Digital Image Processing (CSE/ECE 478) Lecture2: Intensity transformations and histograms

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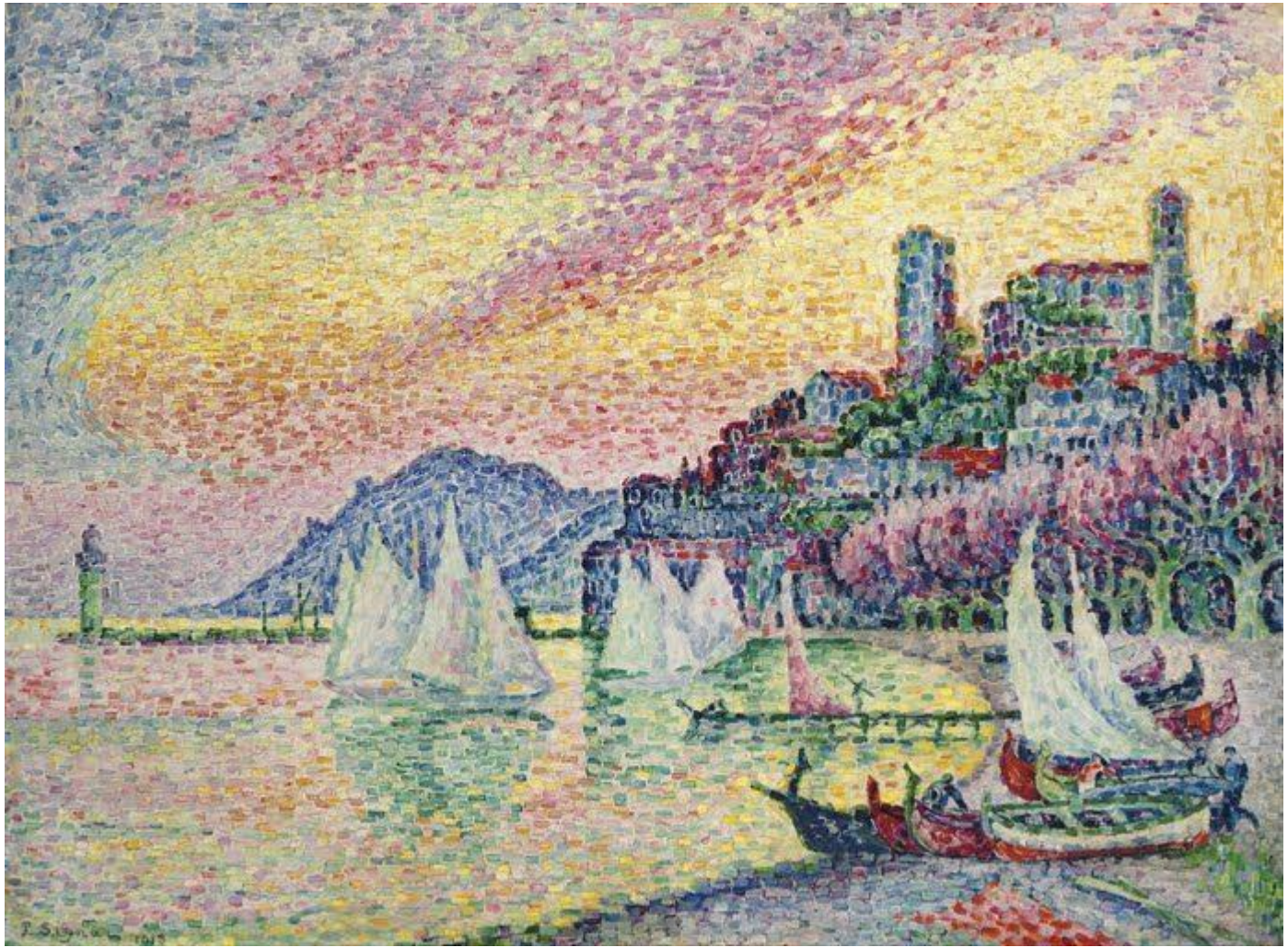
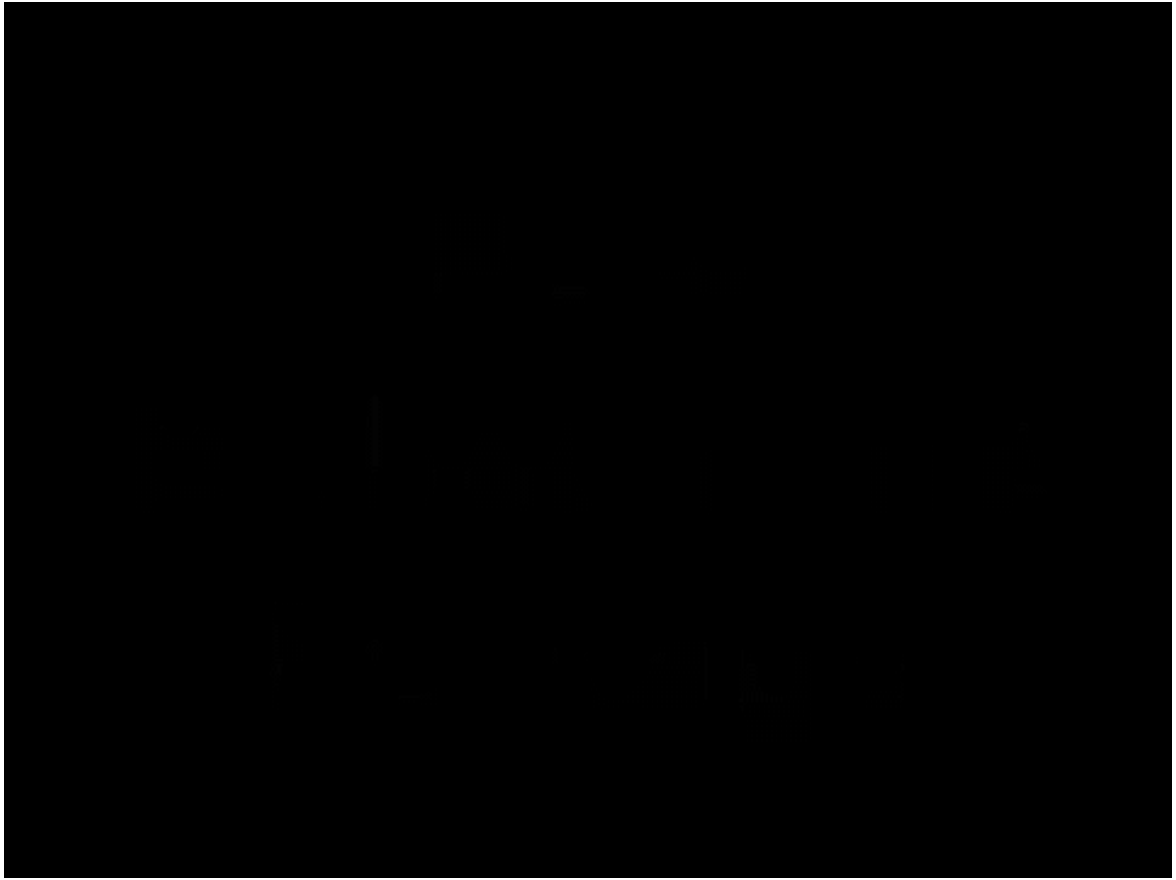


Matrix scene



Motivation

Image courtesy: NASA

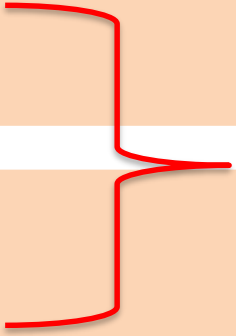
Motivation

Image courtesy: rationalqm.us

Organization (today's lecture)

1. Intensity Transformation Functions

2. Histogram Processing



Point Operations

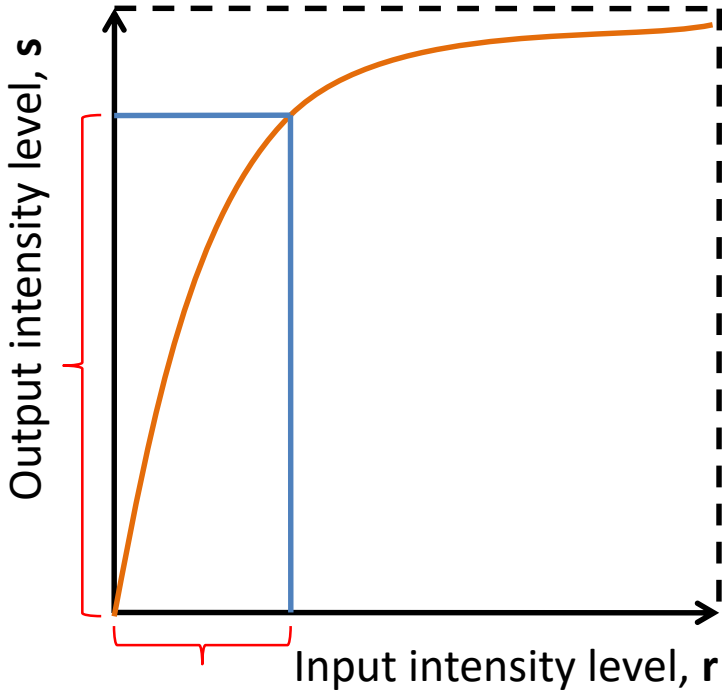
Organization (today's lecture)

1. Intensity Transformation Functions

2. Histogram Processing

Intensity transformation

- Input pixel (r) → output pixel (s)
- Independent pixel to pixel mapping



Standard Intensity transformations

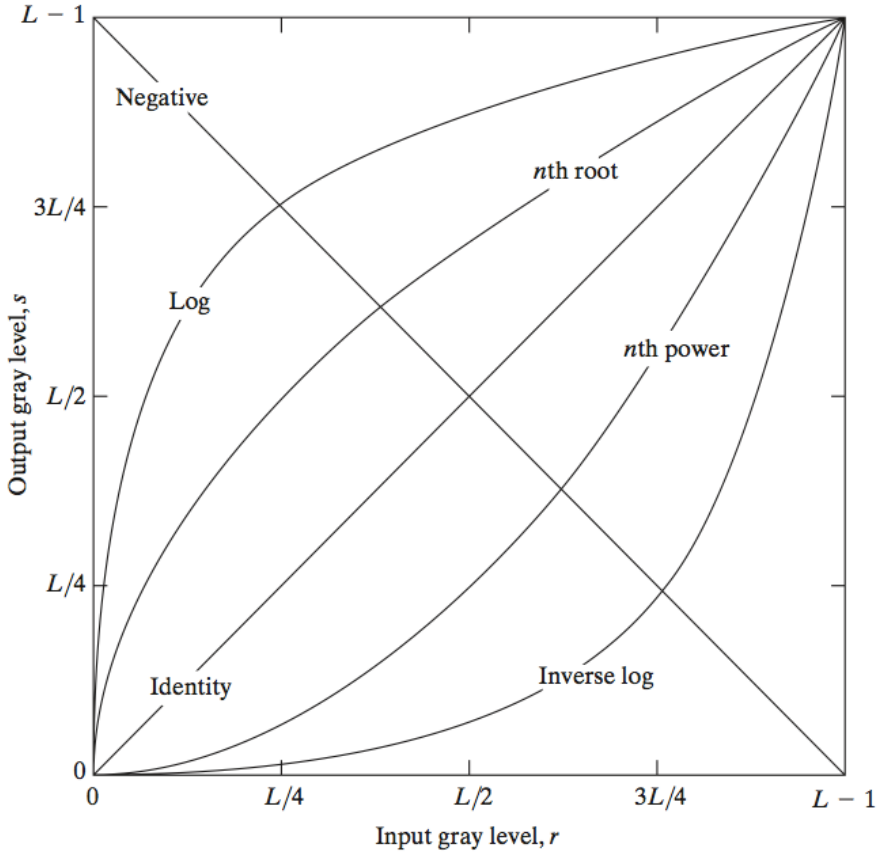
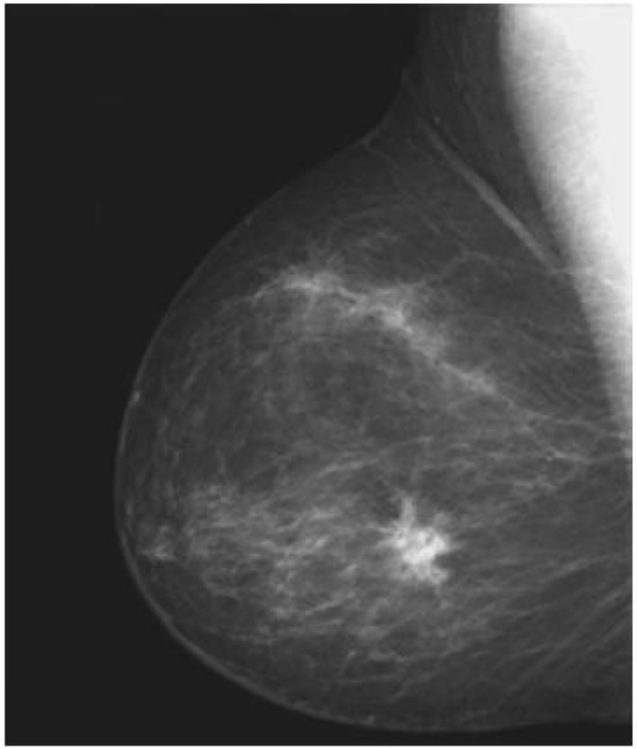
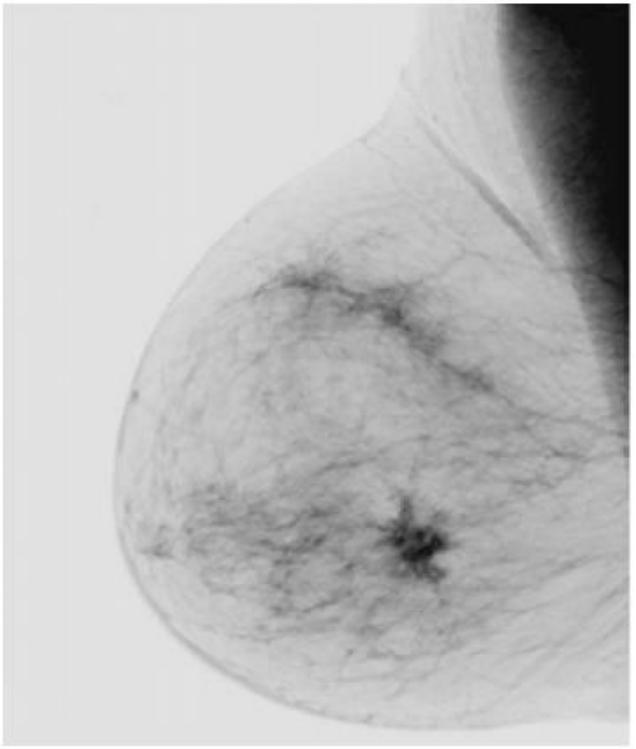


Image Negatives





a b

FIGURE 3.4
(a) Original digital mammogram. (b) Negative image obtained using the negative transformation in Eq. (3.2-1). (Courtesy of G.E. Medical Systems.)

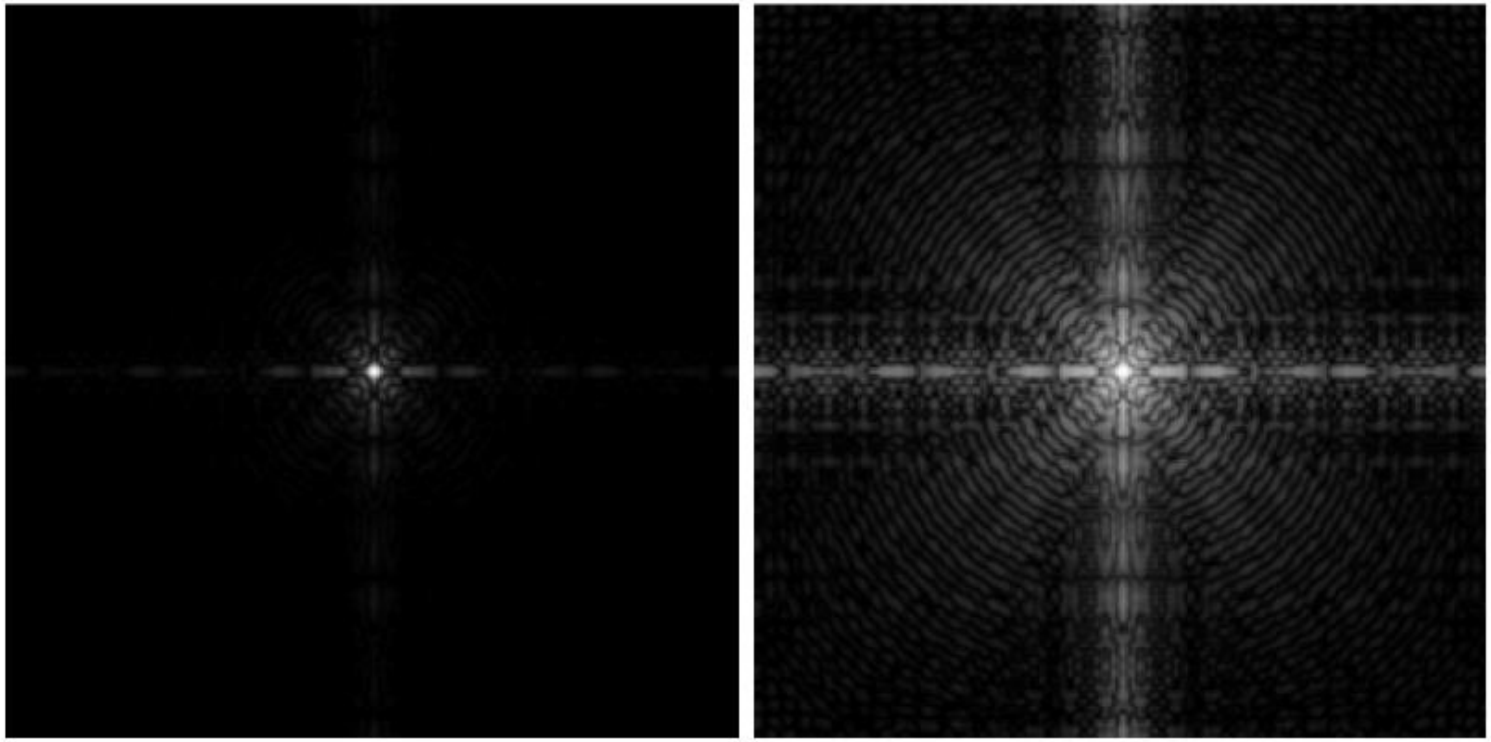
Intensity levels: [0, L-1]

Transformation: s = L – 1 - r

Log Transformations

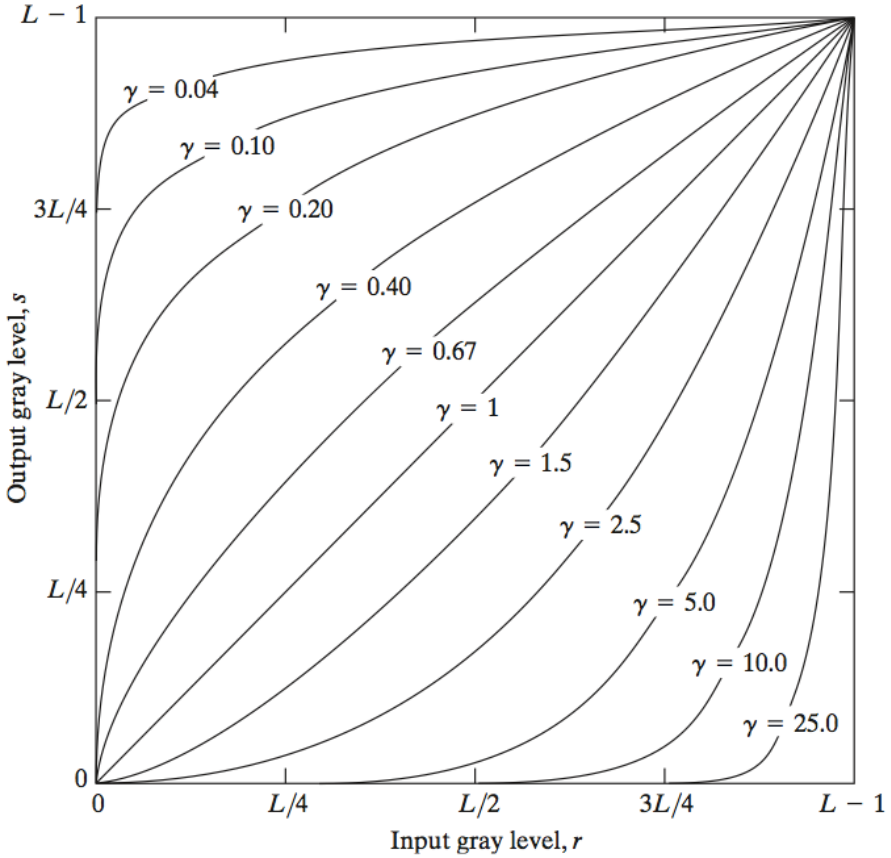
a b

FIGURE 3.5
(a) Fourier spectrum.
(b) Result of applying the log transformation given in Eq. (3.2-2) with $c = 1$.



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

Power-Law (Gamma) Transformations



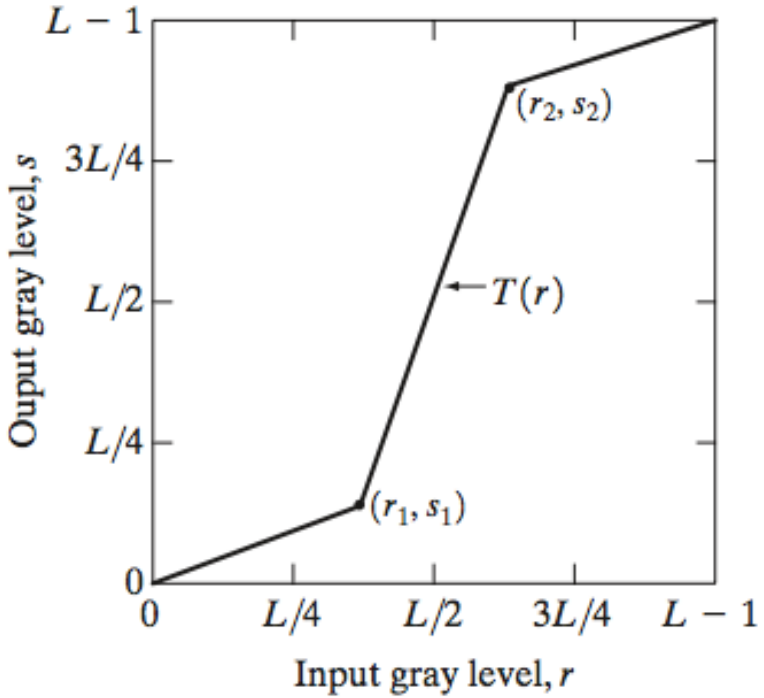
$s = c\, r^{\gamma}$

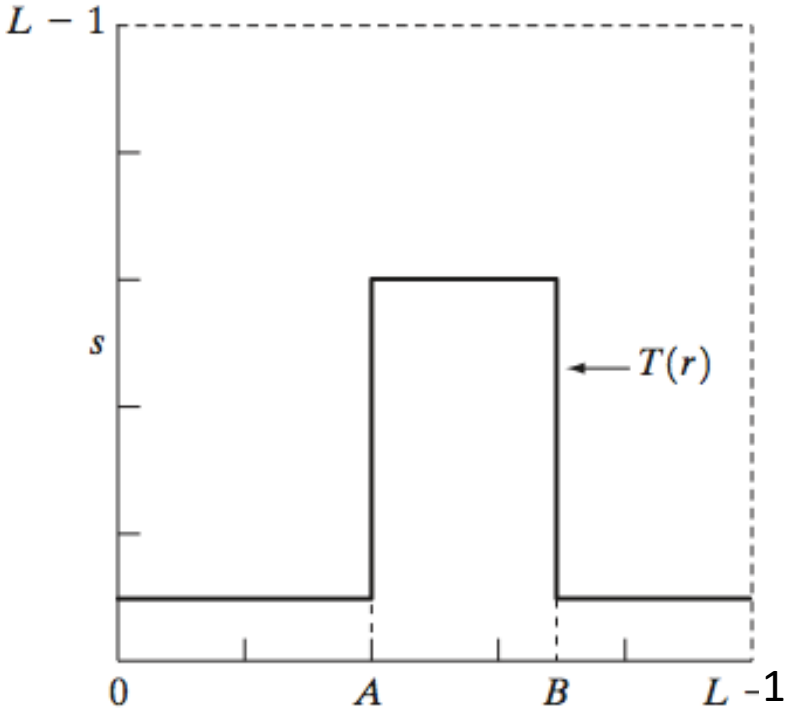
Power-Law (Gamma) Transformations

a b
c d

FIGURE 3.9
(a) Aerial image. (b)–(d) Results of applying the transformation in Eq. (3.2-3) with $c = 1$ and $\gamma = 3.0, 4.0$, and 5.0, respectively. (Original image for this example courtesy of NASA.)

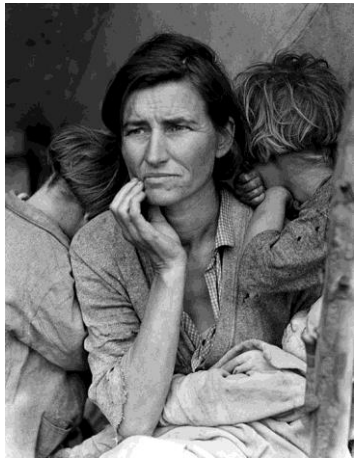
Piecewise Transformations



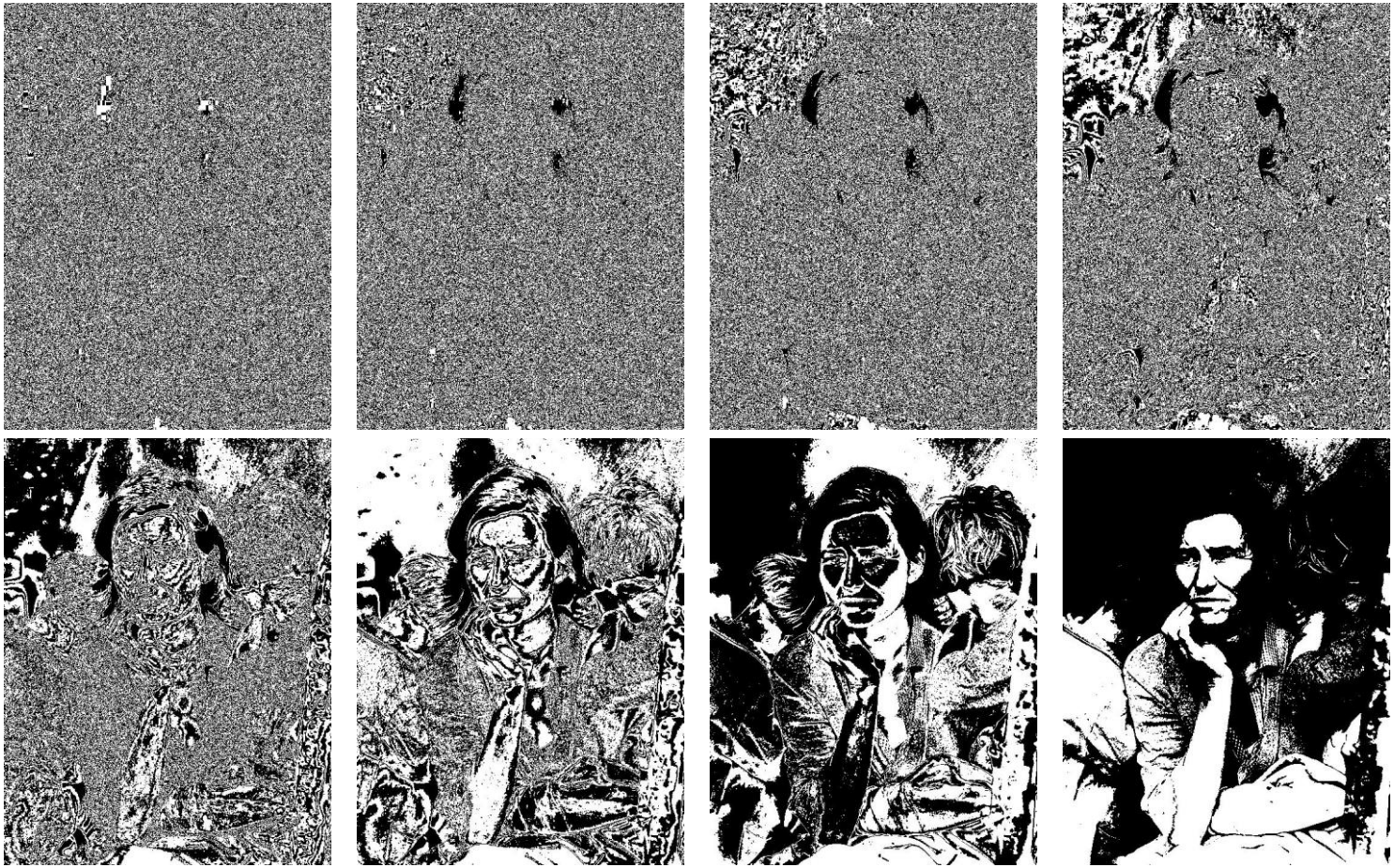


Piecewise Transformations: Contrast Stretching

Bit Plane Slicing

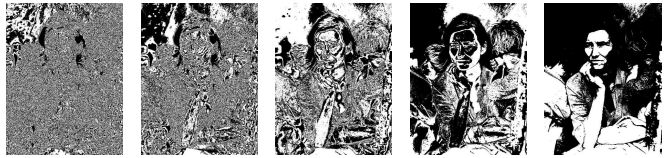
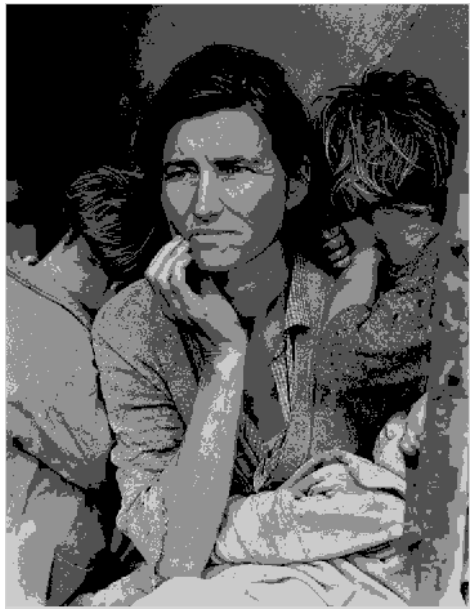
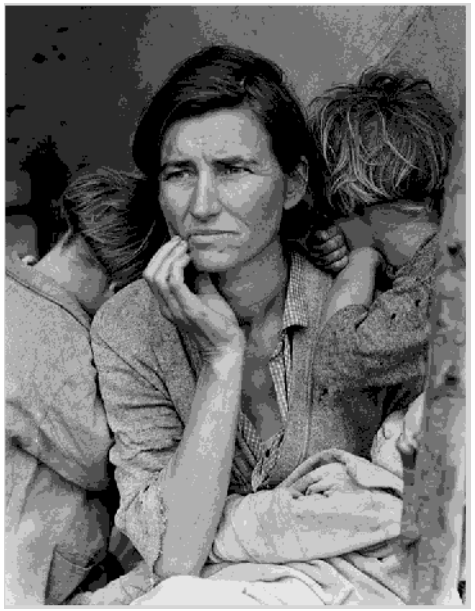
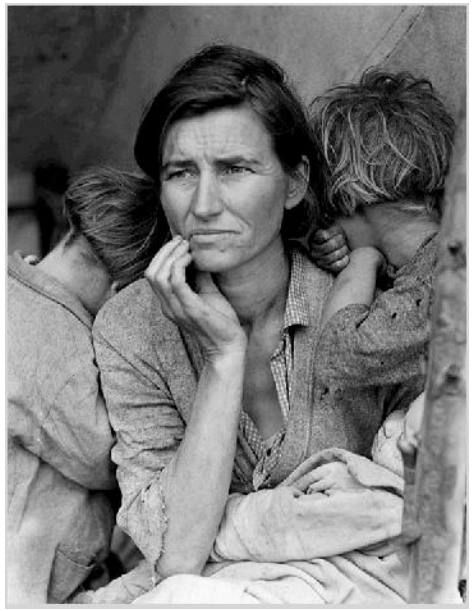


Dorothea Lange's
"Migrant Mother"



Bit Plane Slicing



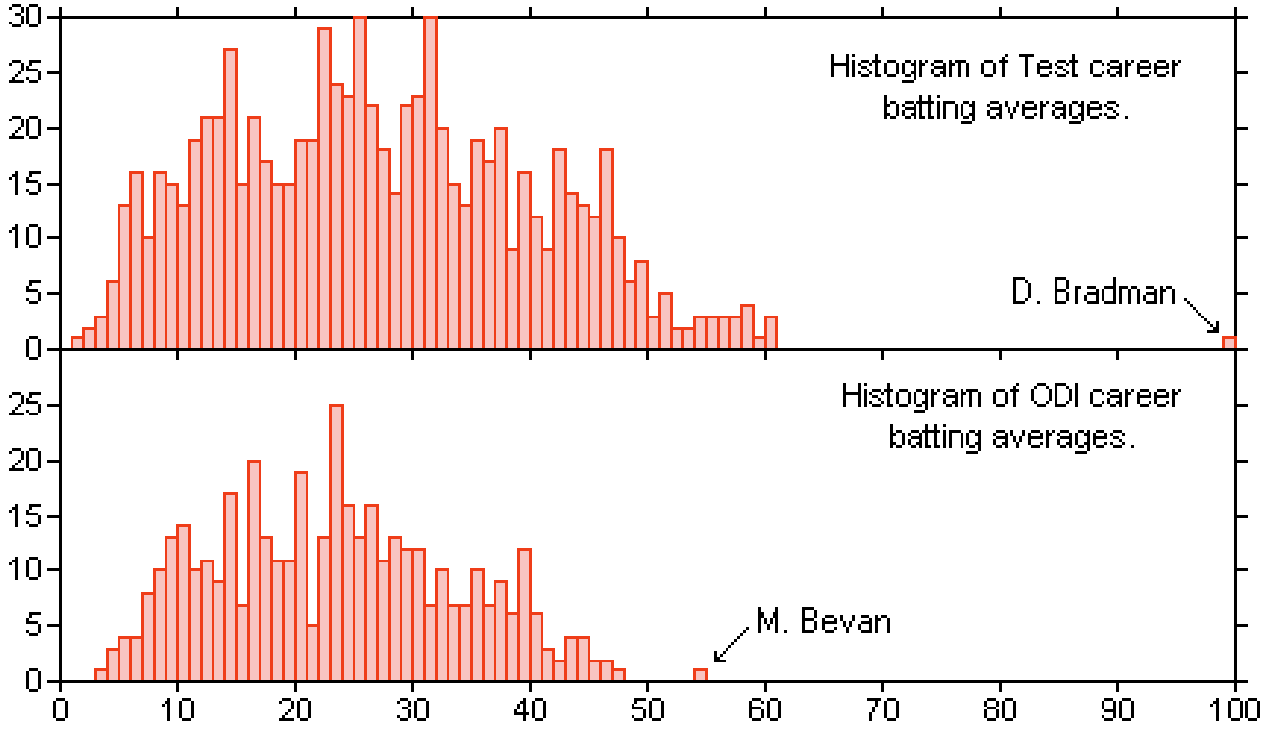





Organization (today’s lecture)

1. Intensity Transformation Functions

2. Histogram Processing

Histogram



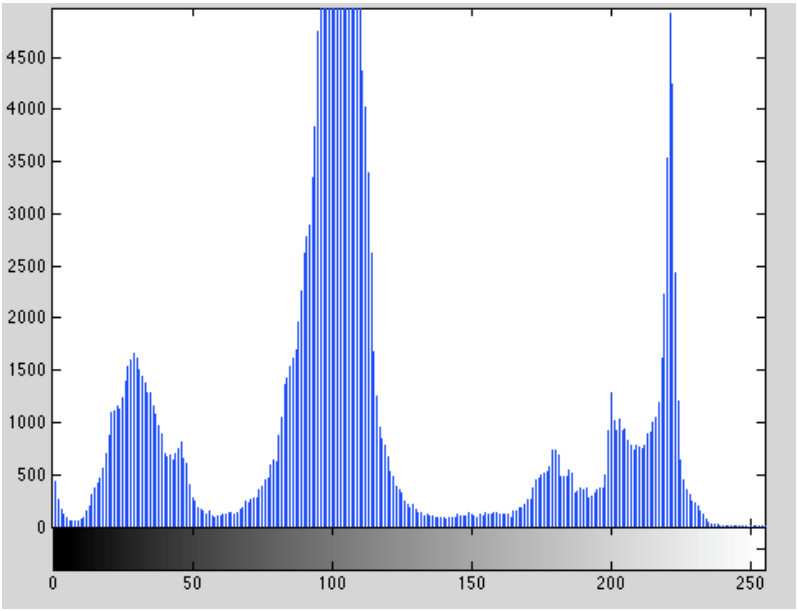
Courtesy: wikipedia

Histogram

$$h_r(i) = n_i$$

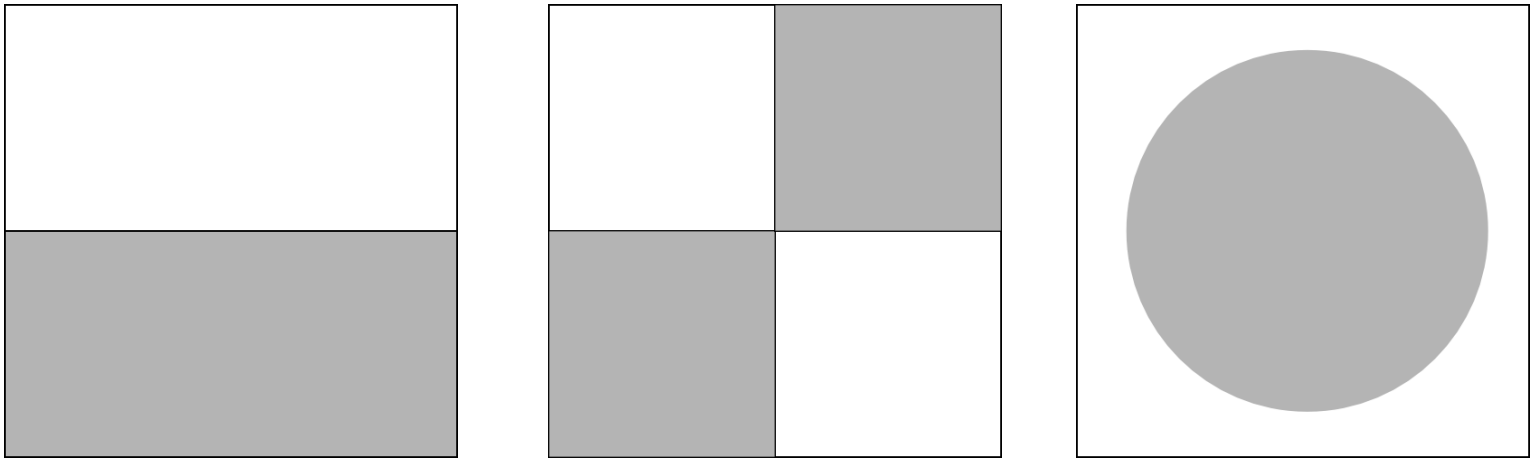
i → intensity value, range [0 L-1]

n_i → number of pixels with intensity i



Histograms

- Different images can have same histogram



- No information about distribution of intensity values

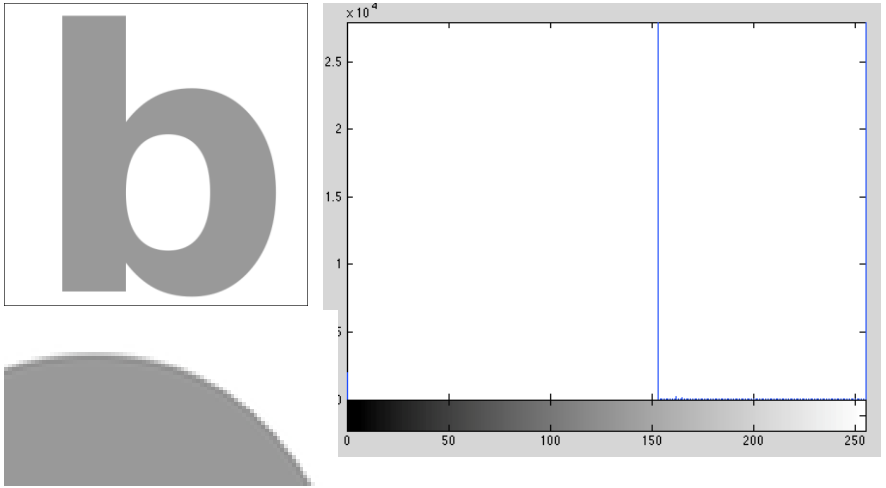
Histograms

- What can we infer from histograms?

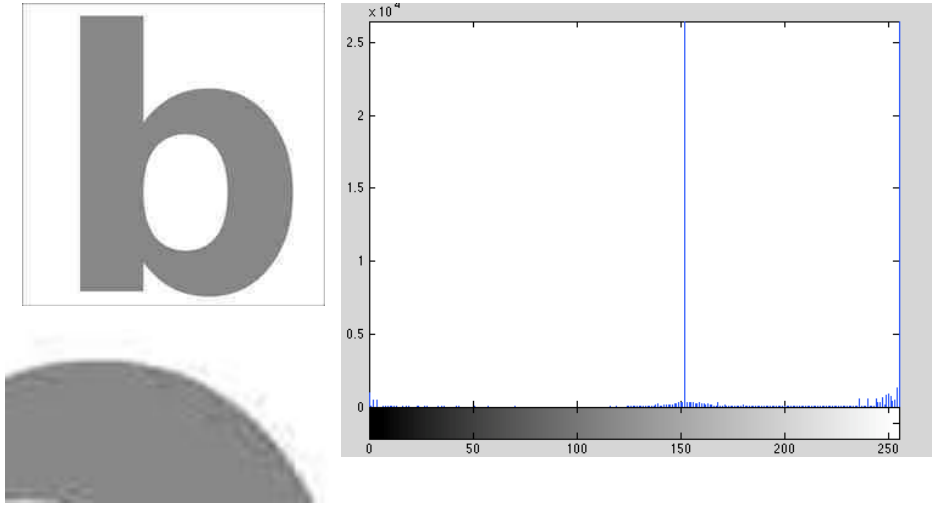
Histogram viewing standard in most DSLR cameras

Histograms

- Histograms can help interpret the images



Original Image and histogram

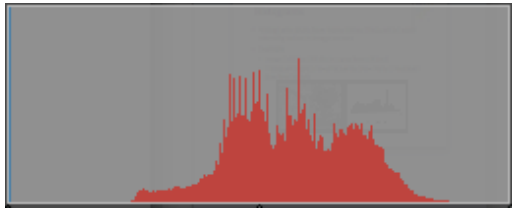
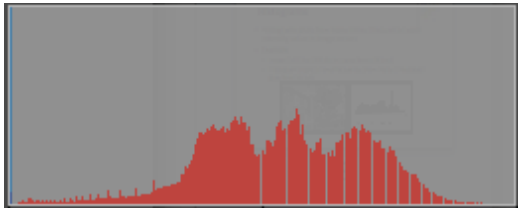
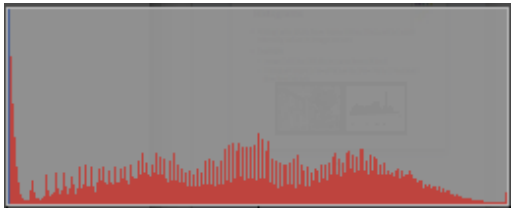


Compressed Image and histogram

Histograms

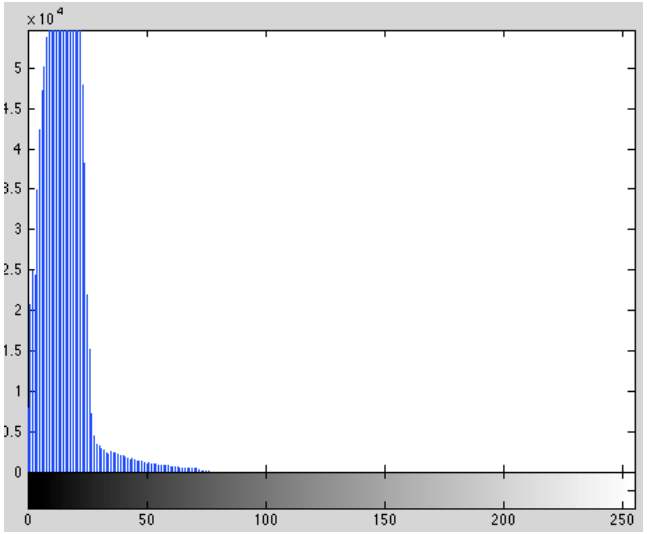
- Histogram and contrast



Histograms

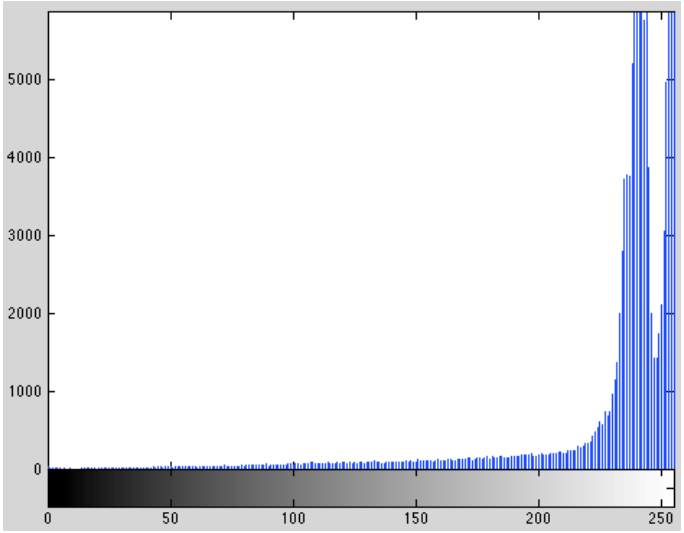
- Histograms and brightness



Under exposure

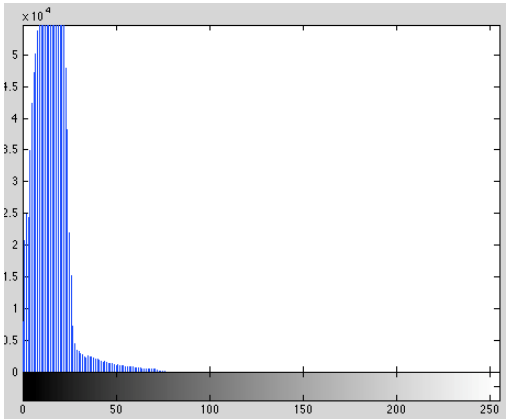
Histograms

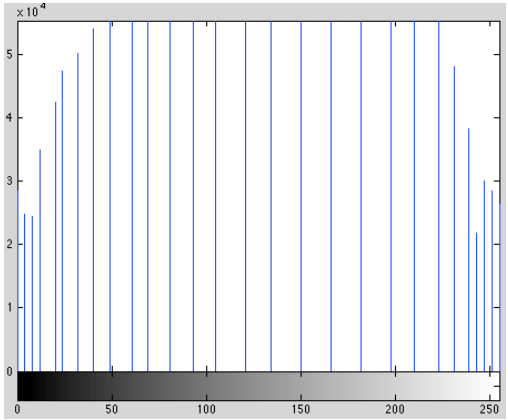
- Histograms and brightness



Over exposure

Histogram Equalization





Histogram Equalization

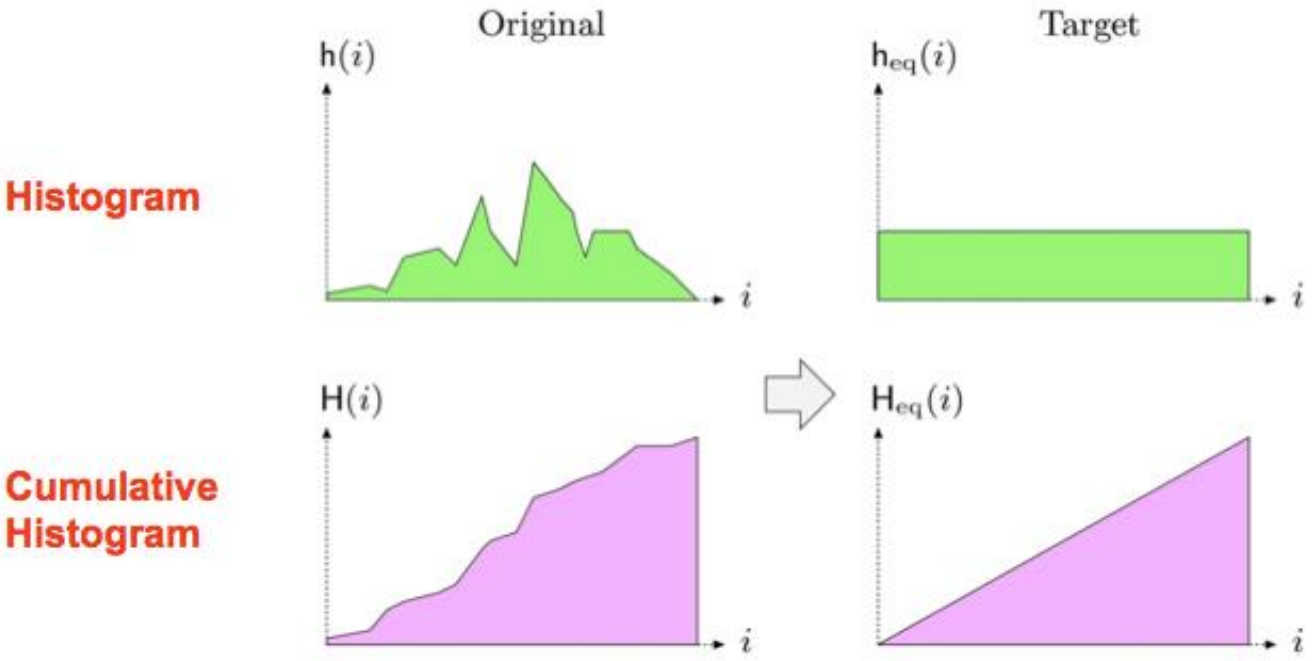


Image courtesy: *Worcester Polytechnic Institute*

Histogram Equalization

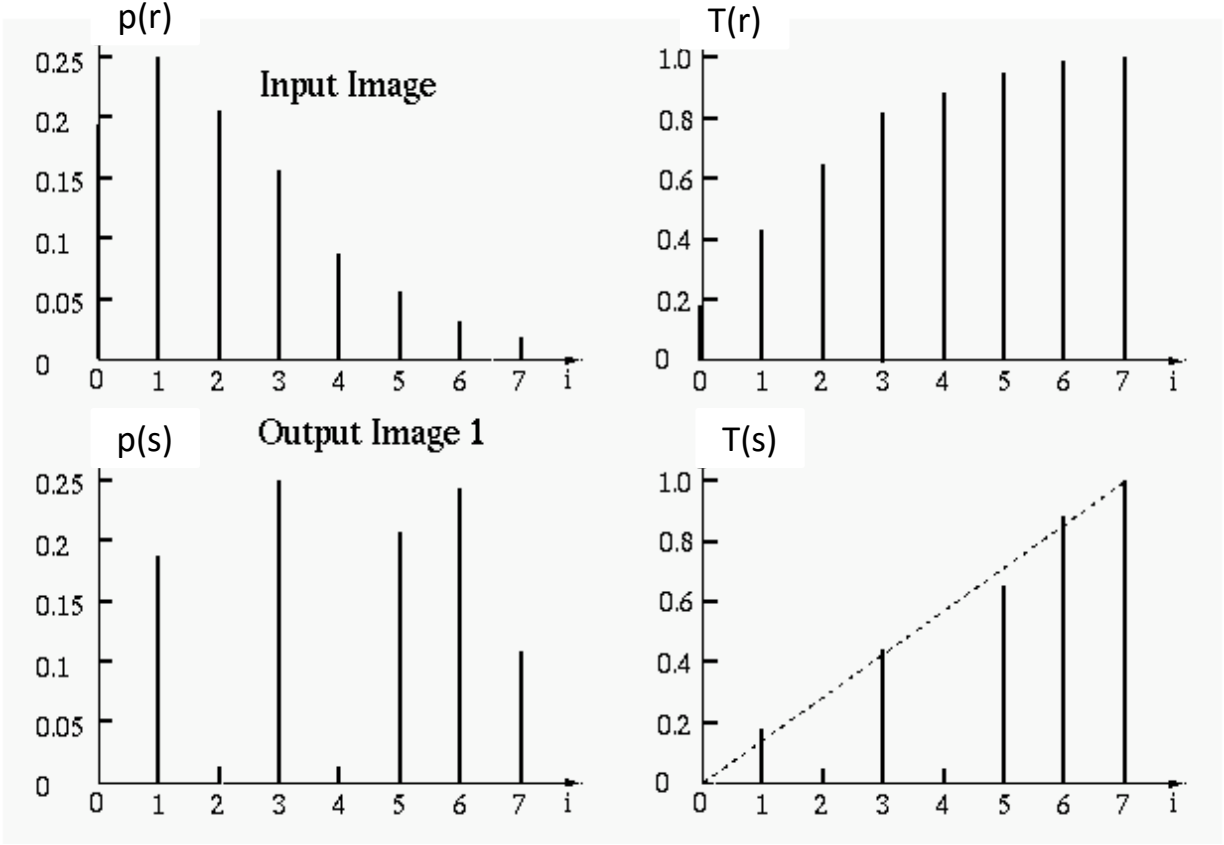
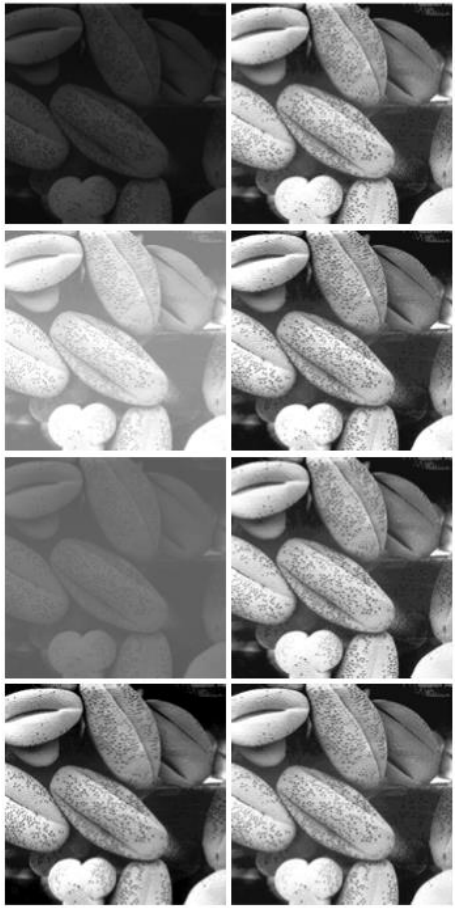


Image Courtesy: fourier.eng.hmc.edu/

Histogram Equalization



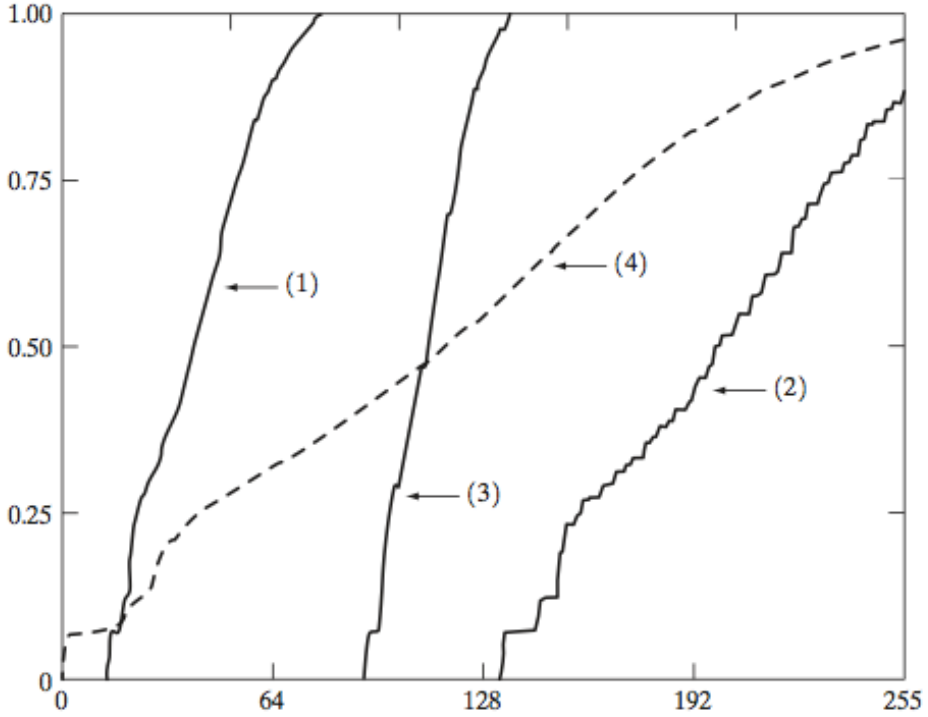


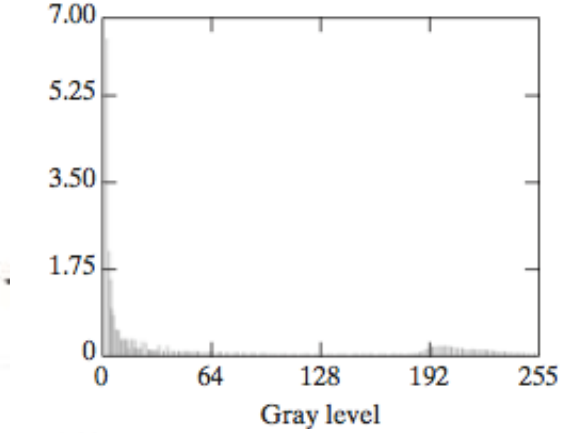
Image Courtesy: Gonzalez and Woods

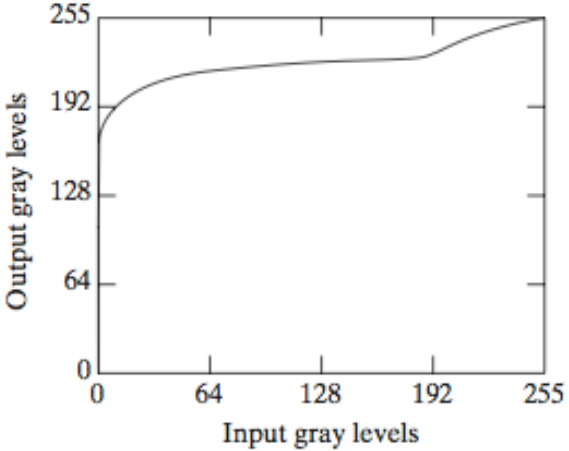
Histogram Equalization

Intensity transformation

Histogram Equalization

Histogram Equalization





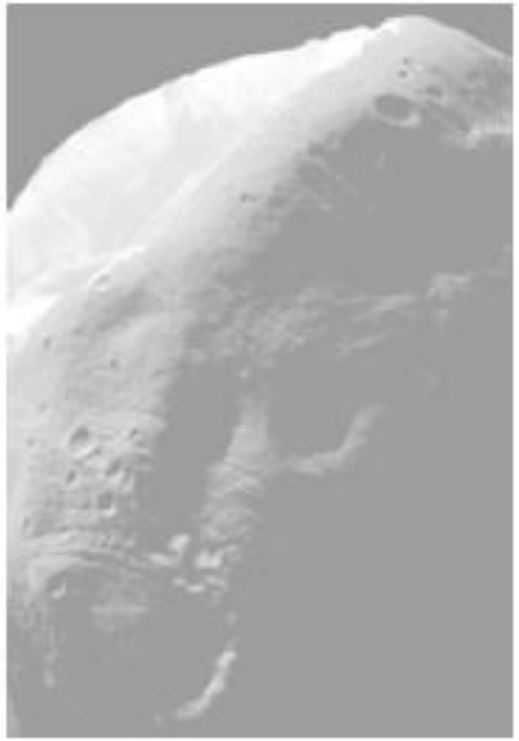


Image Courtesy: Gonzalez and Woods

Histogram Matching

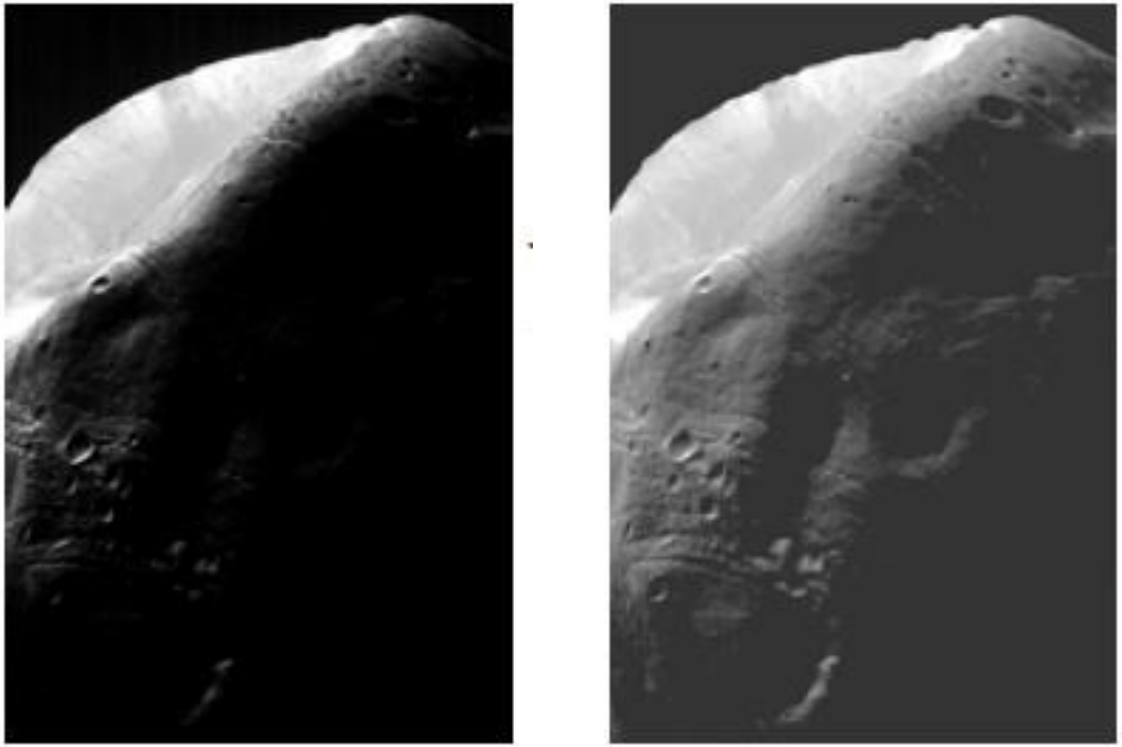


Image Courtesy: Gonzalez and Woods

Local Histogram Processing

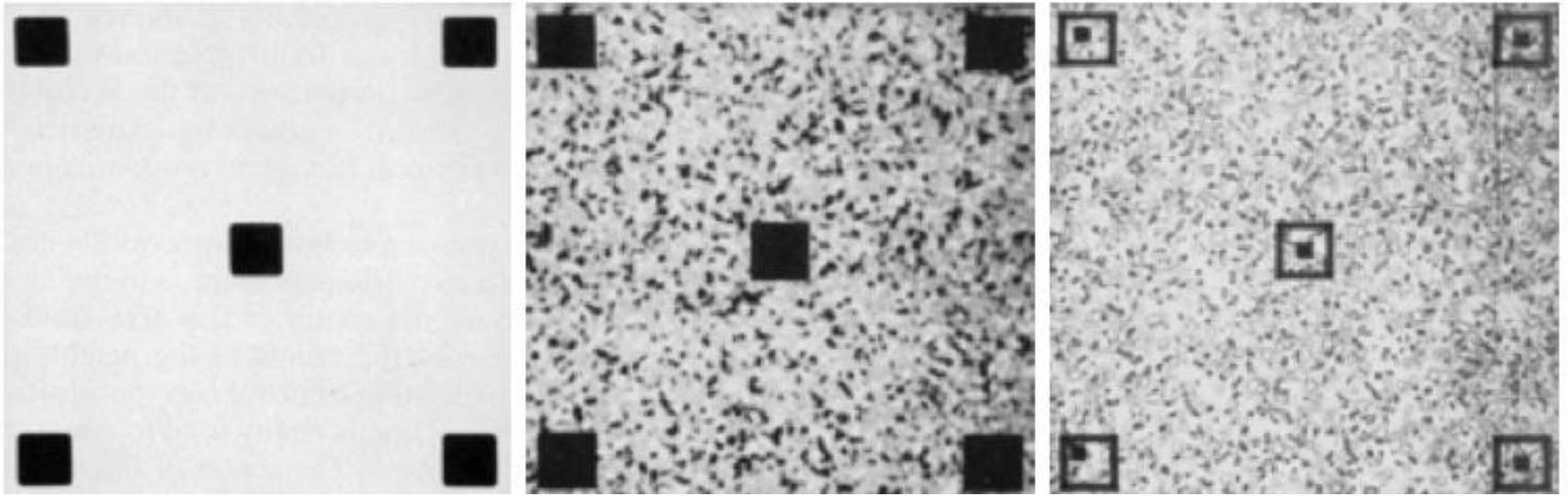
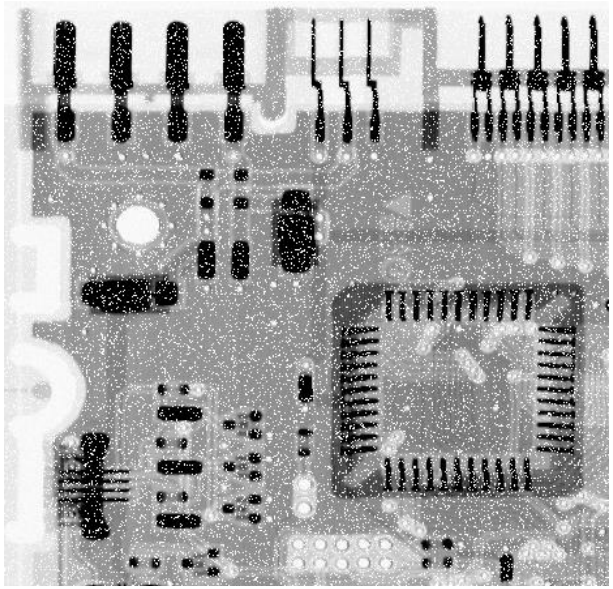


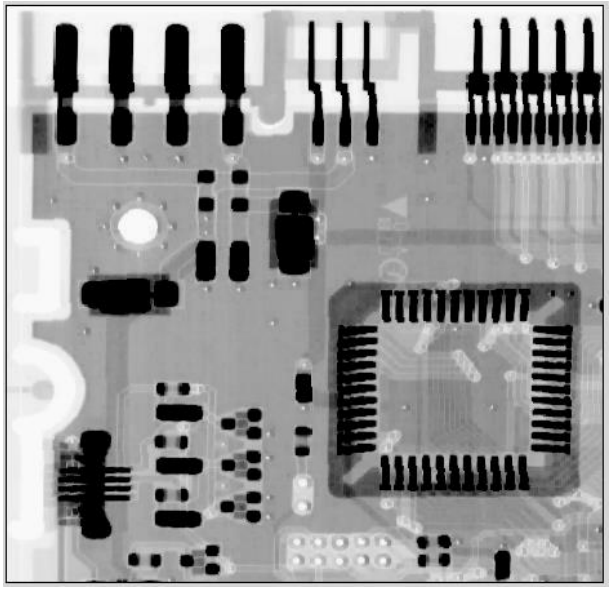
Image Courtesy: Gonzalez and Woods

What point operations can’t do?

Image Sharpening

What point operations can’t do?





Noise removal

Organization (today's lecture)

1. Intensity Transformation Functions

2. Histogram Processing

Spatial Filtering → Next class