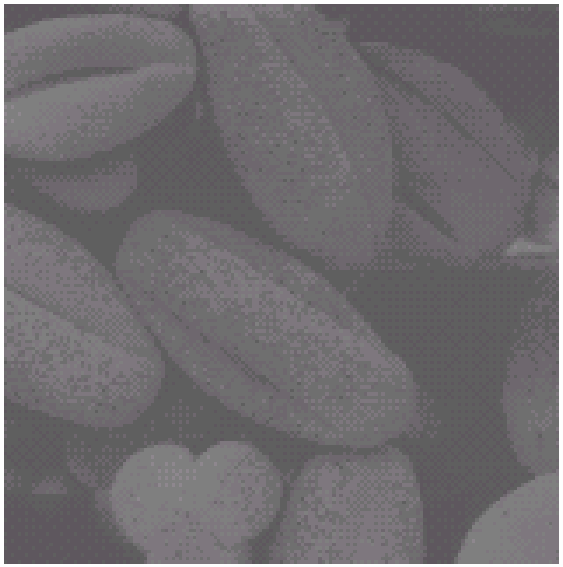

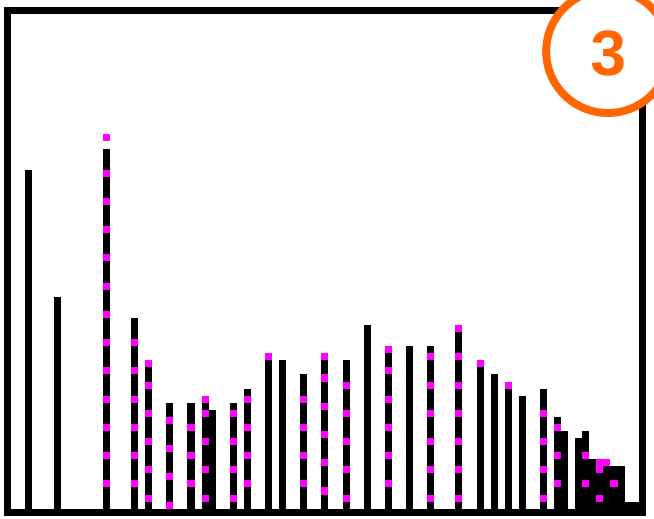

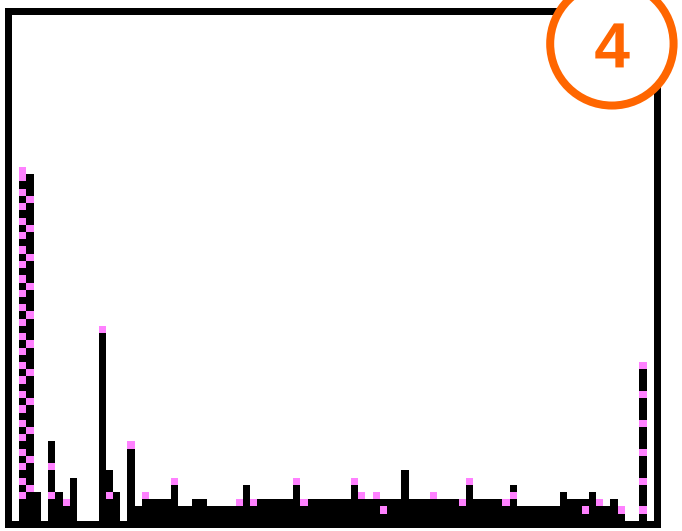

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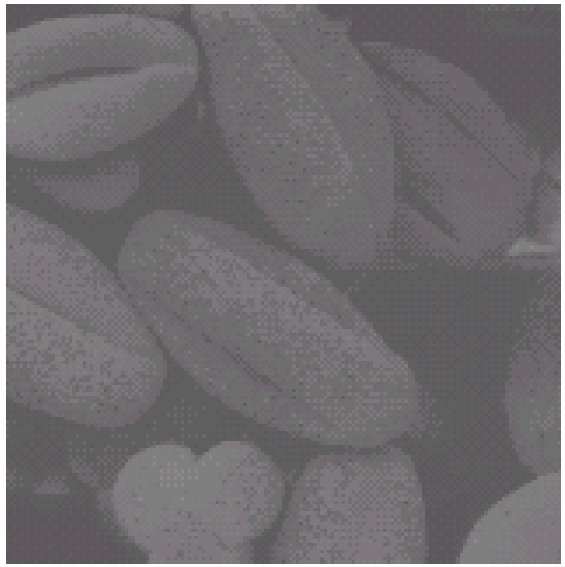
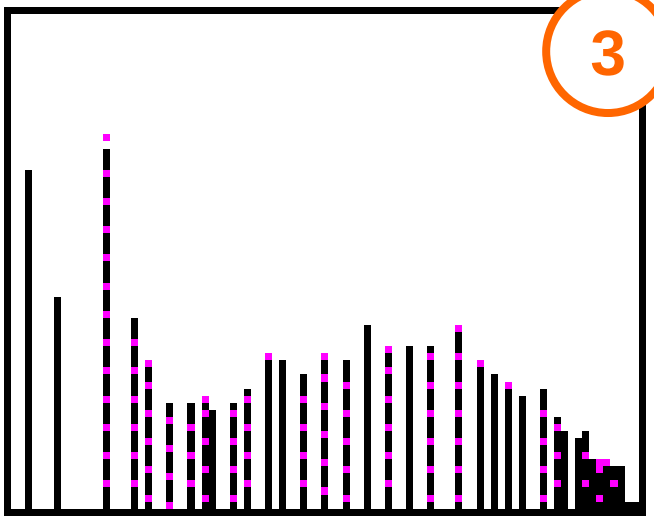
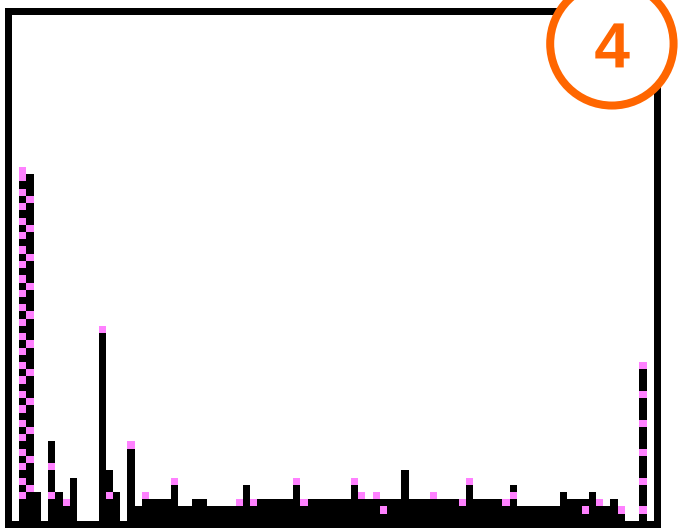
Equalisation Examples (cont…)







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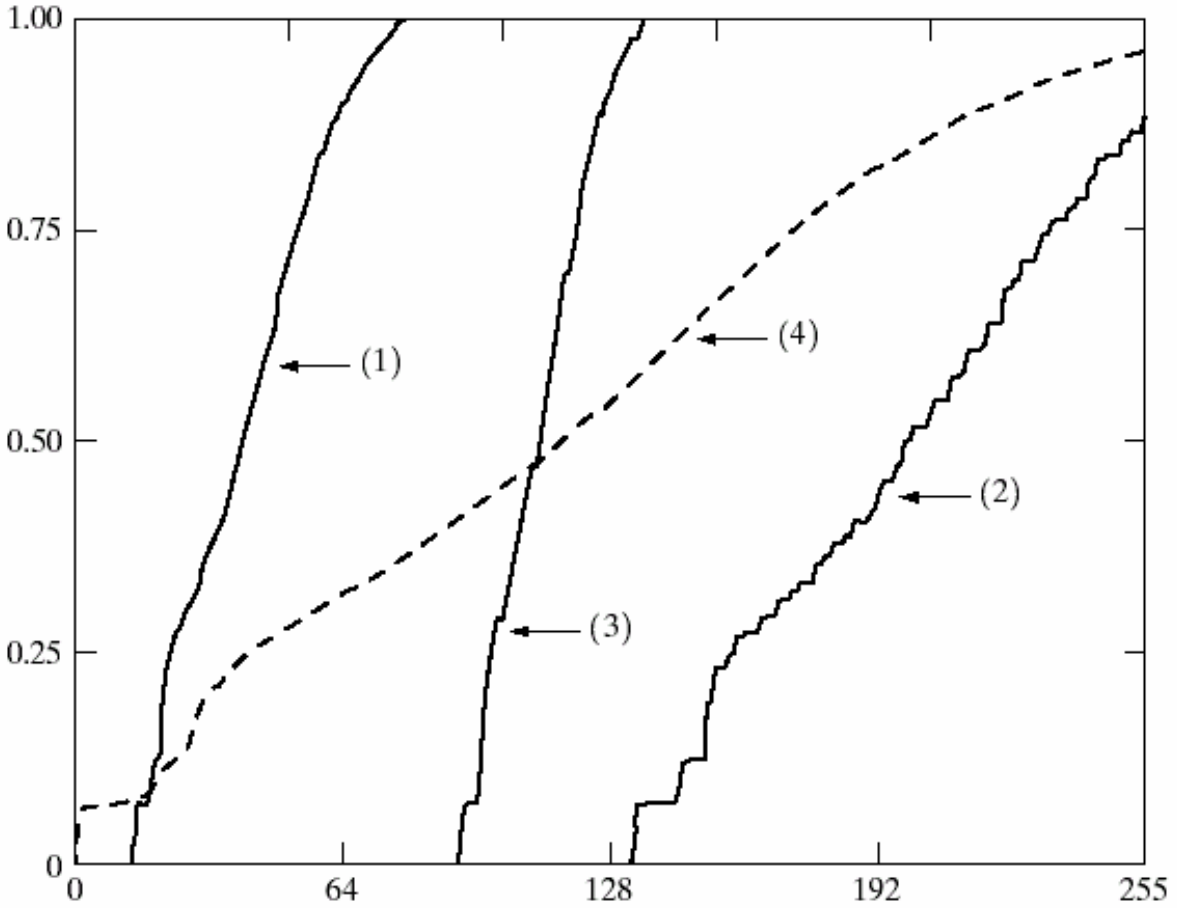

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