Pixelwise mappings

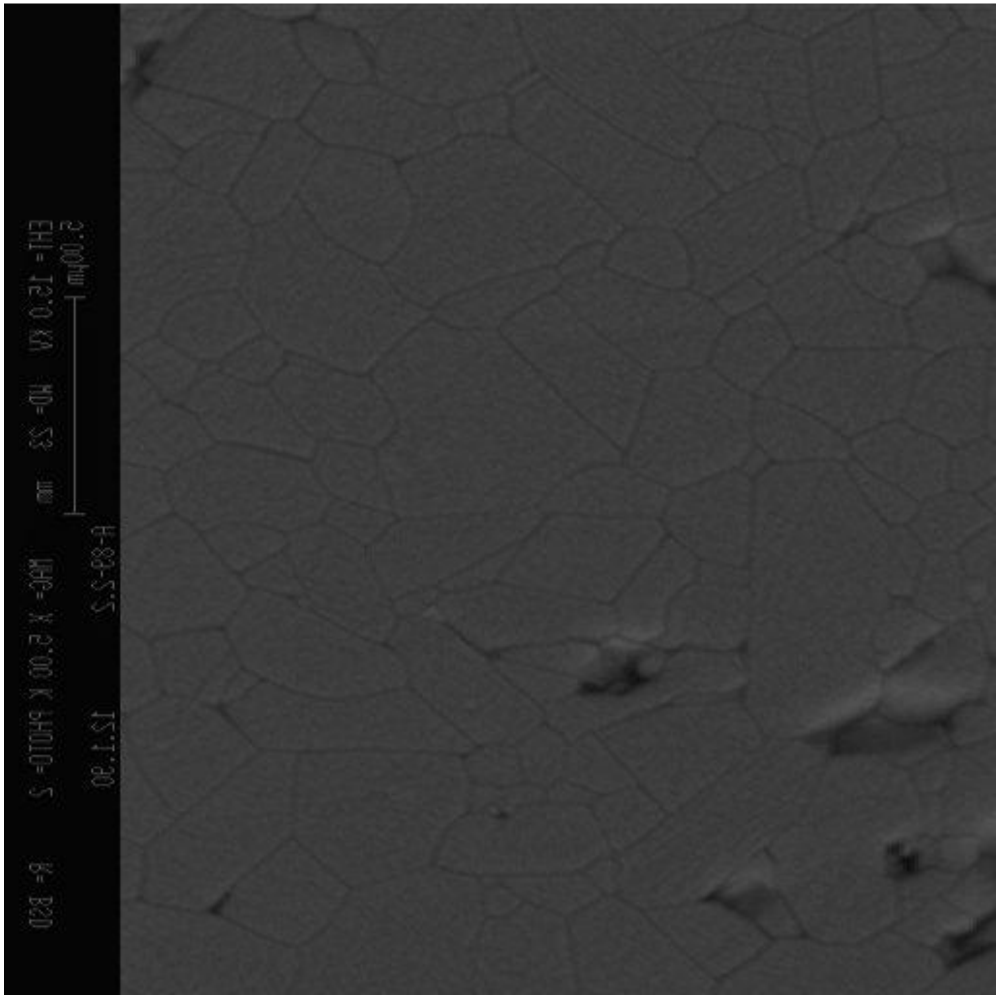
- Linear mappings

$$v_{out} = g \cdot v_{in} + b$$

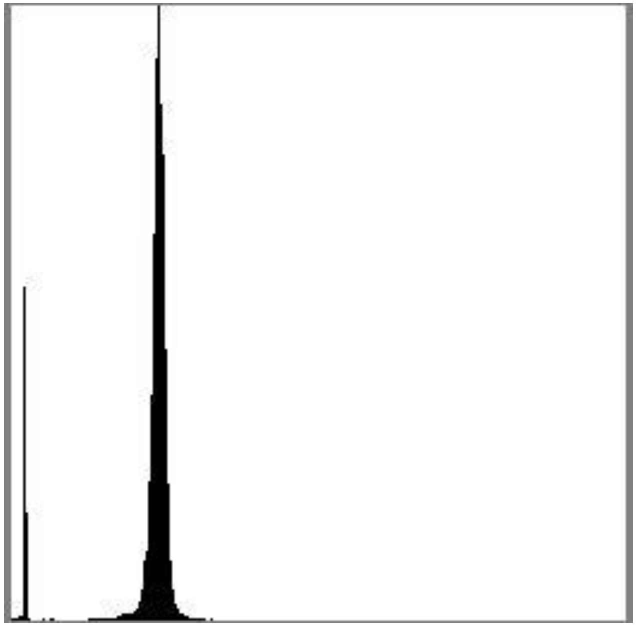
- Other mappings

$$v_{out} = f(v_{in}) \qquad v_{in}, v_{out} \in [0;1]$$

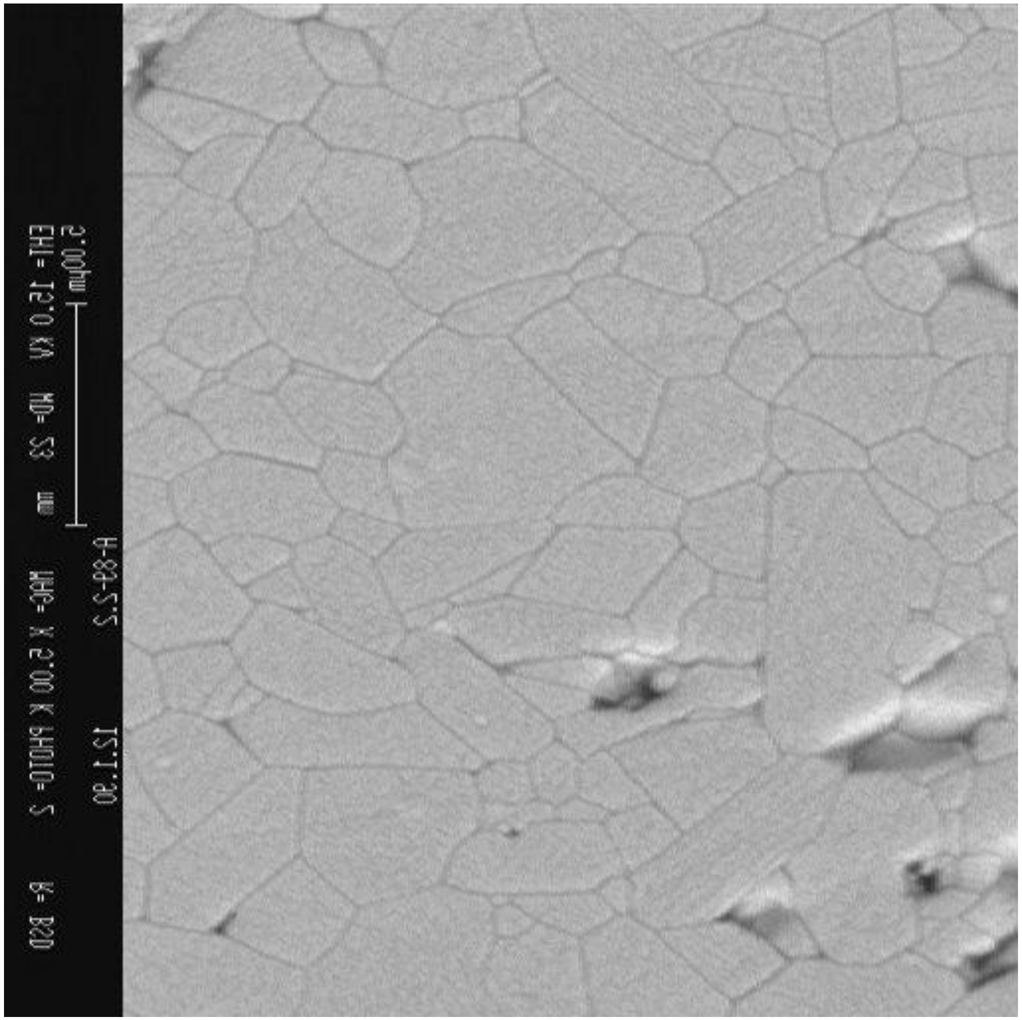
Scanning electrom microscope (SEM) image



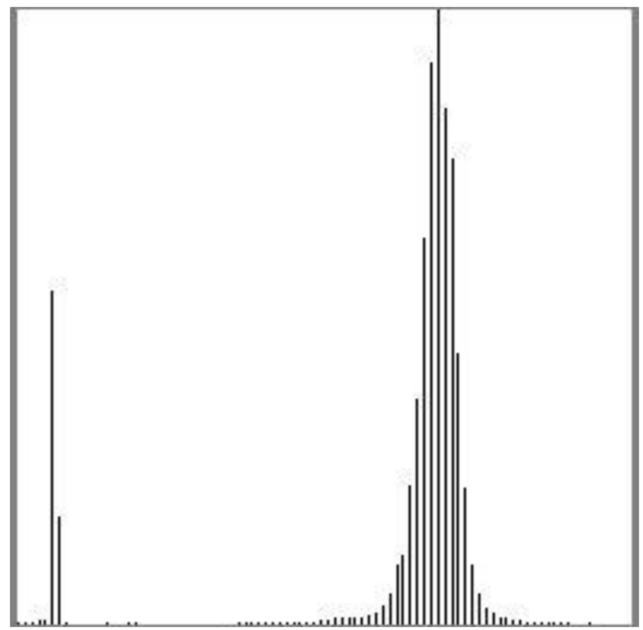
Histogram



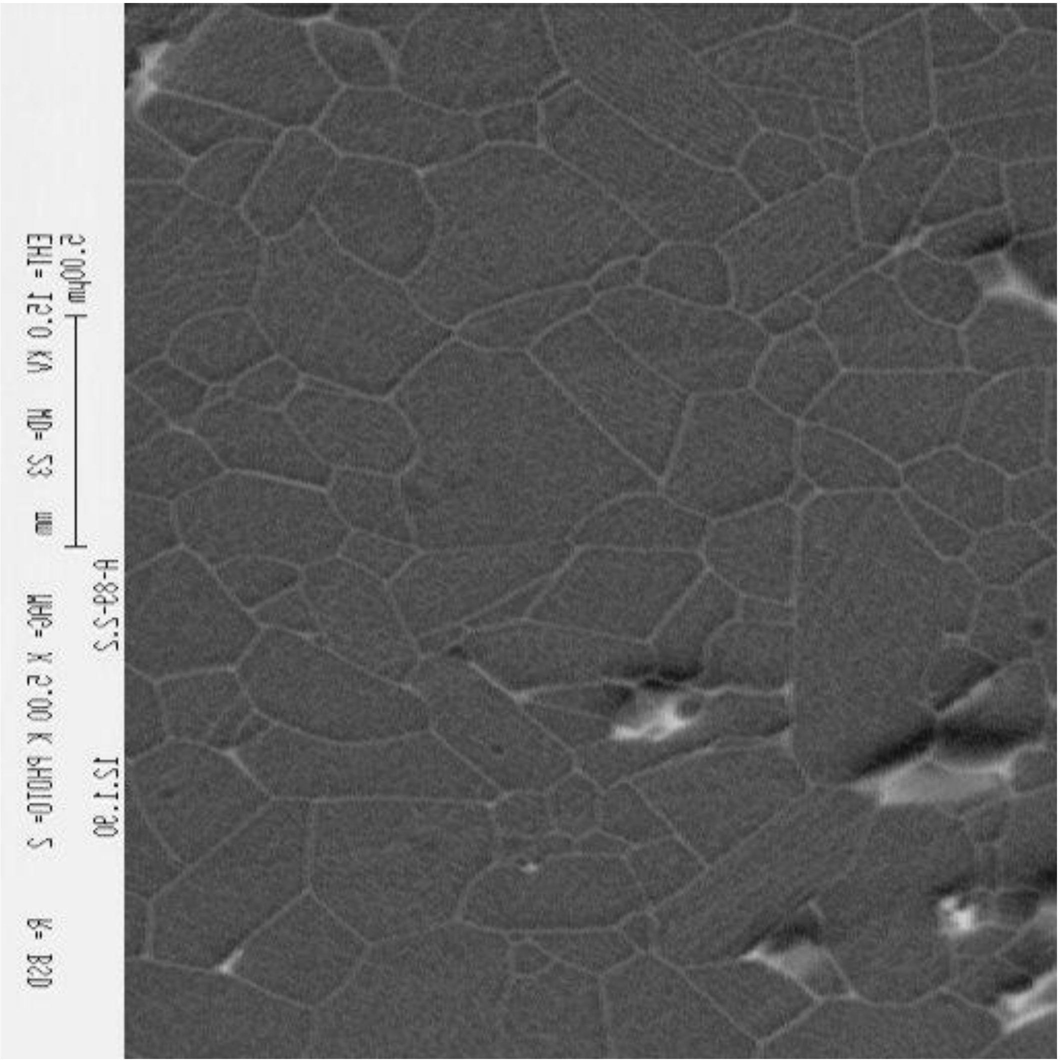
Linear mapping between min and max



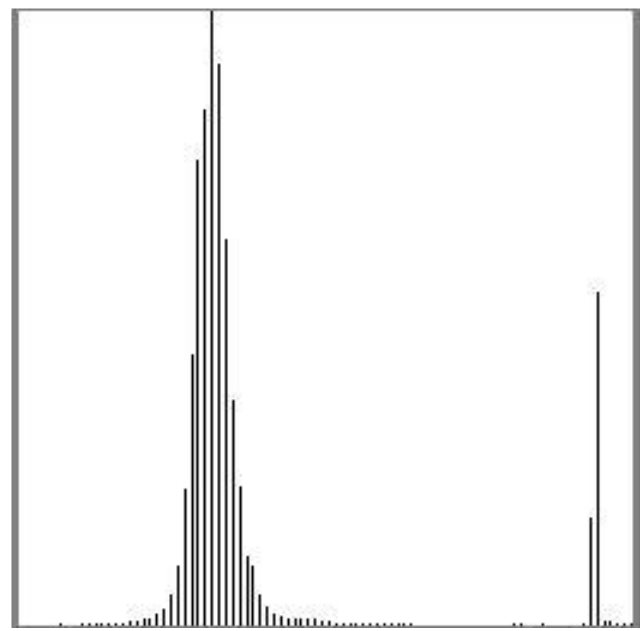
Histogram



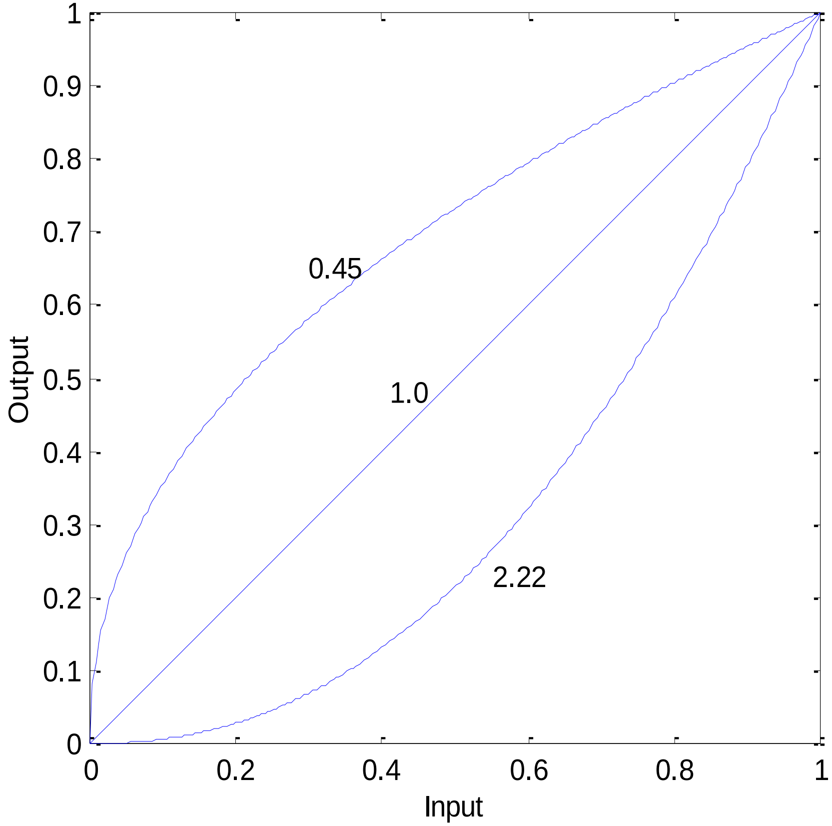
Negated image



Histogram

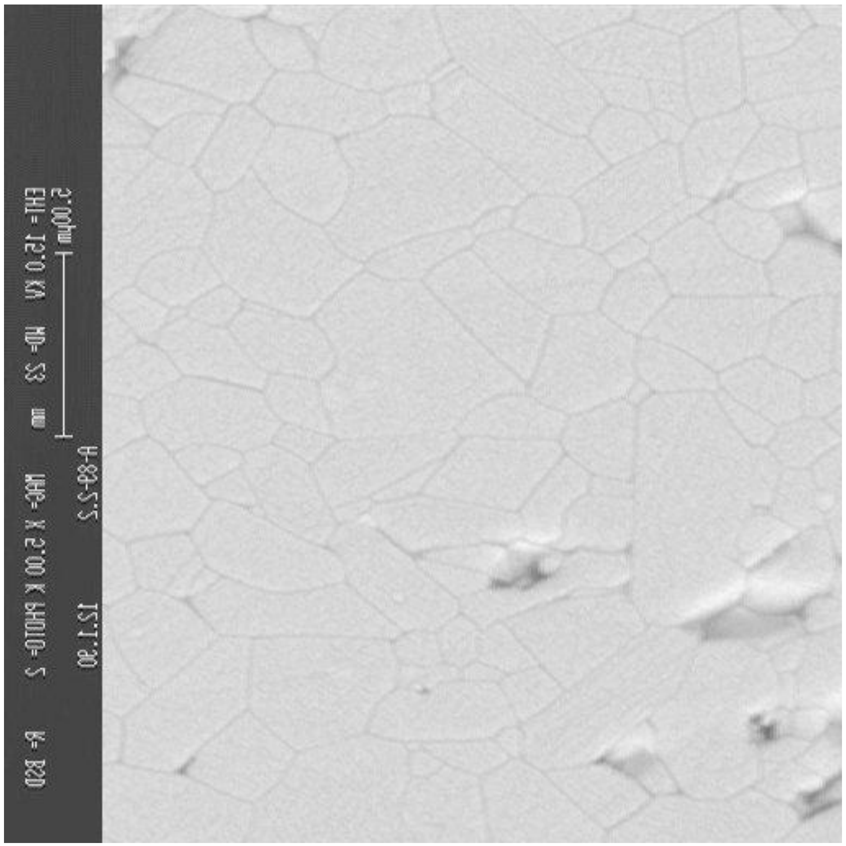


Gamma mapping

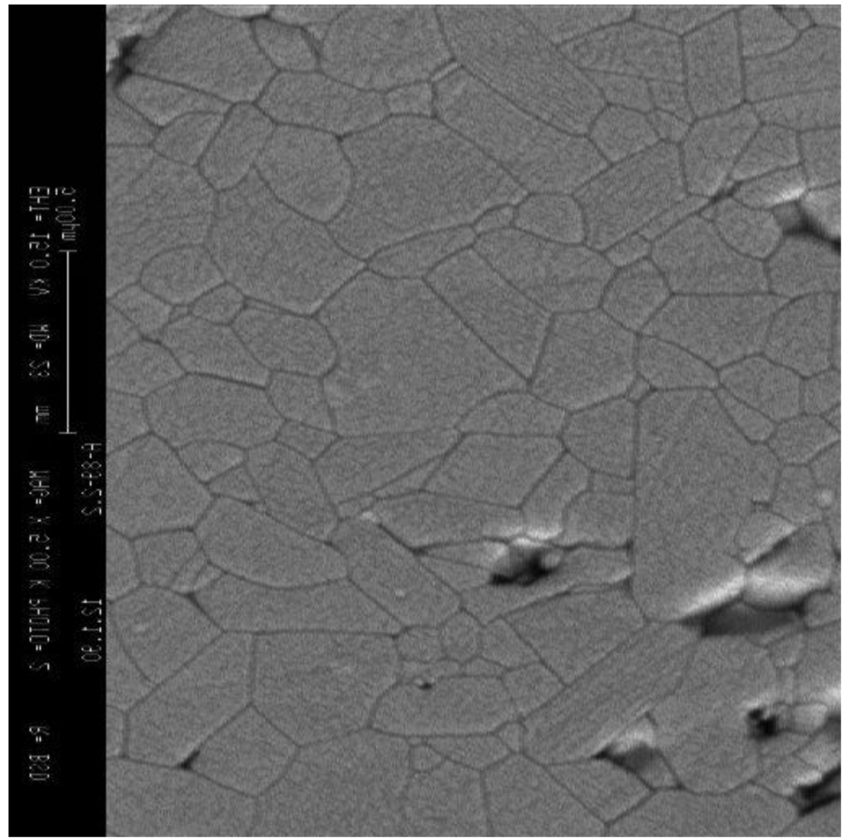


$$v_{out} = v_{in}^{\gamma}$$

Gamma mapping



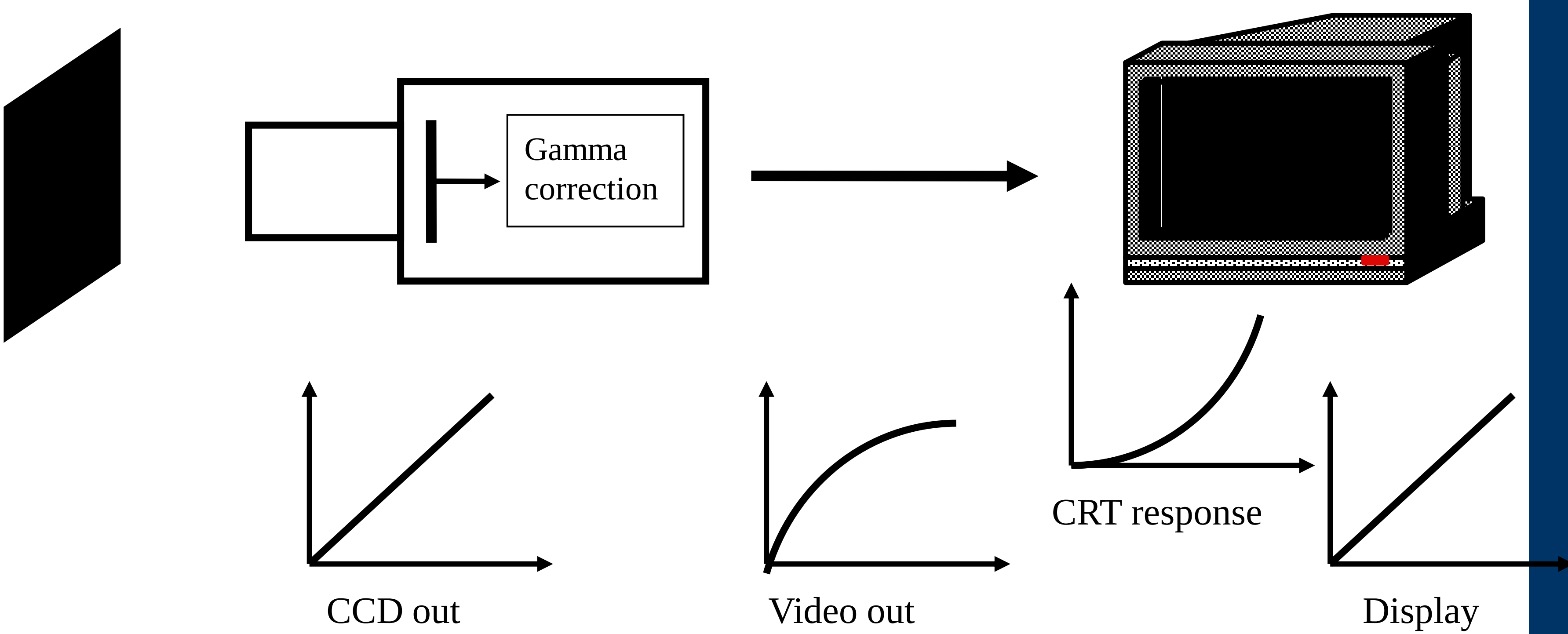
$\gamma = 0.45$



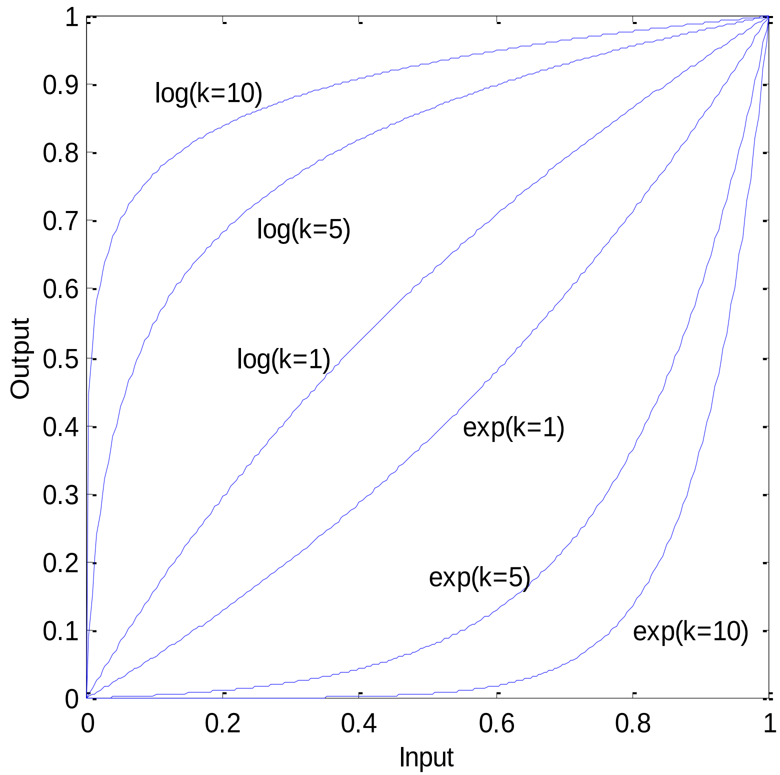
$\gamma = 2.22$

General Video Processing

- Gamma
  - Introduced to compensate for monitor non linearity
  - Has to be switched ON or OFF depending on application



Logarithmic/exponential mappings



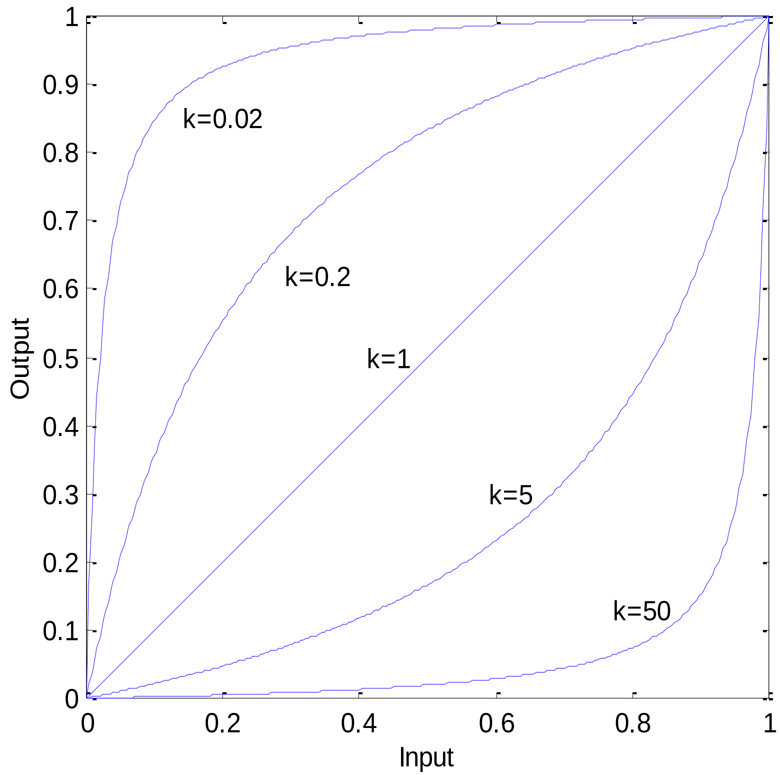
Logarithmic mapping

$$v_{out} = \frac{1}{k}\log(1+(e^{k}-1)v_{in})$$

Exponential mapping

$$v_{out} = \frac{e^{kv_{in}}-1}{e^{k}-1}$$

Hyperbolic mapping



Hyperbolic mapping

$$v_{out} = \frac{v_{in}}{(1-k)v_{in} + k}$$

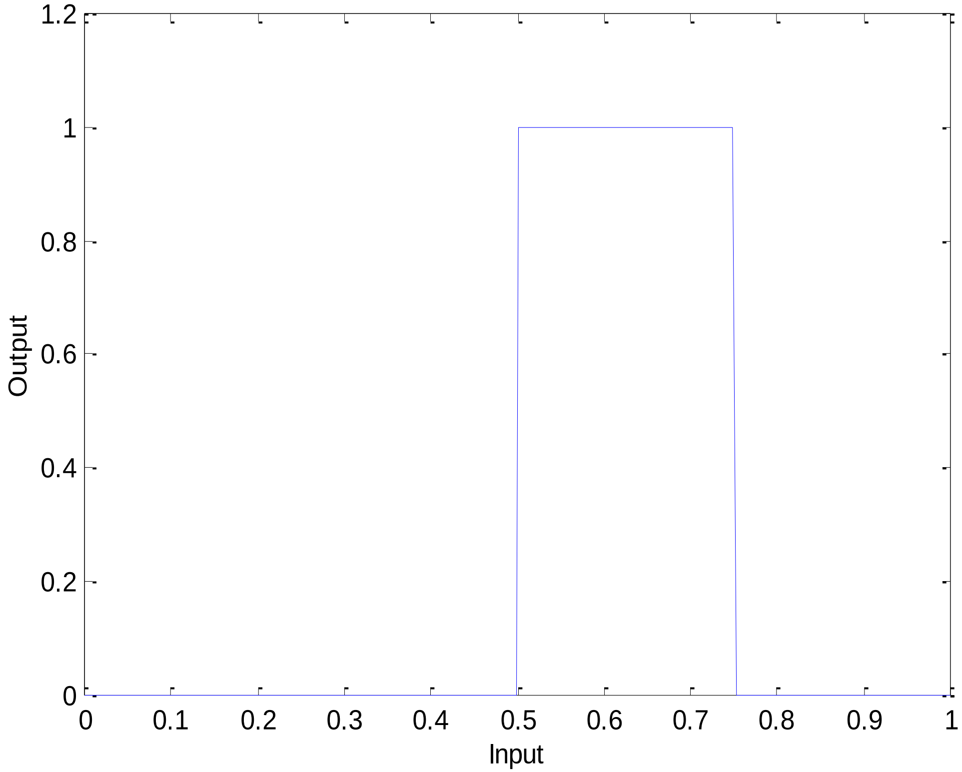
Exercise 99.10

Which of the following monochannel mappings will map 0.0 into 0.0,1.0 into 1.0, and 0.5 into 0.8?

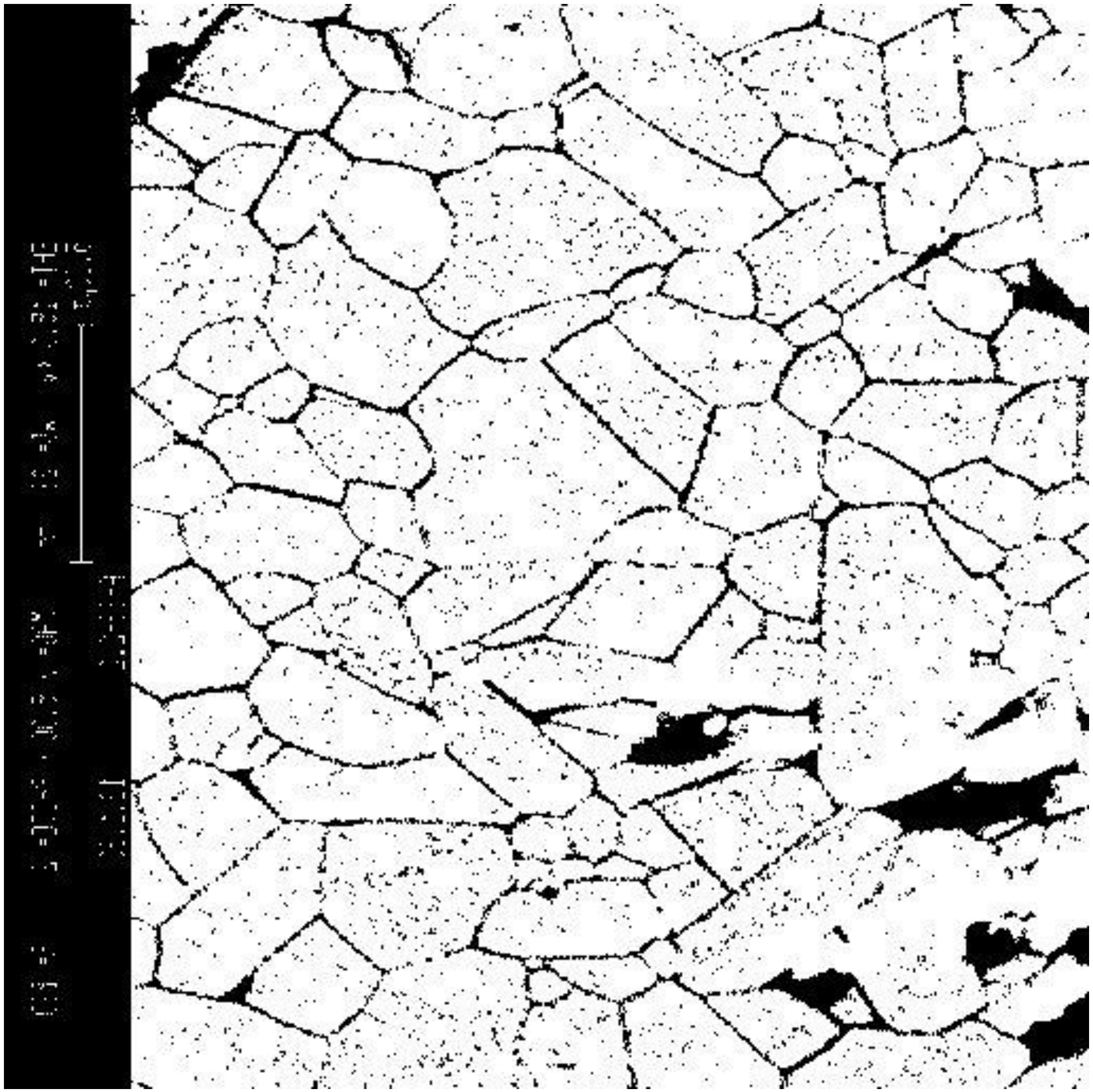
1. Hyperbolic mapping with parameter 0.25
2. Hyperbolic mapping with parameter 0.22
3. Gamma mapping with parameter 0.5
4. Gamma mapping with parameter 1.2
5. Logarithmic mapping with parameter 0.4
6. Don’t know

DTU

Thresholding/slicing

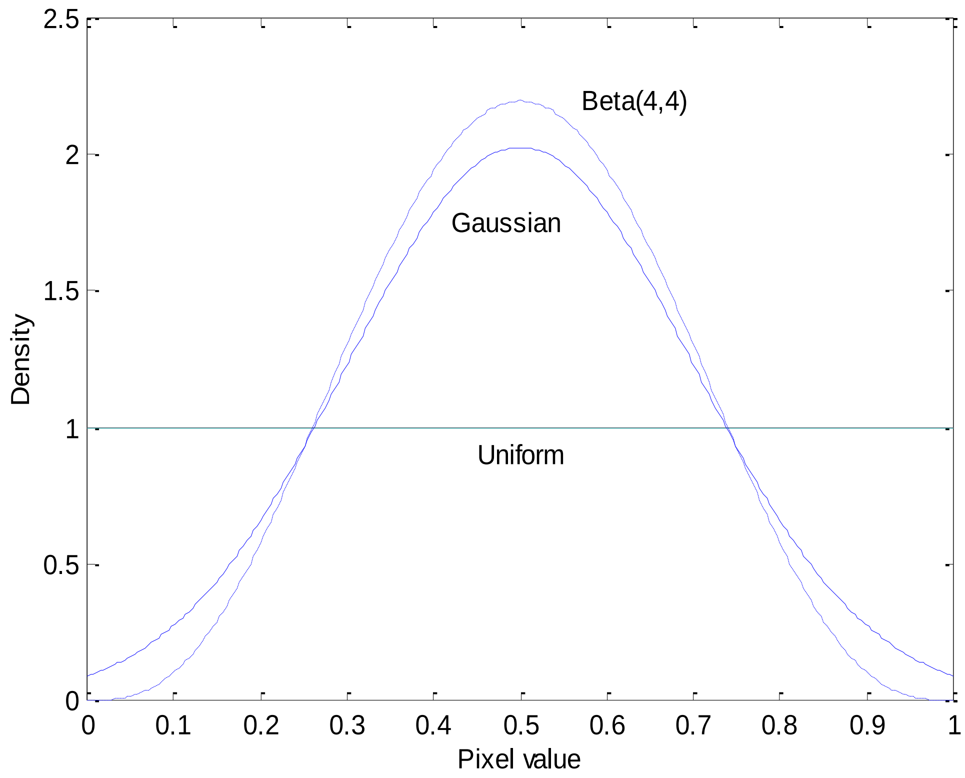


Threshold

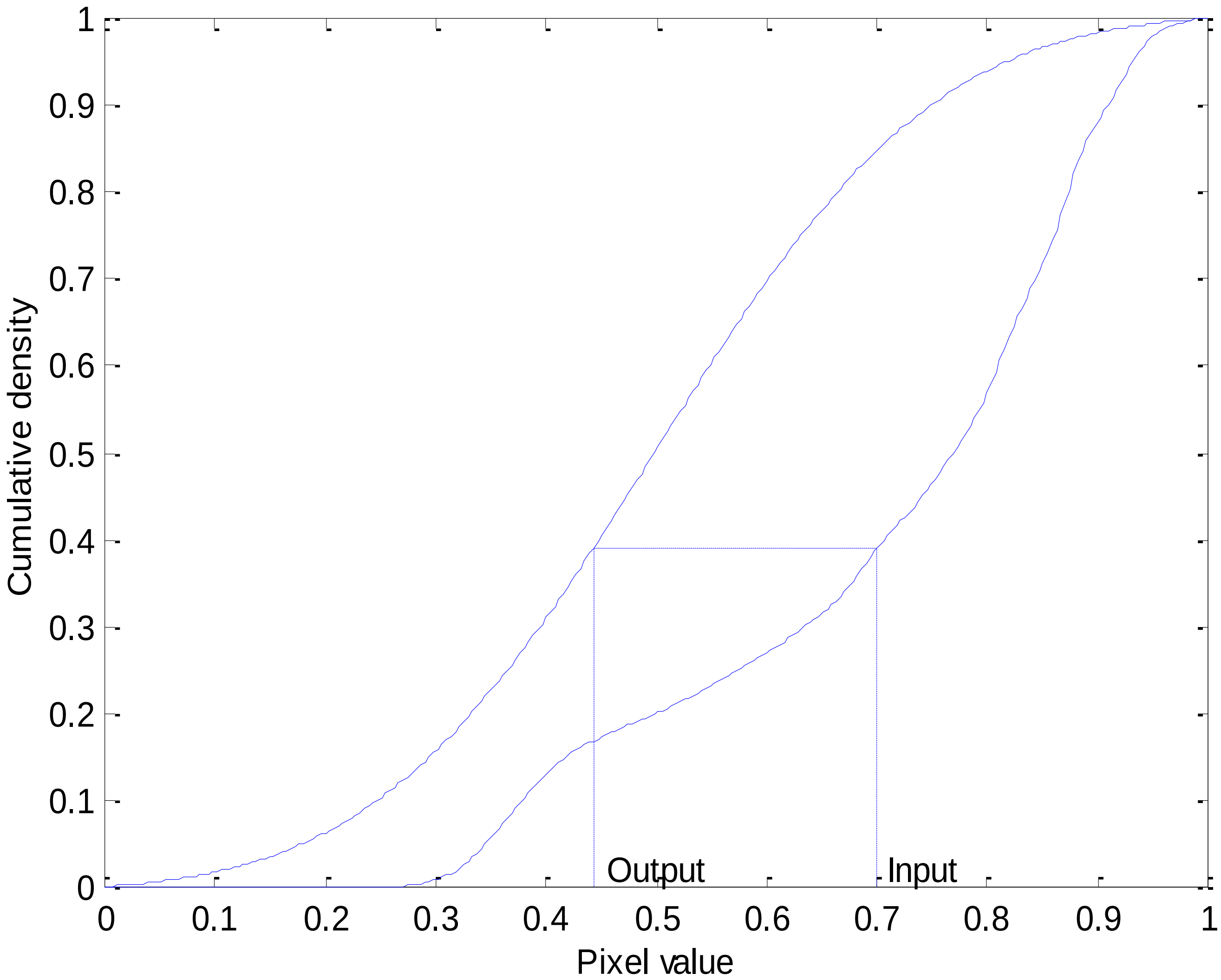


Linear stretch
and threshold
at 165

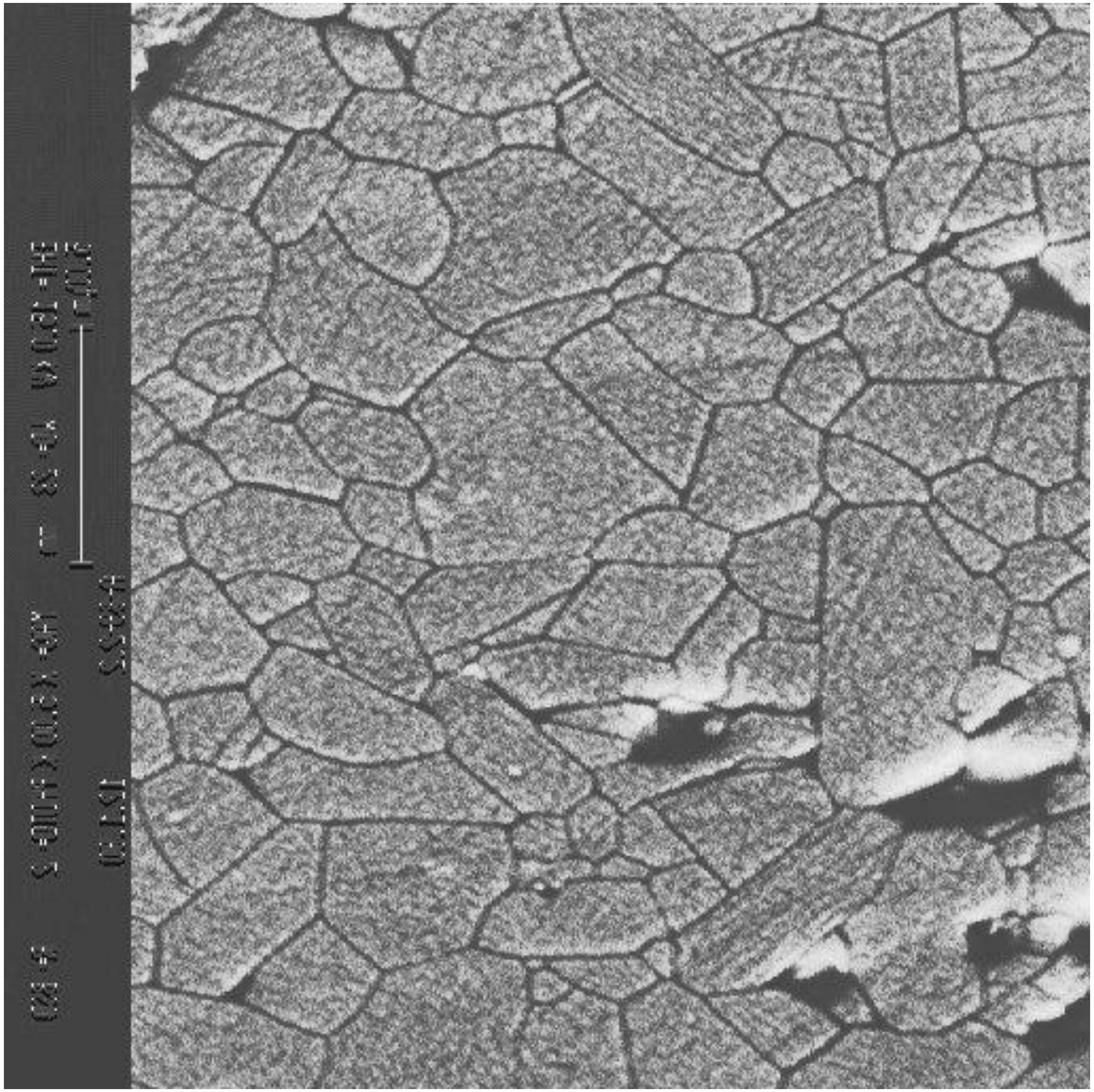
Model histograms



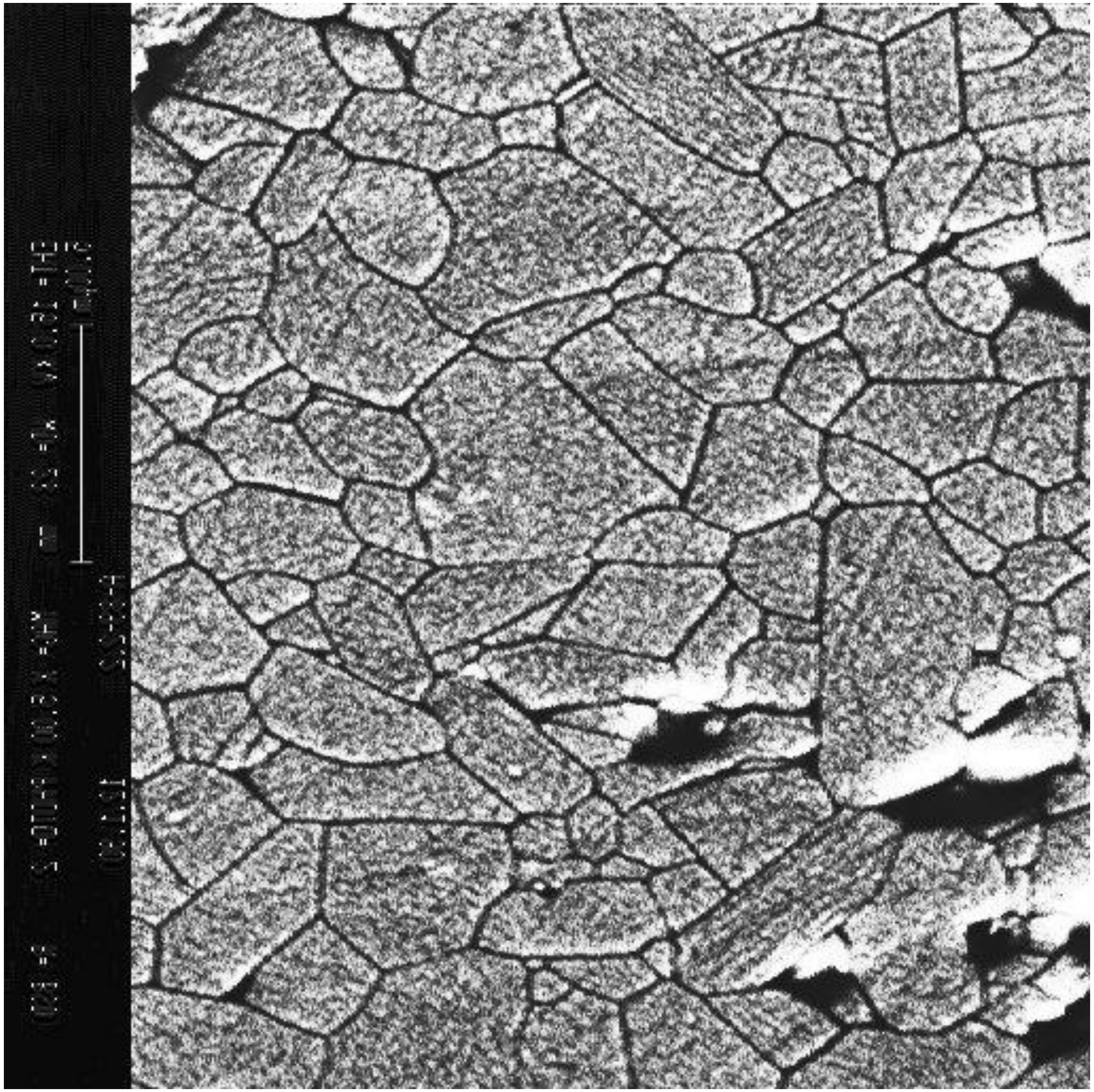
Gaussian histogram matching



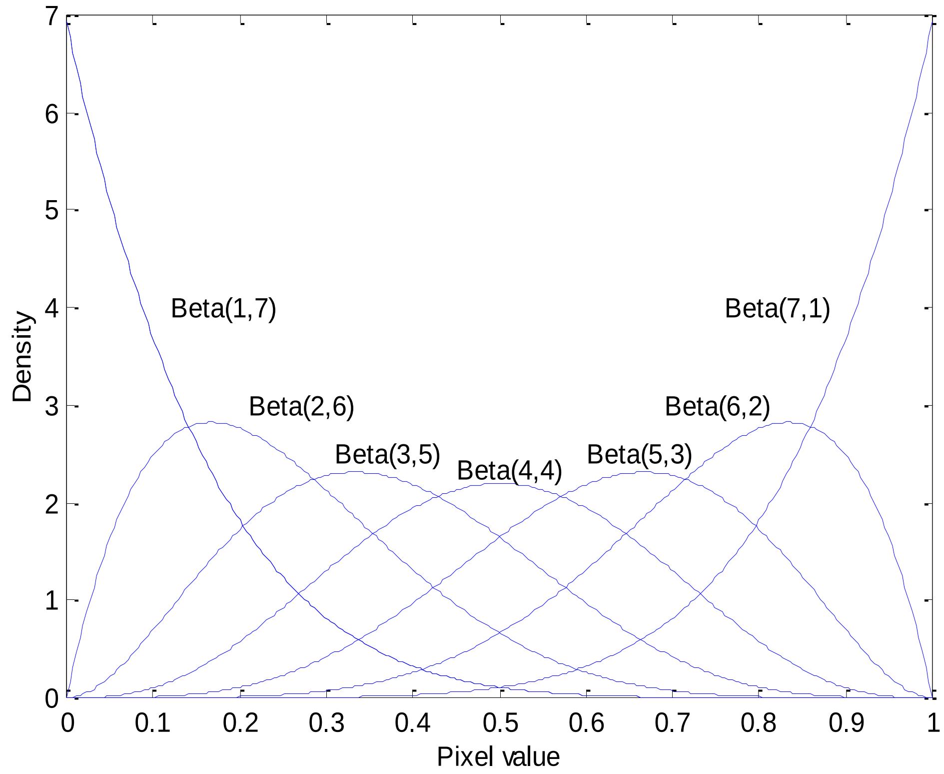
Gaussian histogram match



Histogram equalization

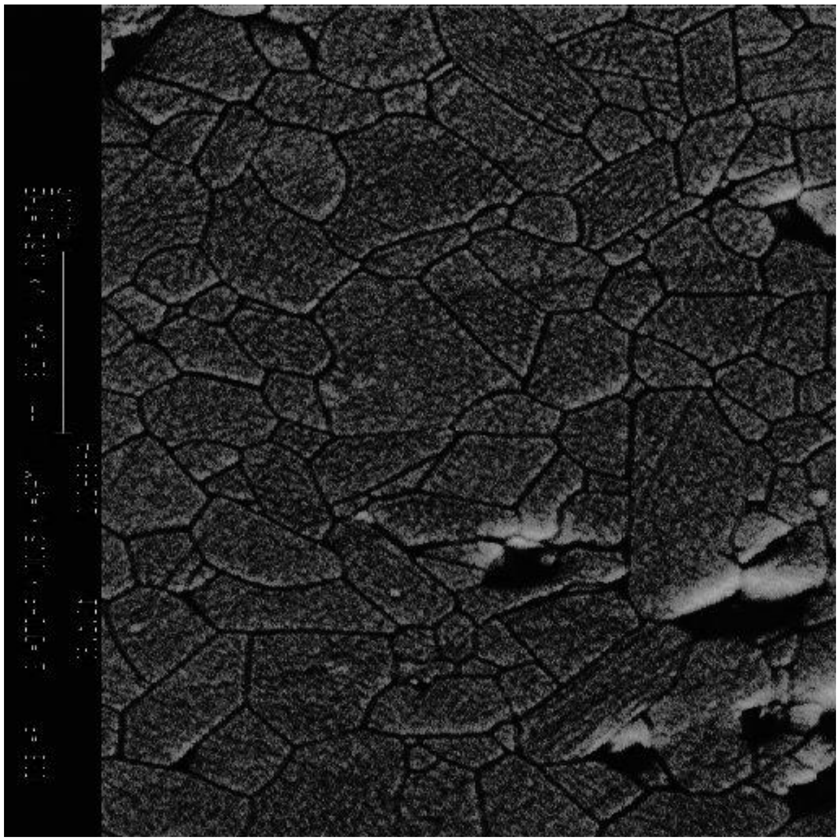


The beta distribution

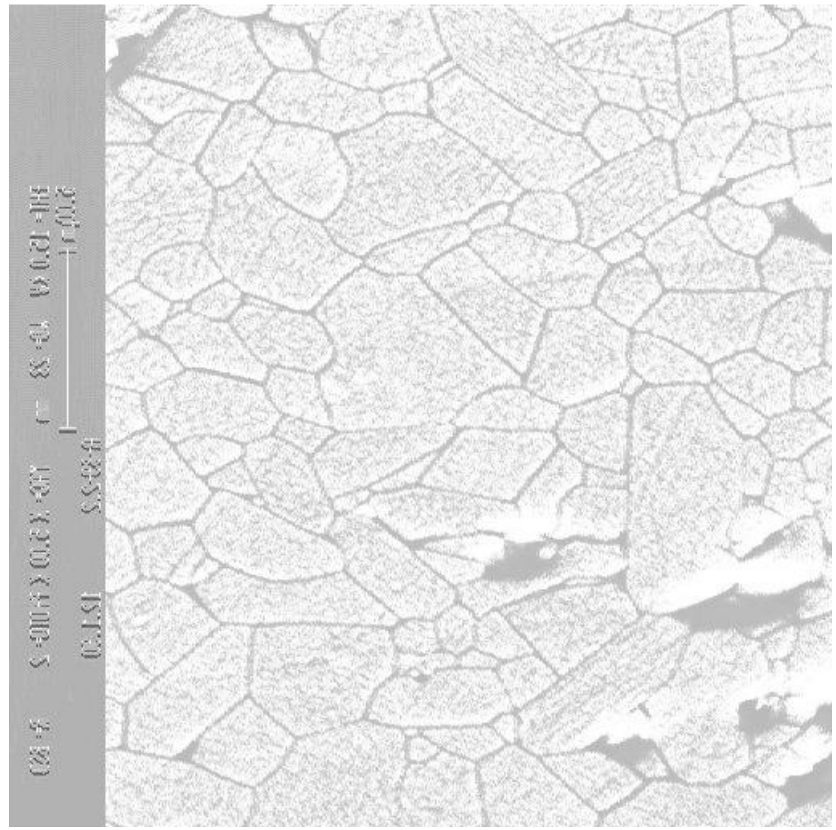


$$f(x) \propto x^{\alpha-1}(1-x)^{\beta-1} \qquad 0 \le x \le 1$$

Beta histogram match



Be(1,7)



Be(7,1)

Exam question 97.9

What parameters for the beta distribution results in a density function proportional to

$$x - x^2$$

where $0<x<1$?

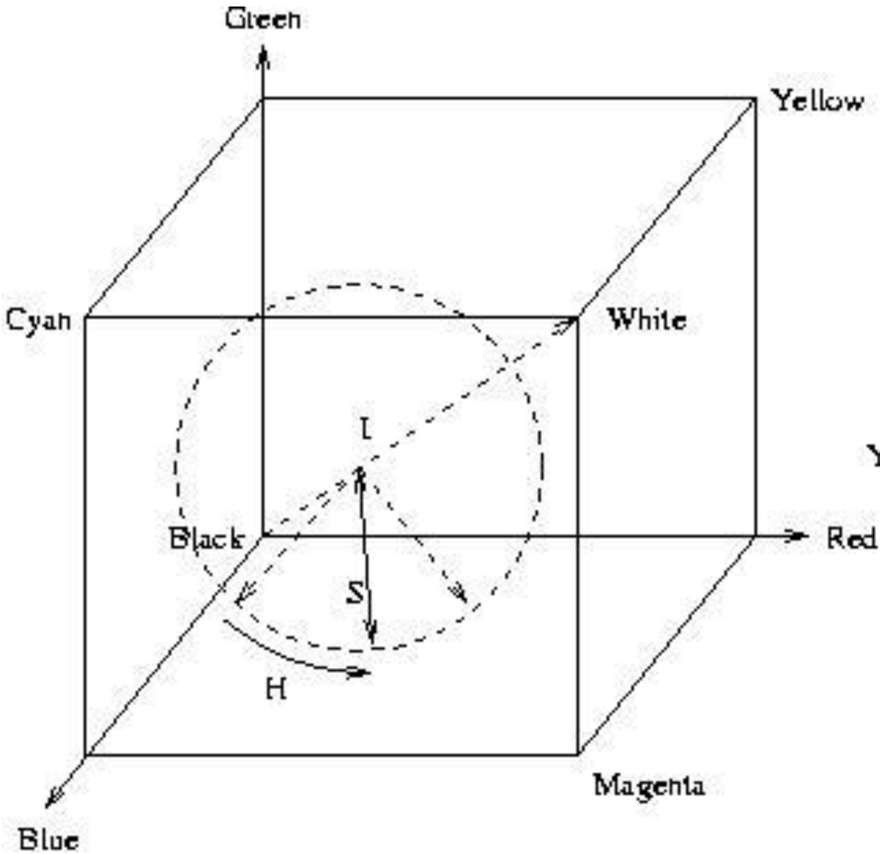
1. $(\alpha, \beta) = (2,2)$
2. $(\alpha, \beta) = (1,3)$
3. $(\alpha, \beta) = (3,2)$
4. $(\alpha, \beta) = (3,3)$
5. None
6. Don’t know

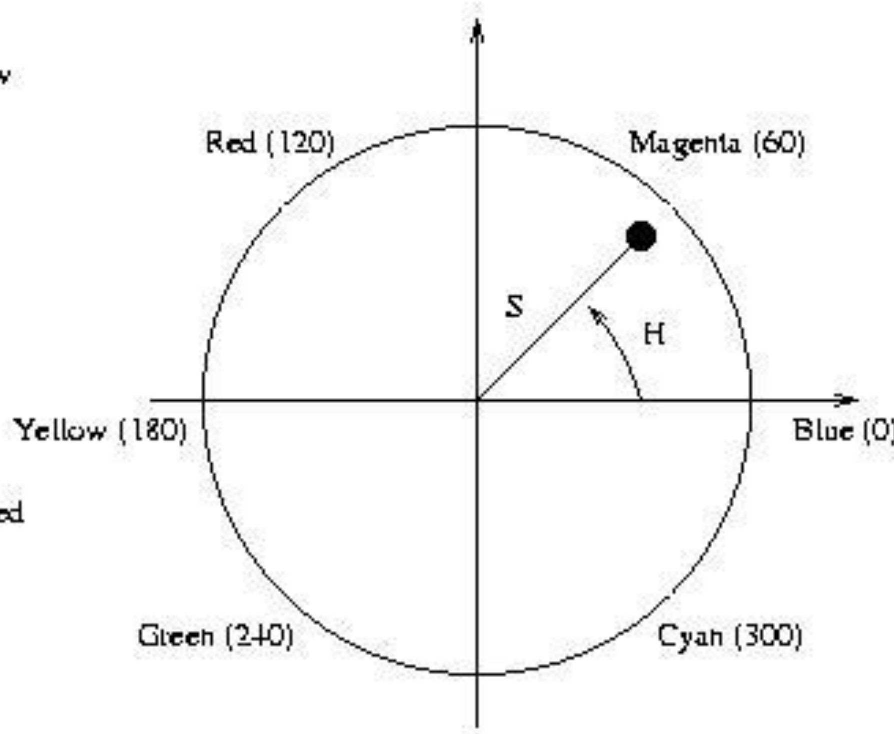
DTU

Color

- Spectrum
- Three types of cones
- RGB primaries
  - Red 645 nm
  - Green 526 nm
  - Blue 444 nm

RGB and IHS color spaces





RGB2IHS

$$\begin{pmatrix} I \\ v_1 \\ v_2 \end{pmatrix} = \begin{pmatrix} \frac{1}{3} & \frac{1}{3} & \frac{1}{3} \\ -\frac{1}{2} & -\frac{1}{2} & 1 \\ \frac{\sqrt{3}}{2} & -\frac{\sqrt{3}}{2} & 0 \end{pmatrix} \cdot \begin{pmatrix} R \\ G \\ B \end{pmatrix}$$

$$S = \sqrt{v_1^2 + v_2^2}$$

$$H = \arctan\left(\frac{v_2}{v_1}\right)$$

IHS2RGB

$$\begin{pmatrix} R \\ G \\ B \end{pmatrix} = \begin{pmatrix} 1 & -\frac{1}{3} & \frac{1}{\sqrt{3}} \\ 1 & -\frac{1}{3} & -\frac{1}{\sqrt{3}} \\ 1 & -\frac{2}{3} & 0 \end{pmatrix} \cdot \begin{pmatrix} I \\ v_1 \\ v_2 \end{pmatrix}$$

$$v_1 = S \cos H$$

$$v_2 = S \sin H$$

DTU

Exercise 96.14

In an IHS color space a rainbow color scale is constructed by changing the hue-angle and by keeping the intensity (I) and the saturation (S) constant.

We introduce a shift in the hue-angle so that the blue color (R,G,B)=(0,0,1) corresponds to an angle of 25 degrees. What is the hue-angle then for the yellow color (R,G,B)=(1,1,0)?

1. 90 degrees
2. 205 degrees
3. 185 degrees
4. 305 degrees
5. 120 degrees
6. Don’t know

Exercise 98.10

We wish to represent the red color (1,0,0) in the RGB color space with half saturation and unchanged intensity and hue. Which RGB value must be used?

1. (2/3,1/6,1/6)
2. (1/2,0,0)
3. (1/3,1/3,1/3)
4. (3/4,1/4,1/4)
5. (1/3,1/3,2/3)

DTU

Solution 98.10

Transform from RGB space to

$$\begin{pmatrix} I \\ v_1 \\ v_2 \end{pmatrix} = \begin{pmatrix} \frac{1}{3} & \frac{1}{3} & \frac{1}{3} \\ -\frac{1}{2} & -\frac{1}{2} & 1 \\ \frac{\sqrt{3}}{2} & -\frac{\sqrt{3}}{2} & 0 \end{pmatrix} \cdot \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix} = \begin{pmatrix} \frac{1}{3} \\ -\frac{1}{2} \\ \frac{\sqrt{3}}{2} \end{pmatrix}$$

Multiply the two last coordinates with 0.5 and transform back

$$\begin{pmatrix} R \\ G \\ B \end{pmatrix} = \begin{pmatrix} 1 & -\frac{1}{3} & \frac{1}{\sqrt{3}} \\ 1 & -\frac{1}{3} & -\frac{1}{\sqrt{3}} \\ 1 & -\frac{2}{3} & 0 \end{pmatrix} \cdot \begin{pmatrix} \frac{1}{3} \\ -\frac{1}{4} \\ \frac{\sqrt{3}}{4} \end{pmatrix} = \begin{pmatrix} \frac{2}{3} \\ \frac{1}{6} \\ \frac{1}{6} \end{pmatrix}$$

DTU

Pixelwise subtraction