EE 604
Digital Image Processing

IIT KANPUR
Indian Institute of Technology, Kanpur

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Aug - Nov 2017

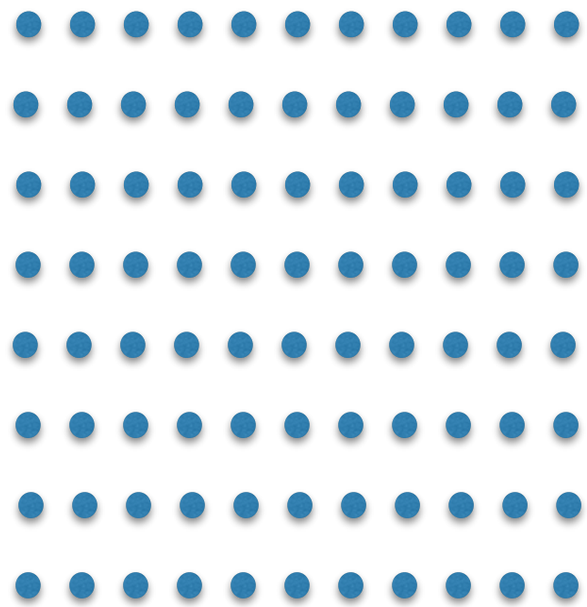
Announcement

- Questions 1 and 2 for assignment will be posted tonight.
- More questions will be added as we progress
- Due : TBD

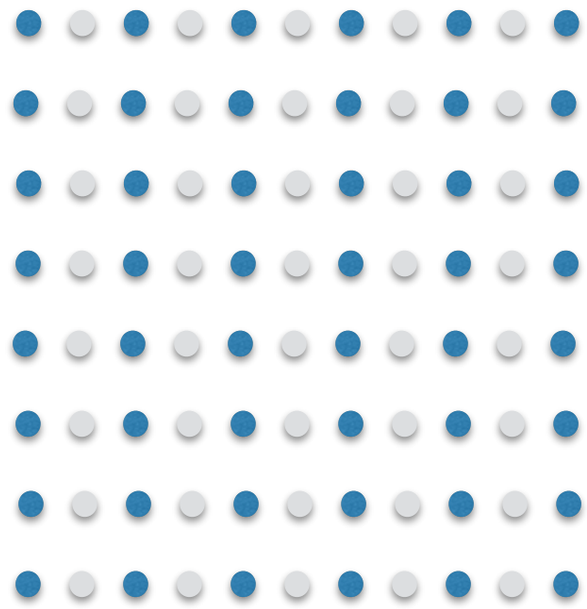
Lecture outline

- **Image interpolation**
- **Image enhancement in spatial domain**
  - **Gray-level transformation**
  - **Histogram processing**

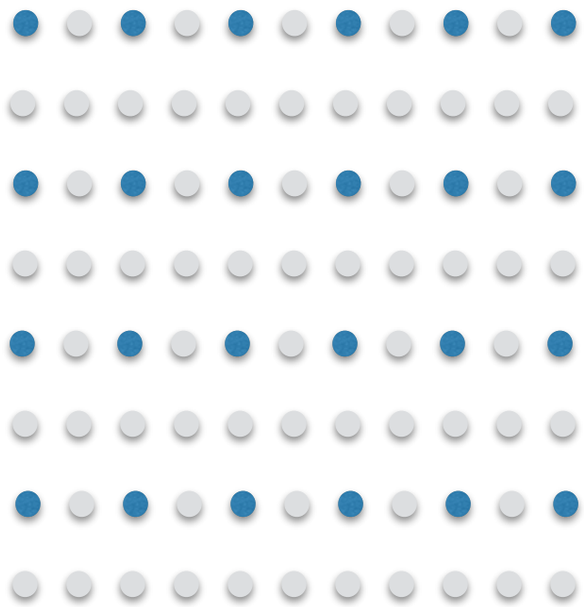
Zooming and Shrinking



Zooming and Shrinking



Zooming and Shrinking



Zooming and Shrinking

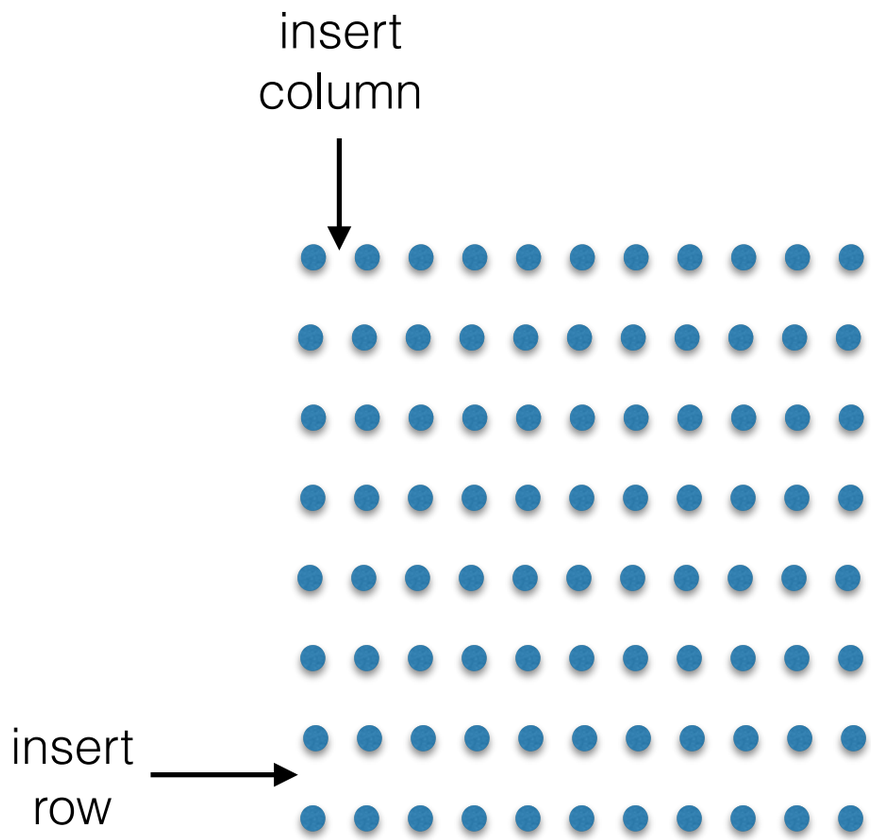
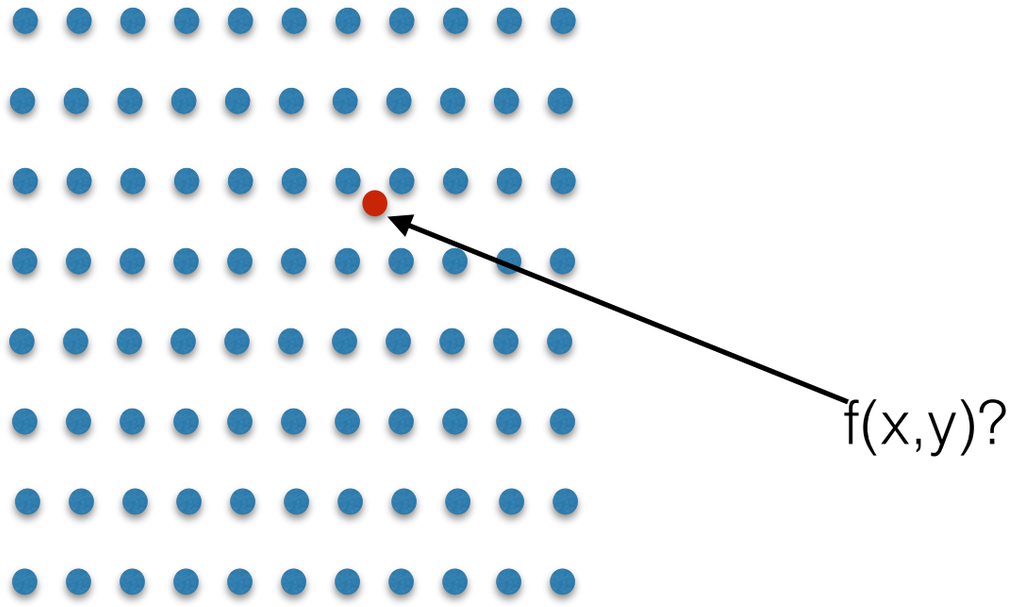


Image interpolation

Image interpolation is required to compute the intensity value at any arbitrary location in an image, or to resize an image.



Checkerboard effect

128 x 128

64 x 64

32 x 32

interpolated to 1024 x 1024 (all)

Lecture outline

- Image interpolation
- Image enhancement in spatial domain
  - Gray-level transformation
  - Histogram processing

Spatial domain transformation

- **Spatial domain** —> pixel domain
- Working directly on the pixel values

$$g(x, y) = T[f(x, y)]$$

output image — input image

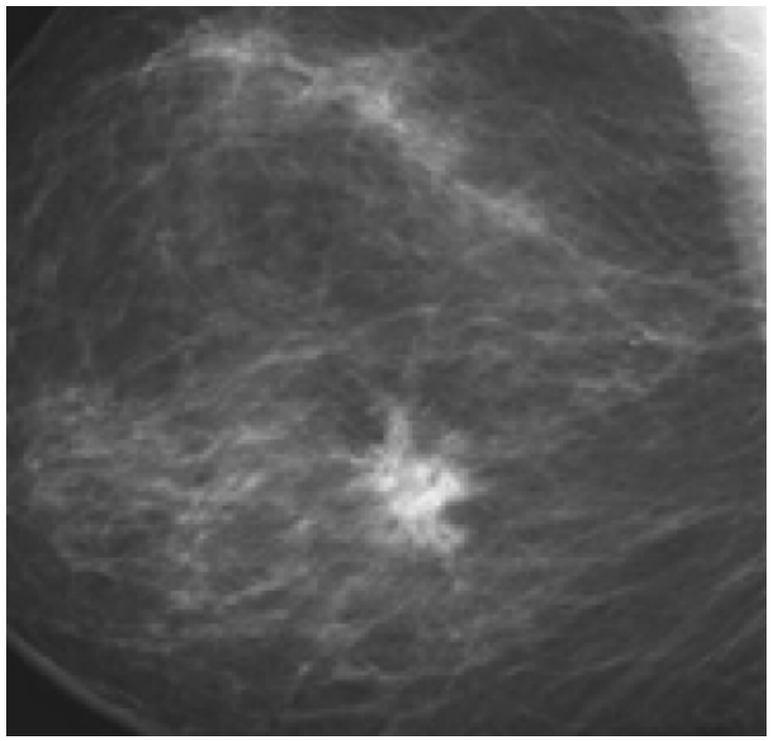
- *T(.)* can operate on a single image or multiple images
- *T(.)* can operate on a single pixel or on a neighborhood

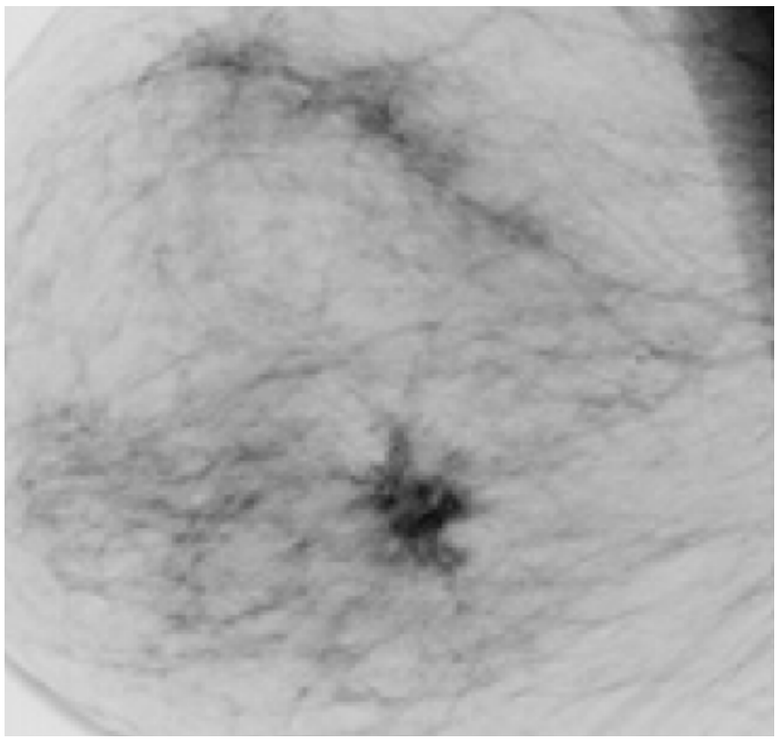
Intensity transformation

- *s* is the intensity at g(x,y)
- *r* is the intensity at f(x,y), *r* has a range of [0, L-1]

$$s = L - 1 - r$$

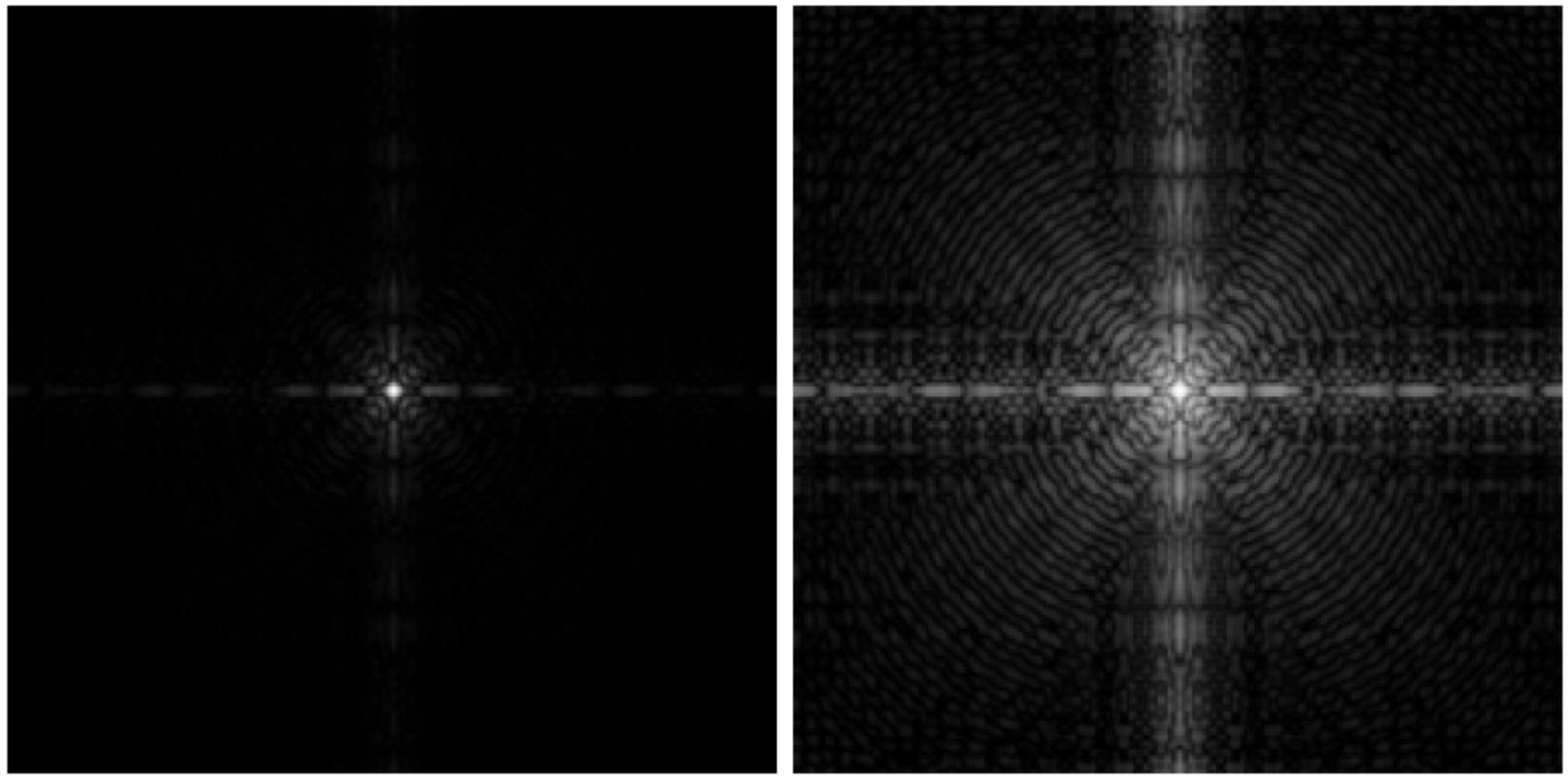
image negatives





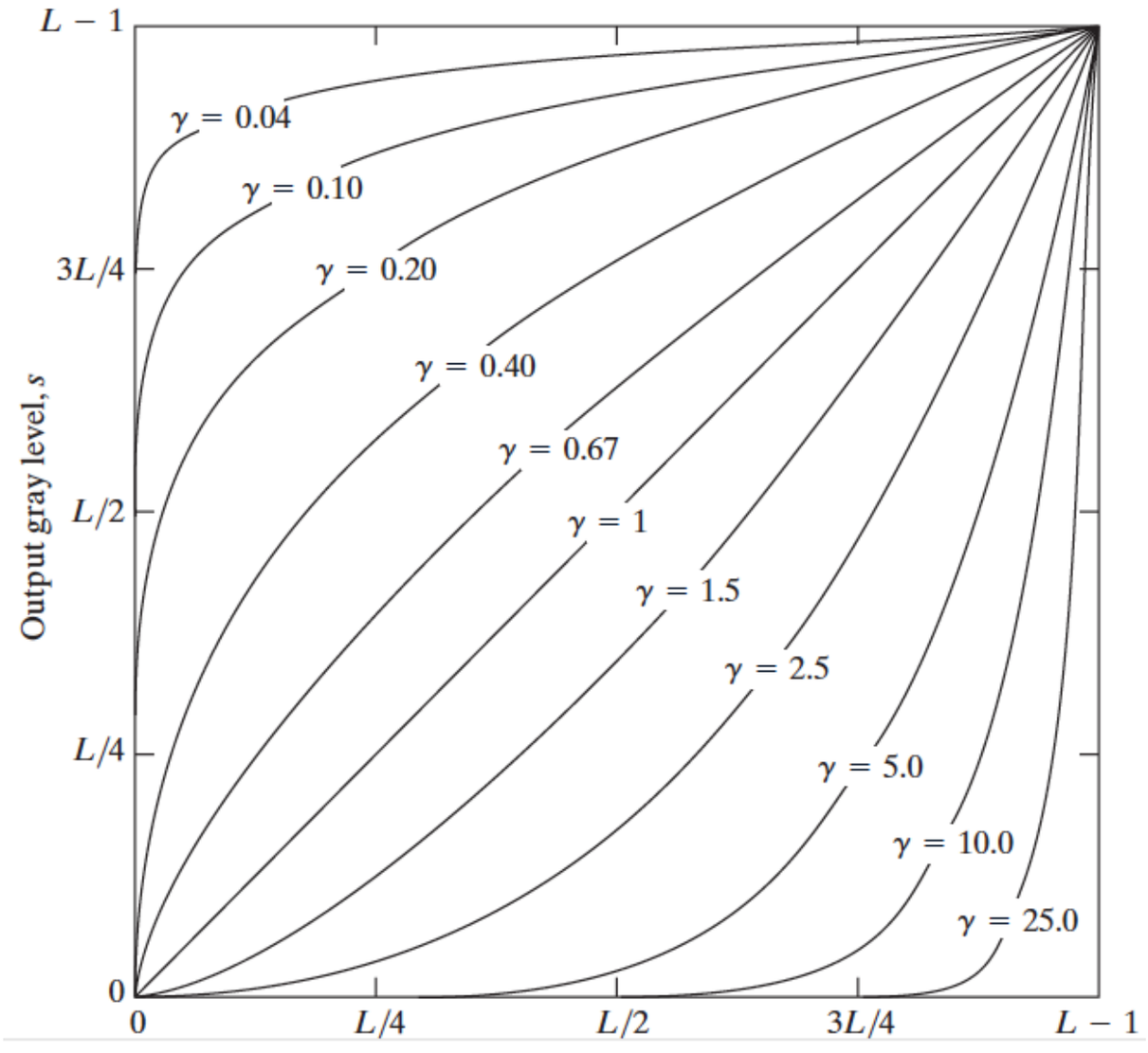
Intensity transformation

$$s = c \log(1 + r)$$



log transformation

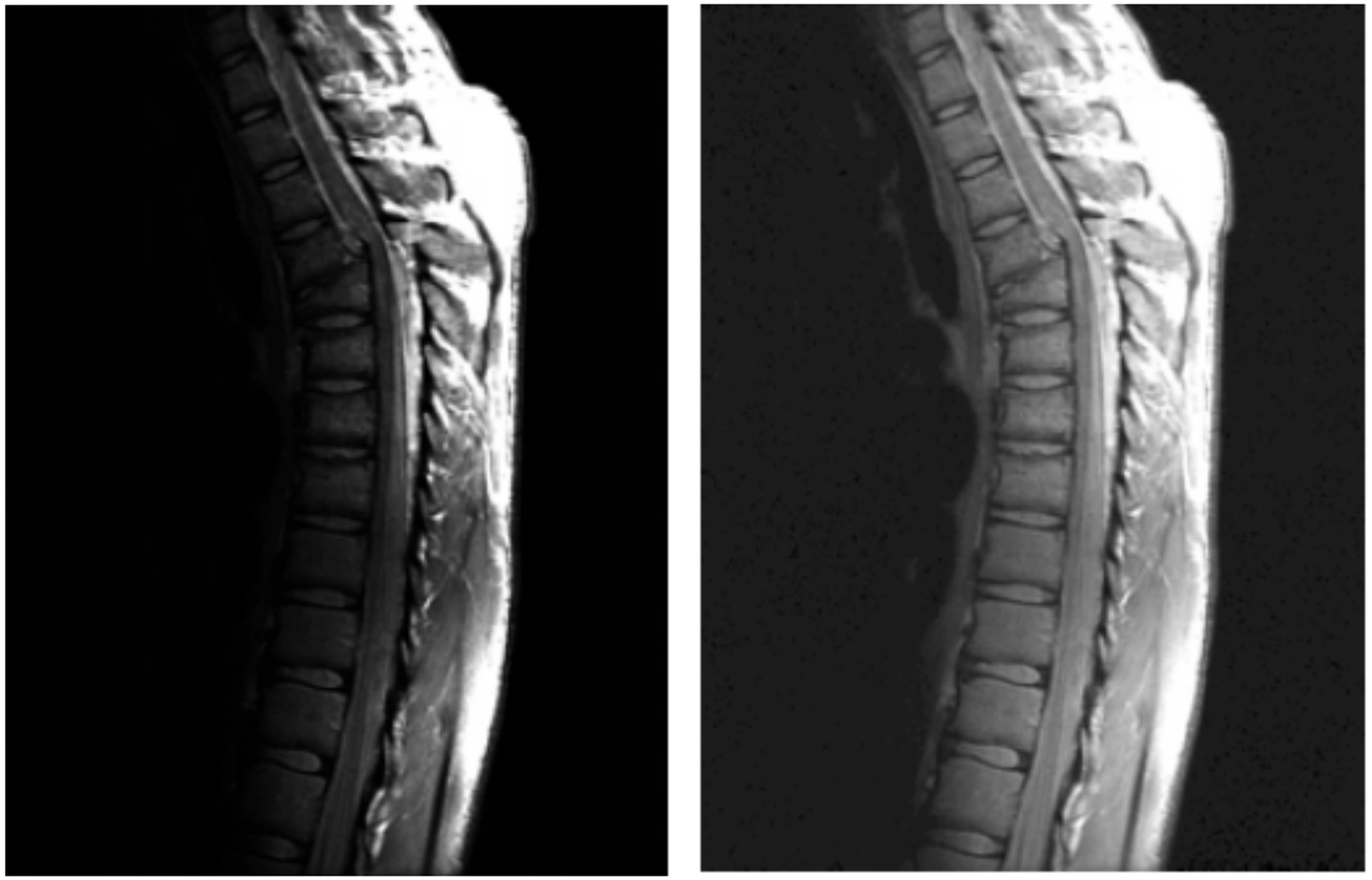
Intensity transformation



Power law transformation

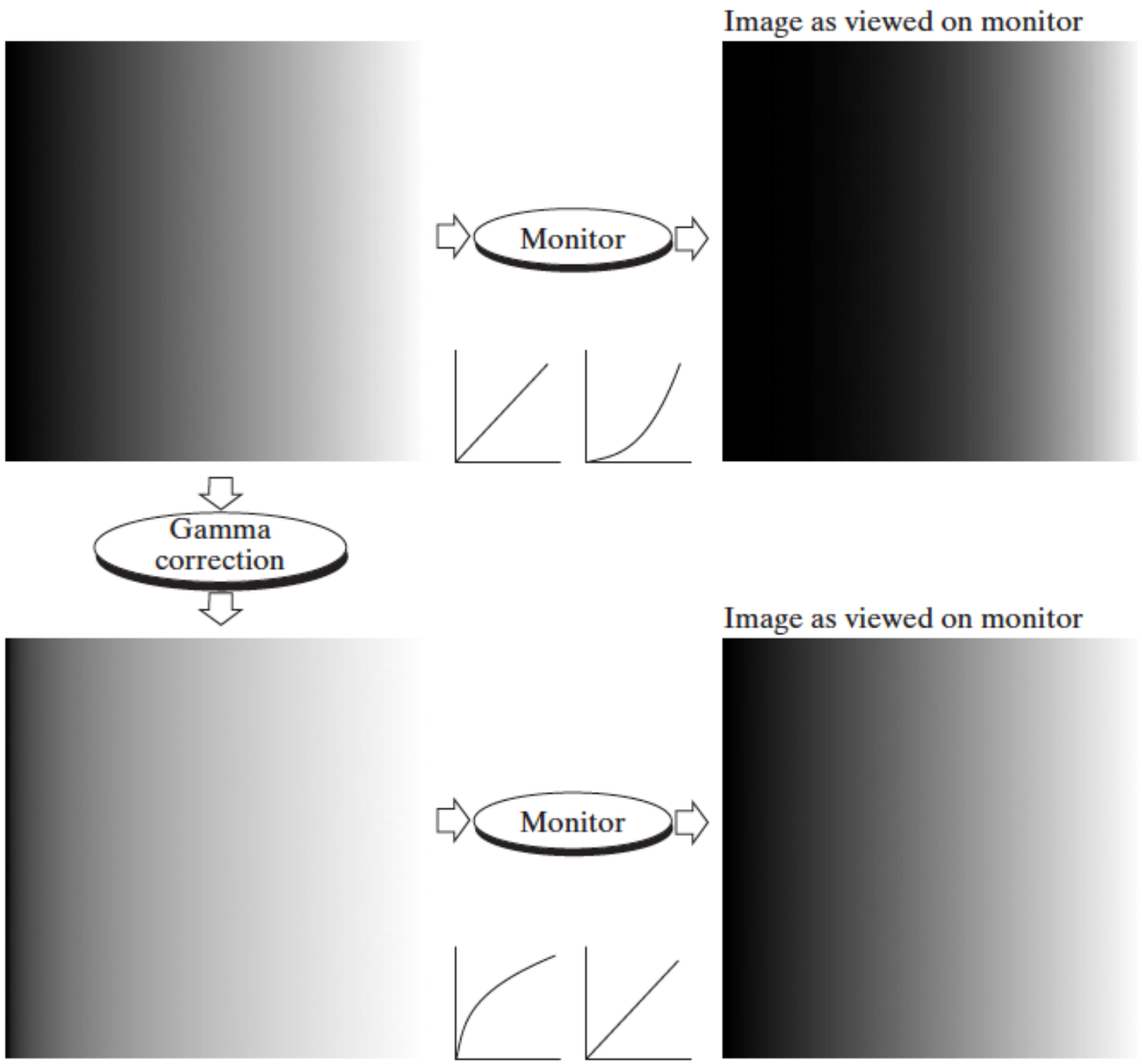
Power law transformation

$$s = cr^{\gamma}$$



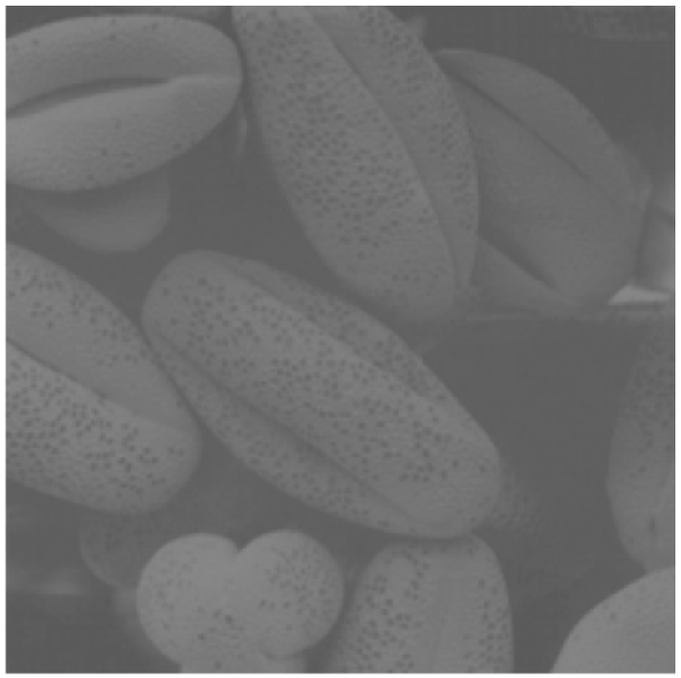
$\gamma = 0.4$

Gamma correction

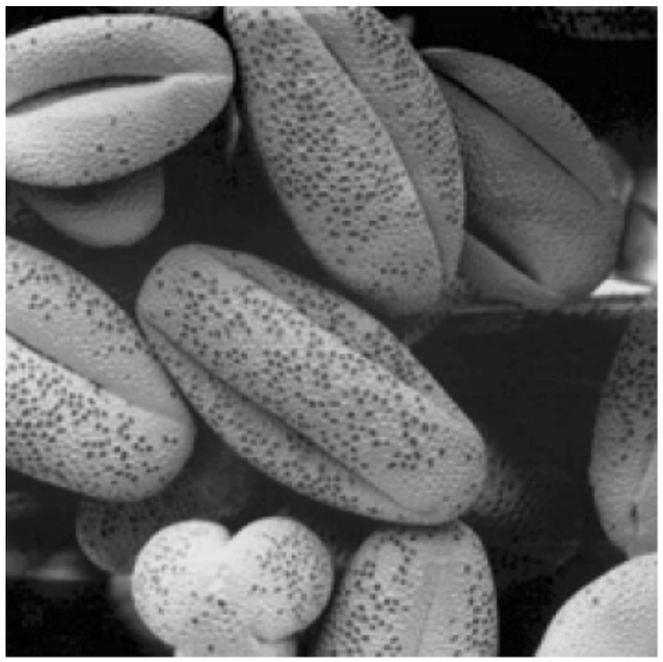


© Gonzalez and Woods, 2nd Ed

Contrast stretching



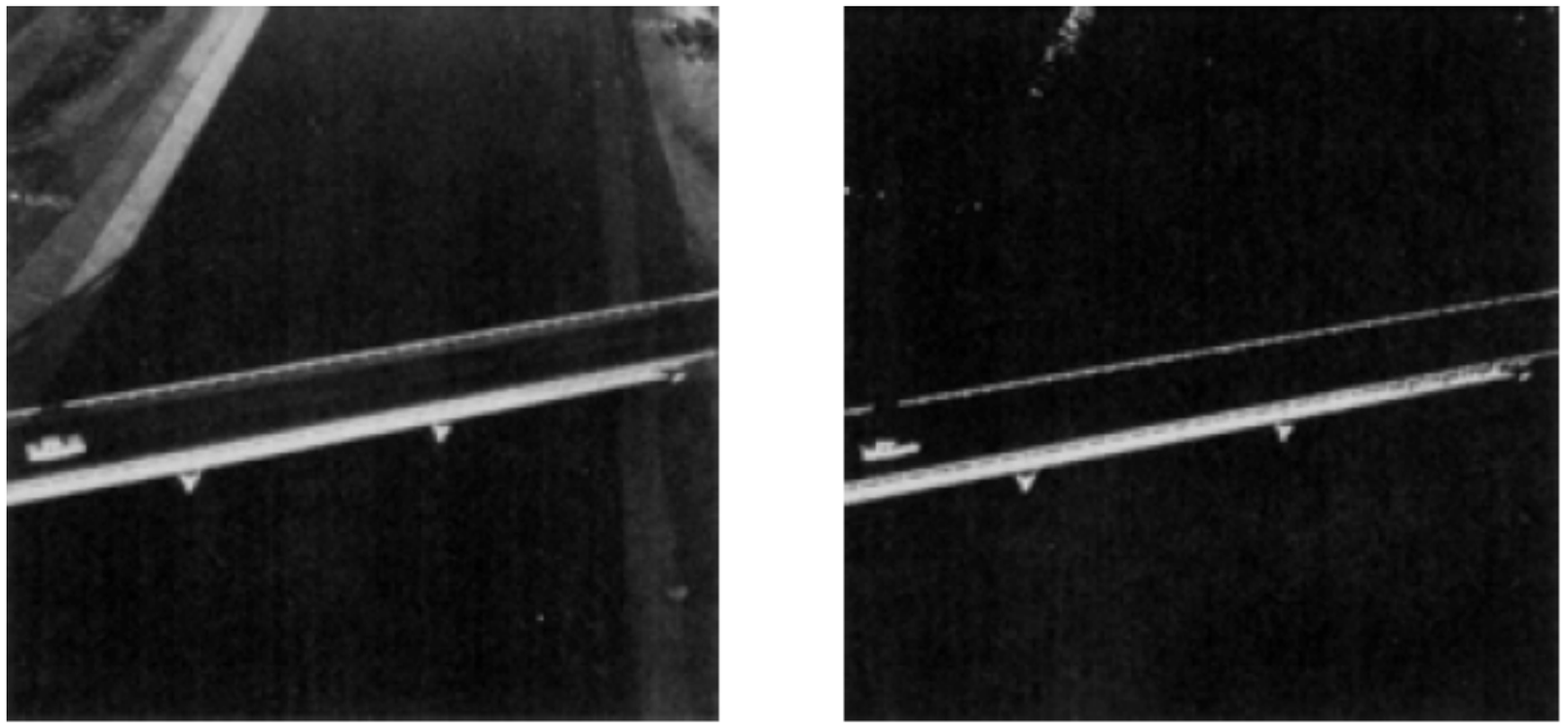
original image



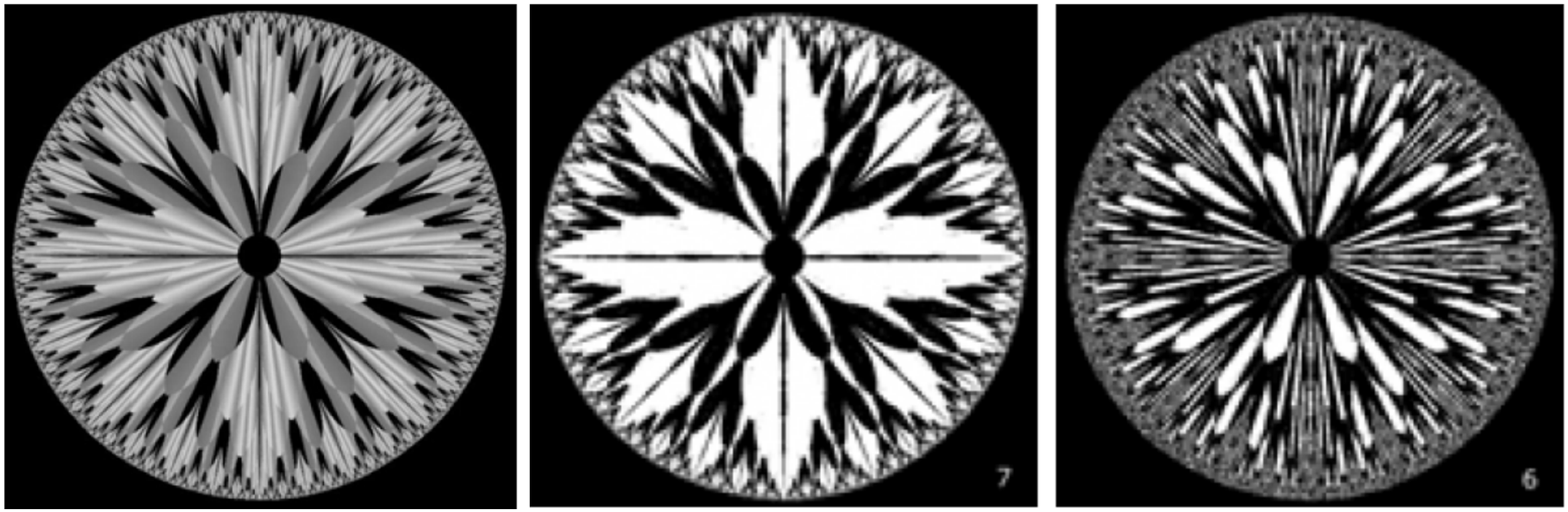
contrast enhanced

binary

Gray-level slicing



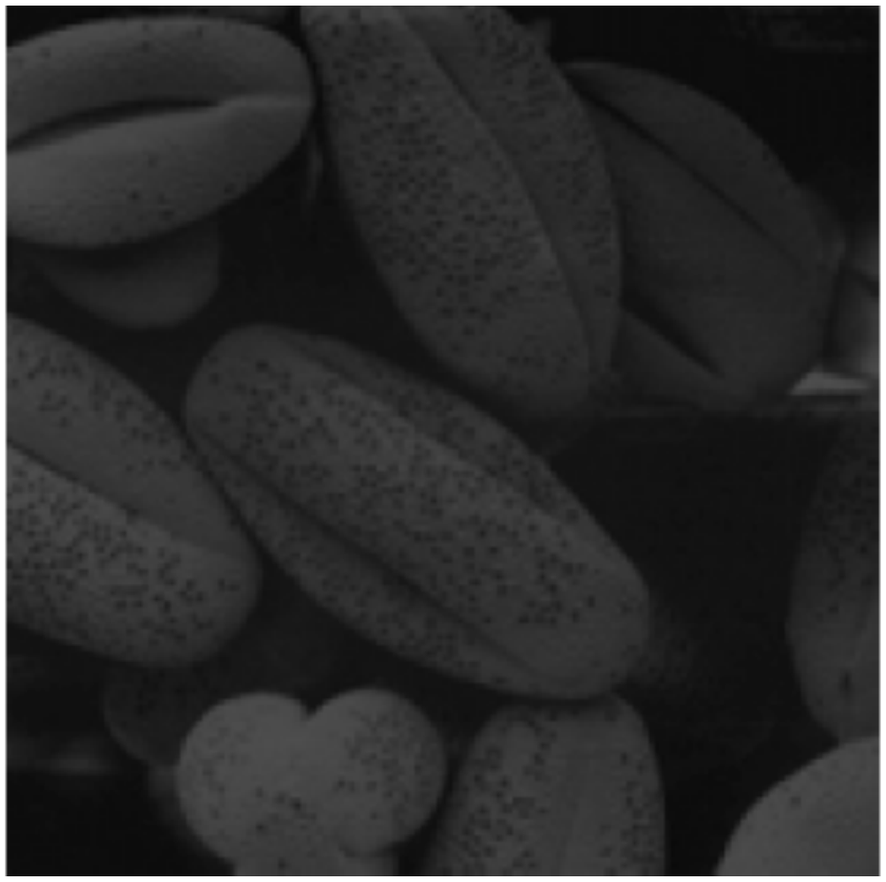
Bit plane slicing

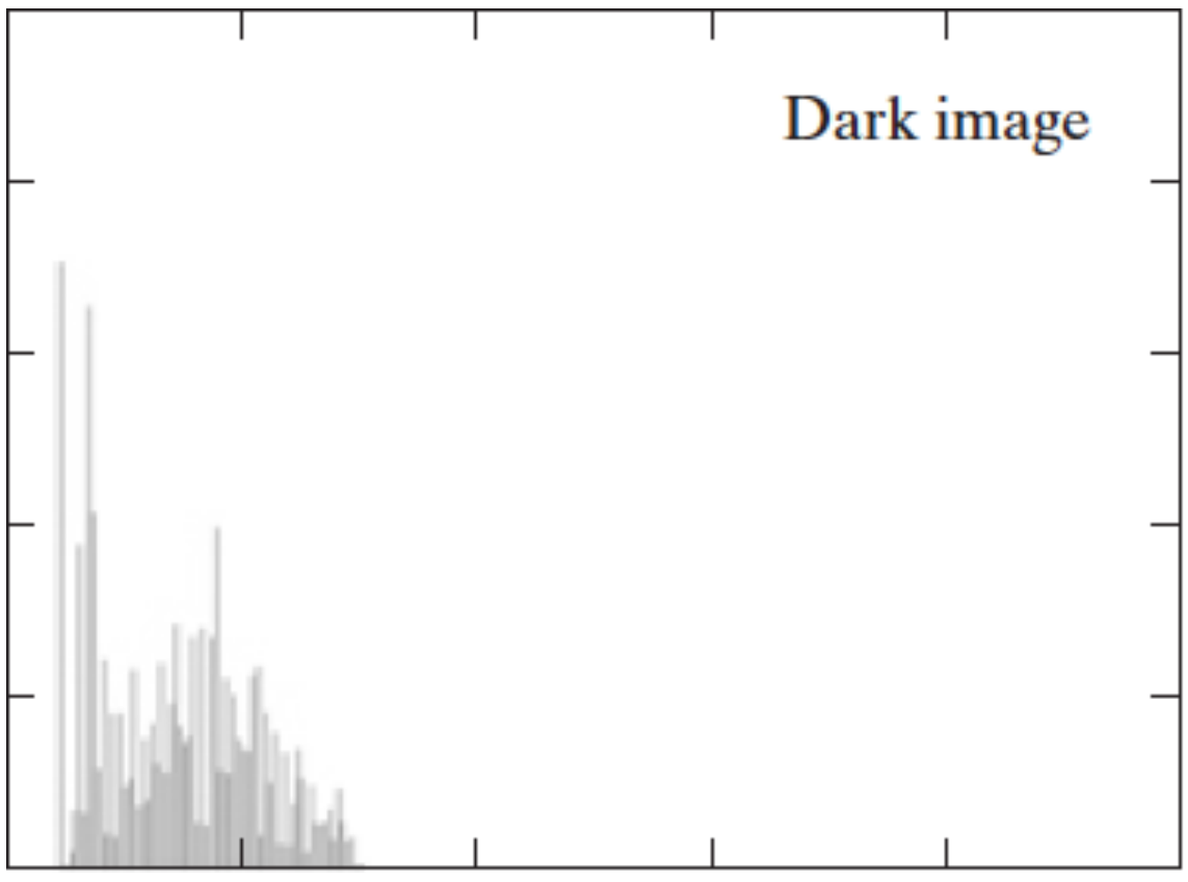


Lecture outline

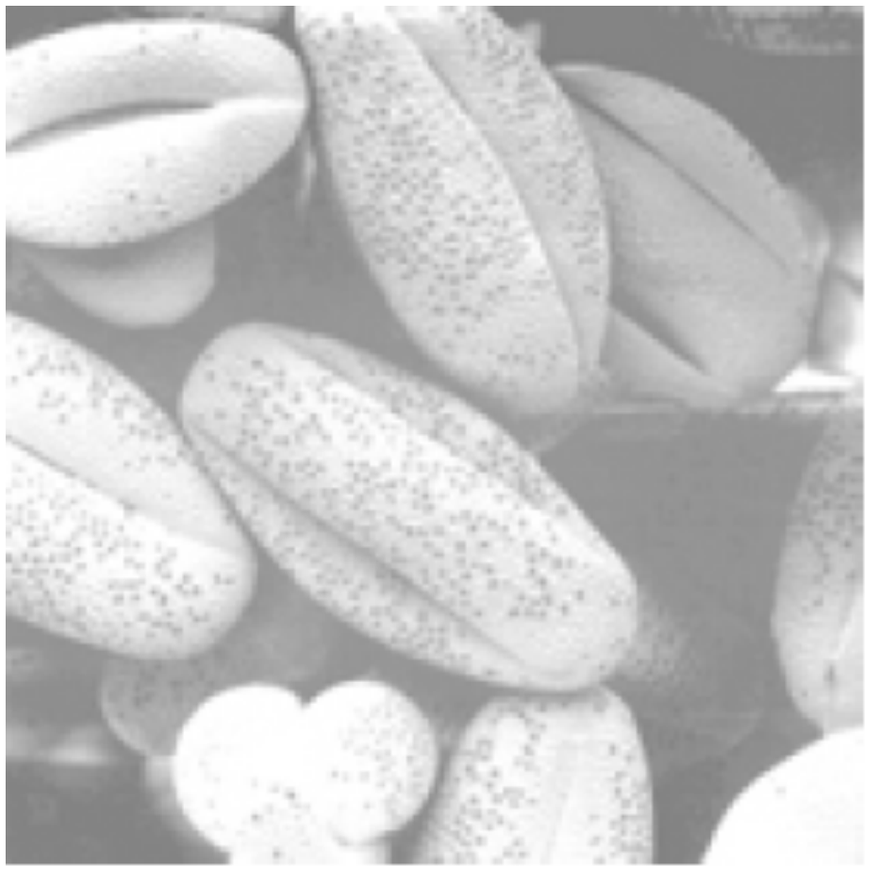
- Image interpolation
- Image enhancement in spatial domain
  - Gray-level transformation
  - Histogram processing

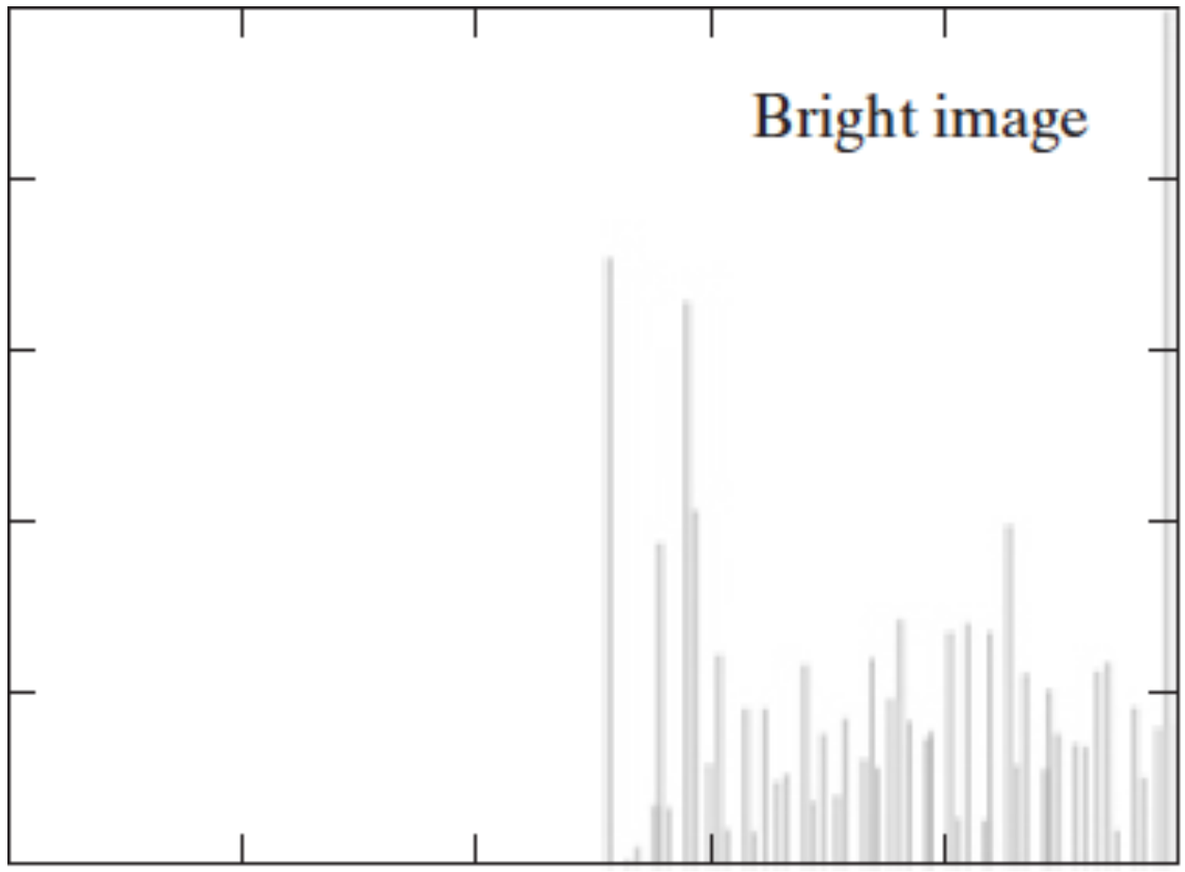
Histogram processing



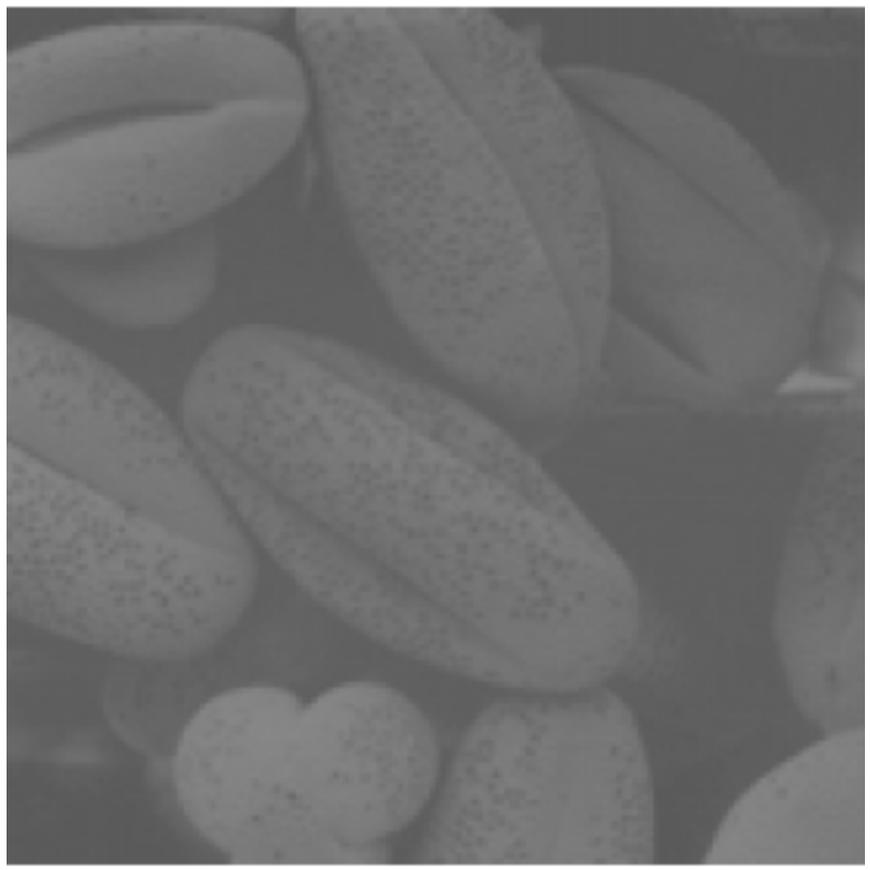


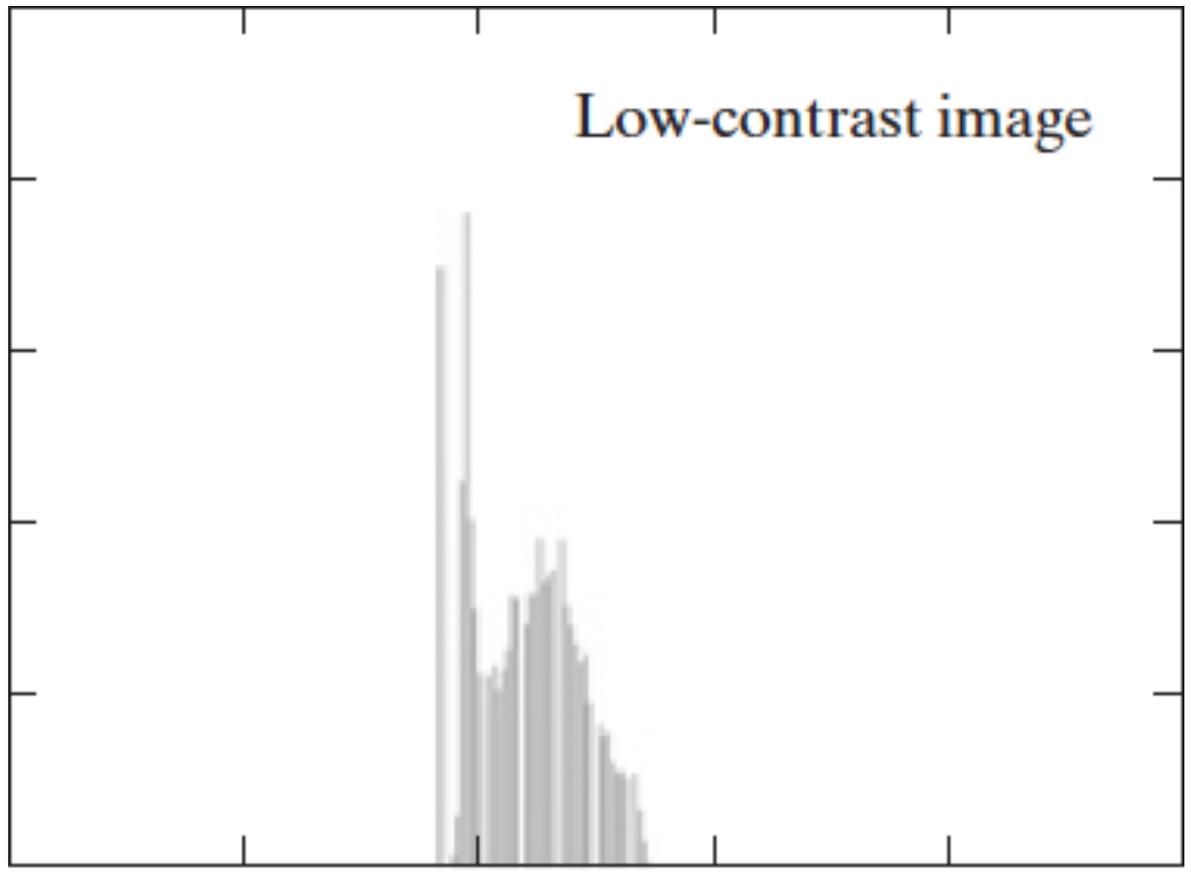
Histogram processing



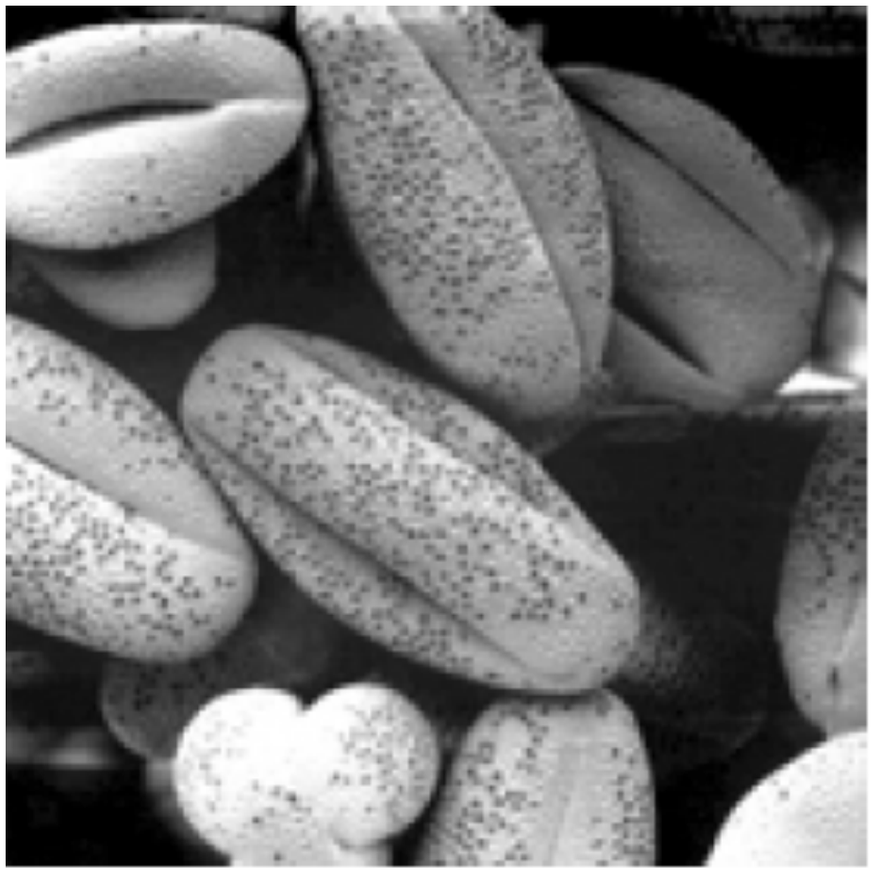


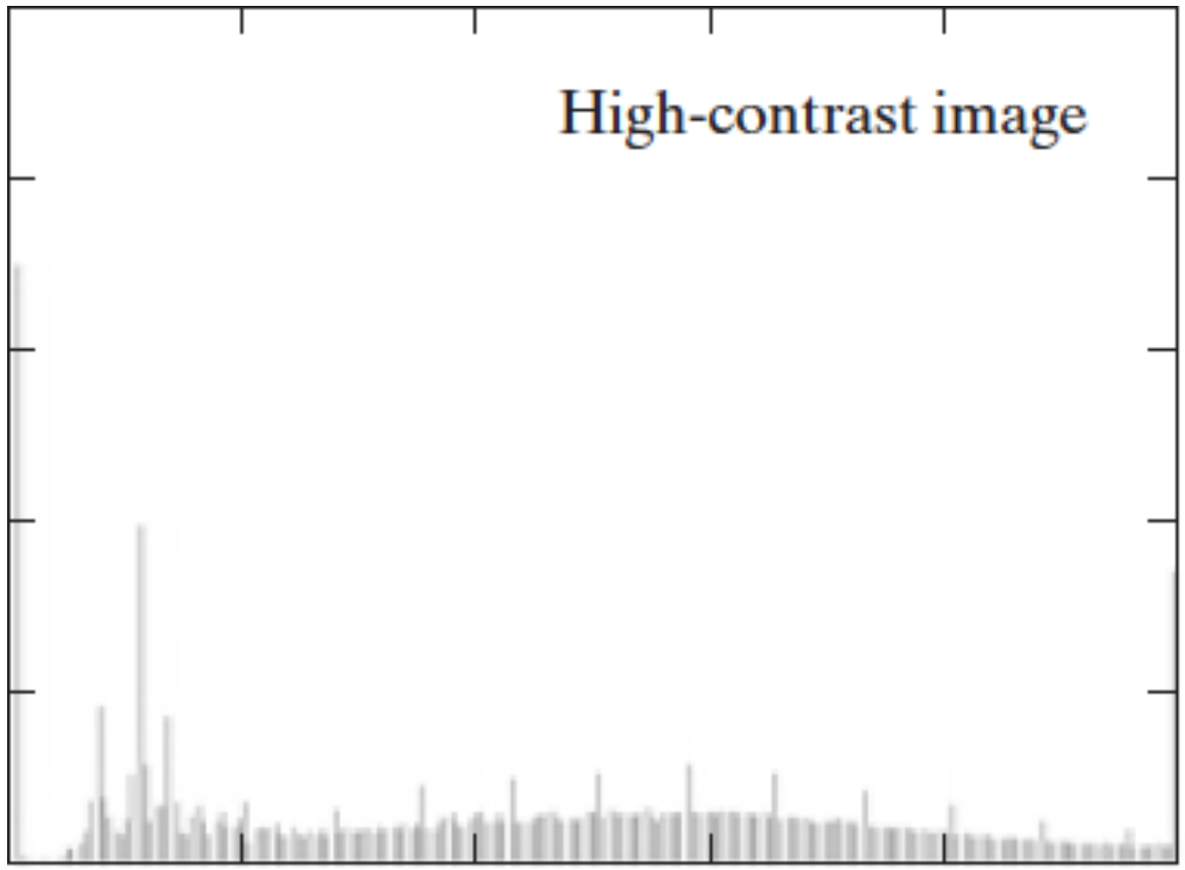
Histogram processing



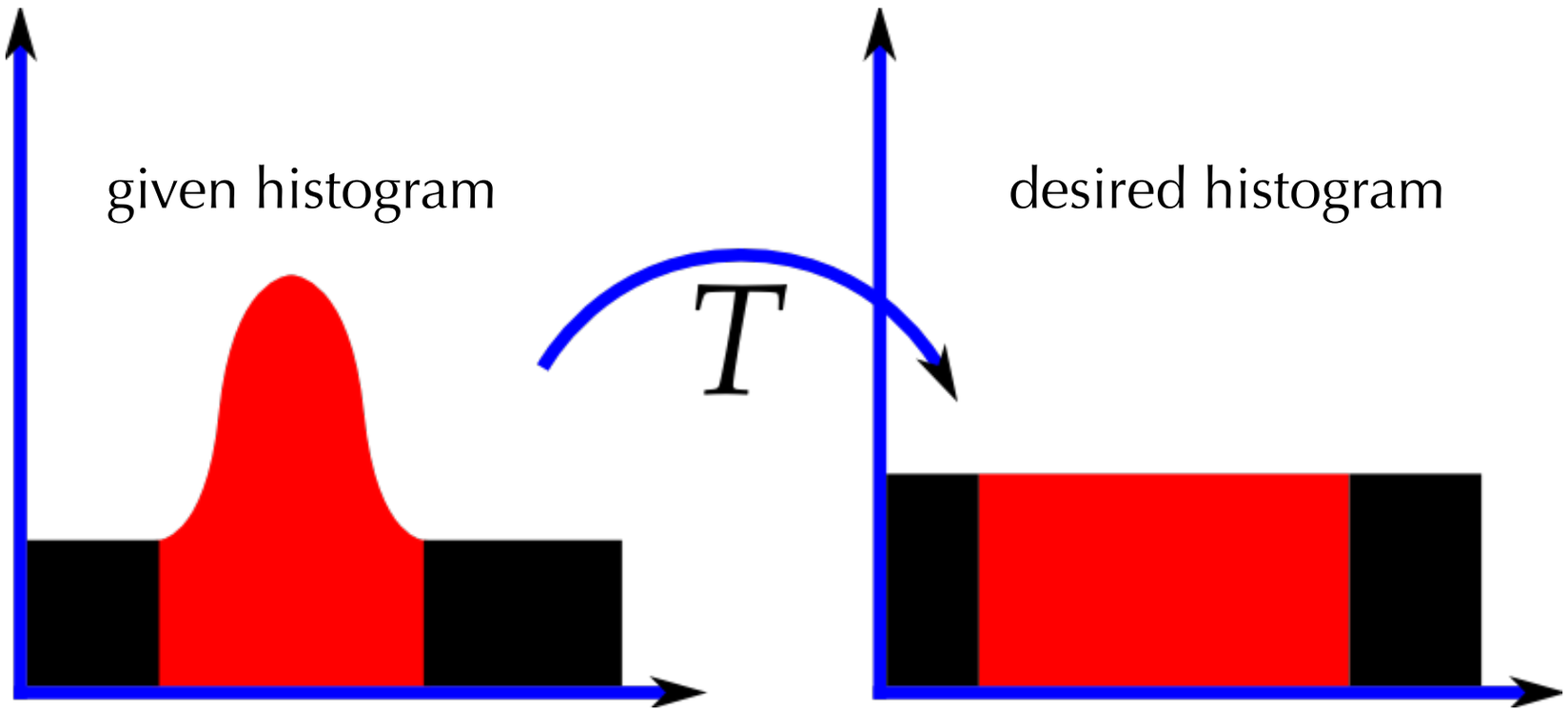


Histogram processing





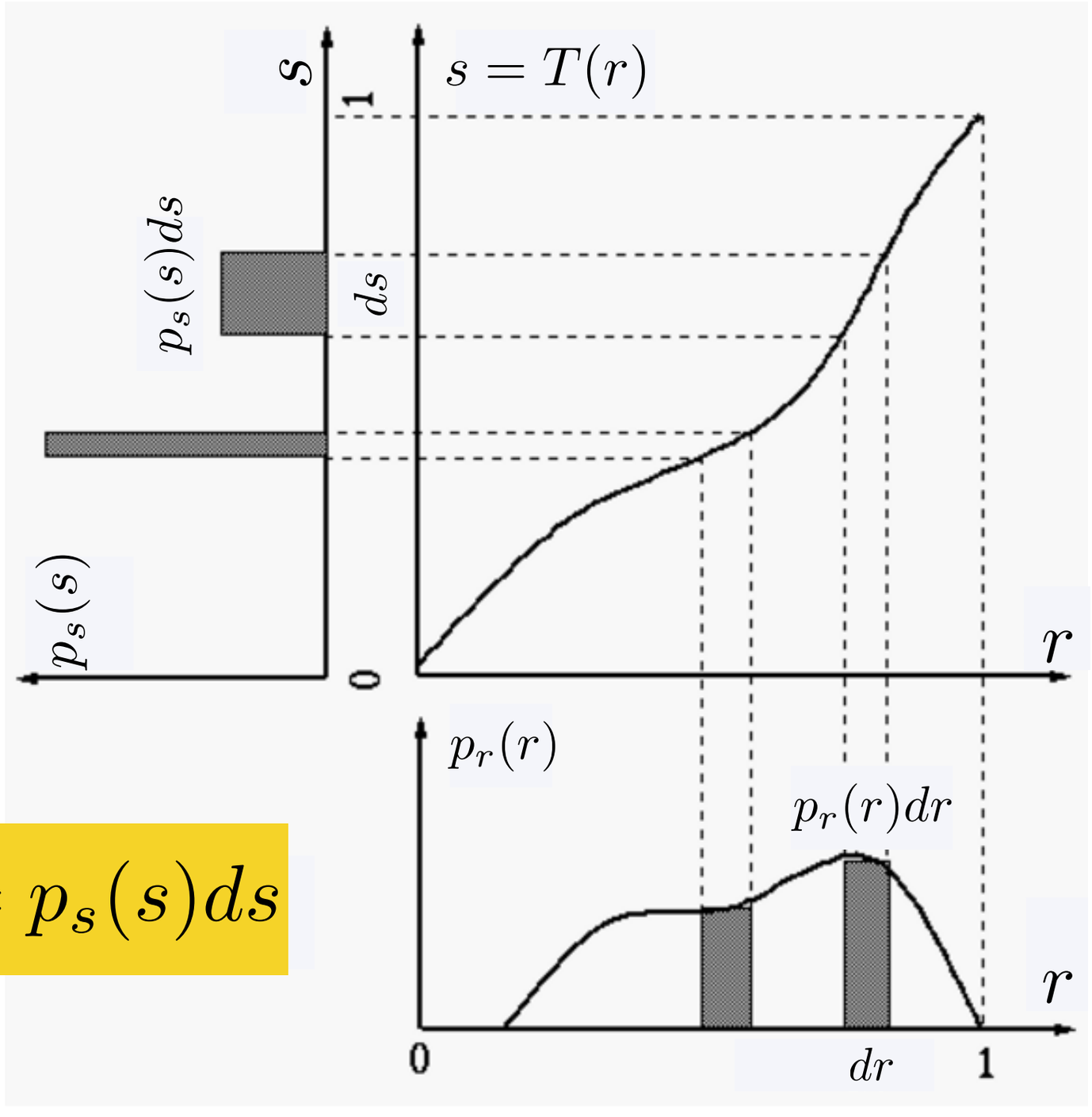
Histogram equalization



The main idea

image source: wikipedia

Histogram equalization



T(.) = CDF of the given image

See class notes for the proof.

$$p_r(r)dr = p_s(s)ds$$

Histogram equalization