

Image processing from Histograms

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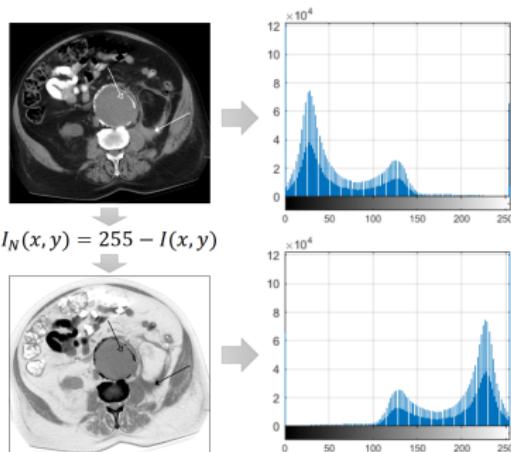


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Intensity Histograms

- ▶ Plot how many times (frequency) each intensity value in an image occurs.
- ▶ It is a measure of the statistical distribution of the image pixels.
- ▶ Can be shaped through intensity transformations.

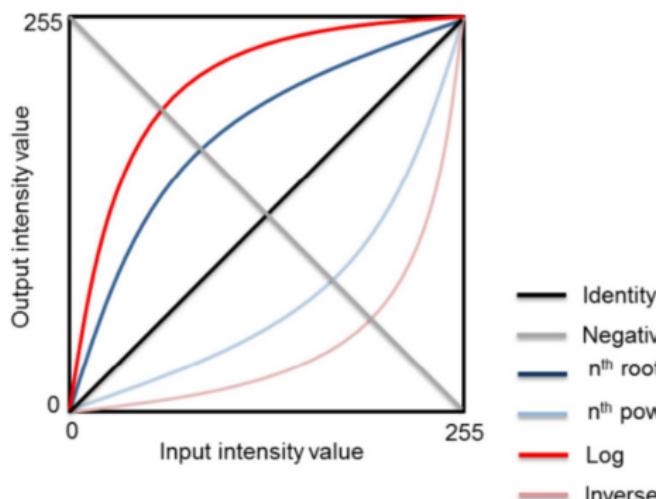


Intensity Transformations

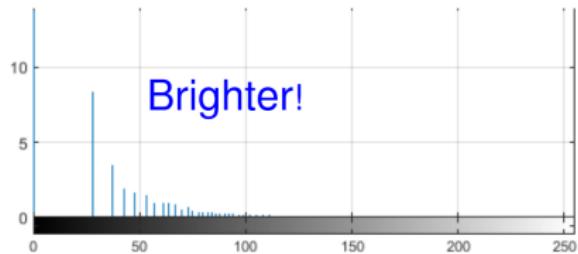
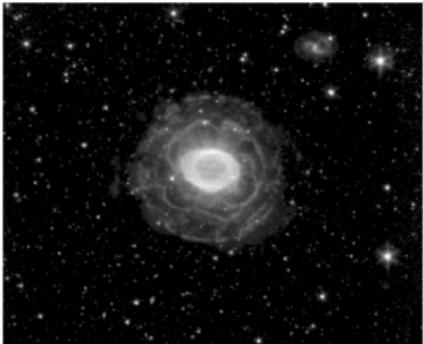
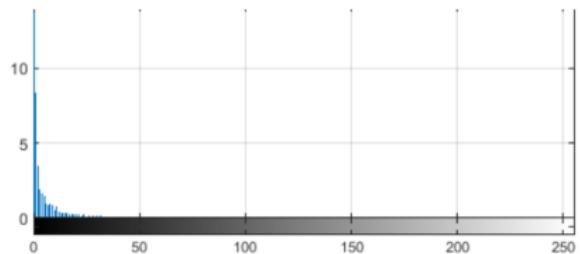
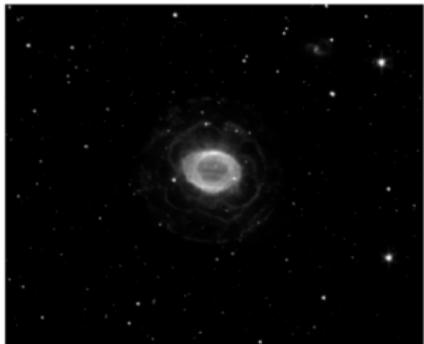
We can apply different transformations over the pixel intensities in an image:

$$I(x, y) = T[I(x, y)]$$

- ▶ Image negative:
 $I_N = 255 - I$
- ▶ Gamma correction:
 $I_\gamma = 255^{1-\gamma} I^\gamma$



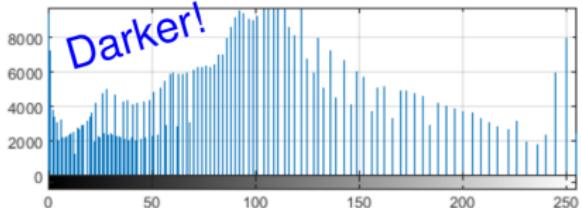
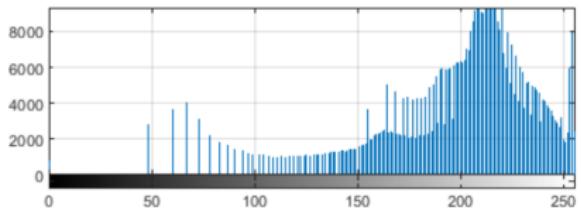
Gamma correction γ



Brighter!

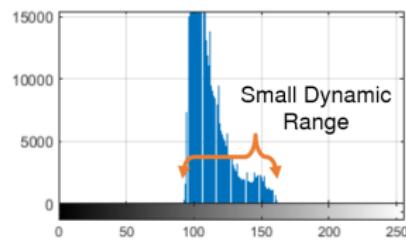
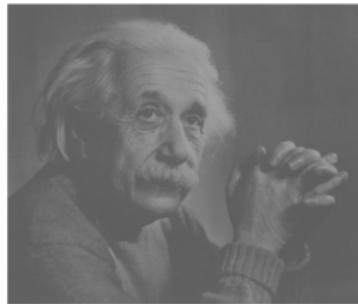
$$I_\gamma = 255^{1-\gamma} I^\gamma, \quad \gamma = 0.4$$

Gamma correction γ



$$I_\gamma = 255^{1-\gamma} I^\gamma, \gamma = 5$$

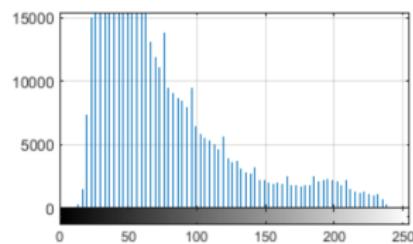
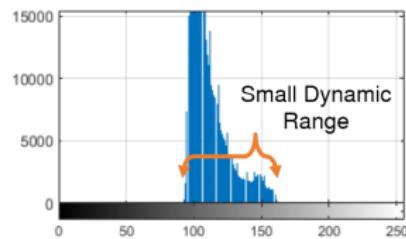
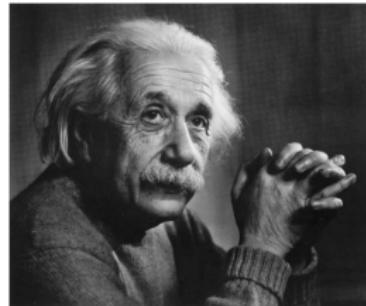
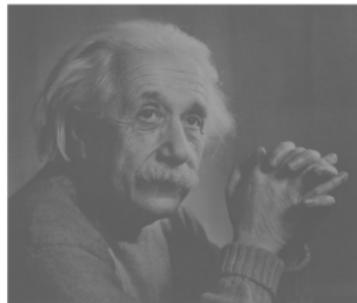
Contrast Stretching



$$I_s = \frac{255[I - \min(I)]}{\max(I) - \min(I)}$$

Low Contrast → High Contrast

Contrast Stretching

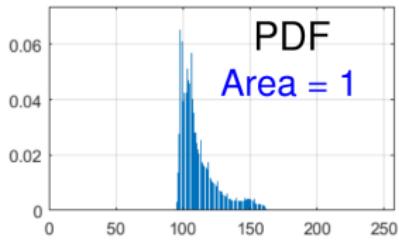
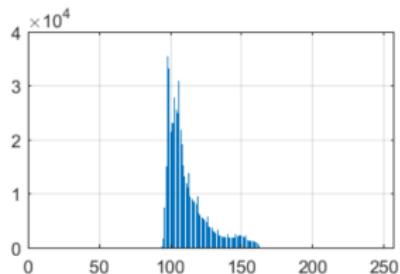


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Low Contrast → High Contrast

Histogram Analysis

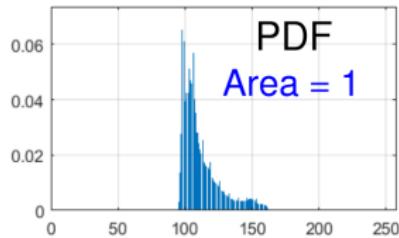
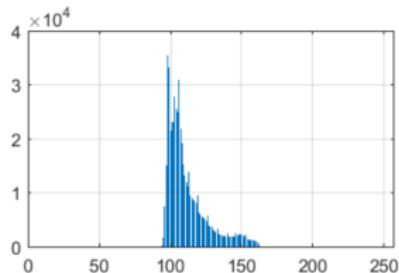
- Histograms can help with brightness, contrast, exposure



$$\frac{h(i)}{\text{\#of pixels}}$$

Histogram Analysis

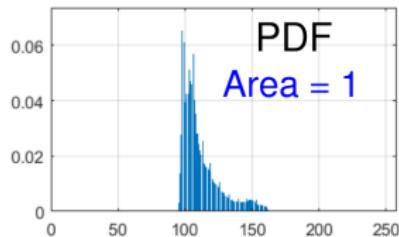
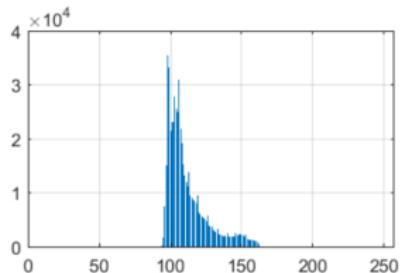
- ▶ Histograms can help with brightness, contrast, exposure
- ▶ Normalizing, it can express a PDF



$$\frac{h(i)}{\text{\#of pixels}}$$

Histogram Analysis

- ▶ Histograms can help with brightness, contrast, exposure
- ▶ Normalizing, it can express a PDF
- ▶ Can represent "shape" to compare among images

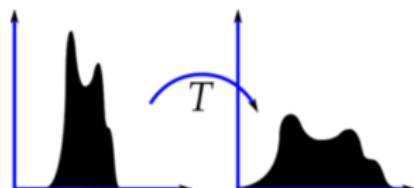


$$\frac{h(i)}{\text{\#of pixels}}$$

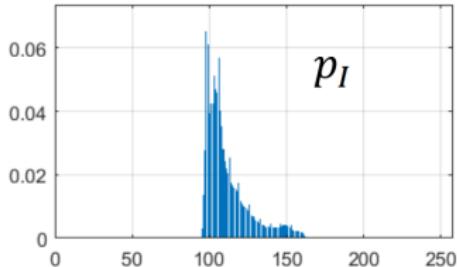
Histogram Equalization

The most frequently shape is a uniform or equalized histogram:

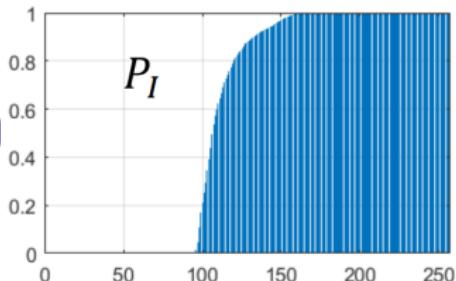
$$p_I(i) = \frac{n_i}{MN}, 0 \leq i \leq 255; \sum_{i=0}^{255} p_I(i) = 1$$



We can define the CDF as:

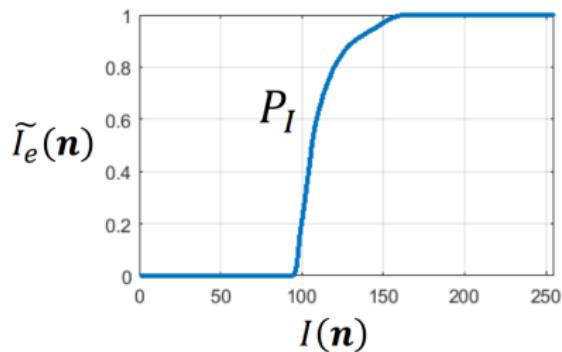


$$P_I(i) = \sum_{j=0}^i p_I(j)$$



Histogram Equalization

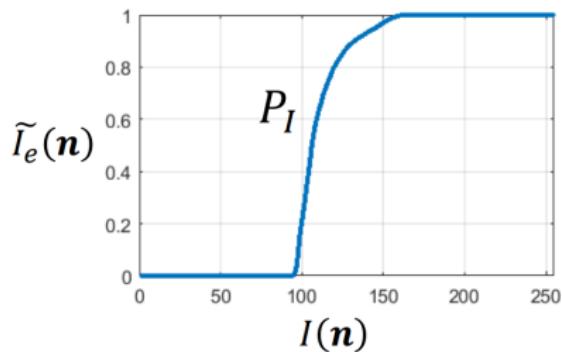
1. Considerations: $p_I(i) = \frac{n_i}{MN}$, $\sum_{i=0}^{255} p_I(i) = 1$
2. The CDF is used to transform: $I_e(\hat{n}) = P_I[I(n)]$
3. The range [0-1] need to be adjusted: $I_e(n) = 255I_e(\hat{n})$



```
Ie = zeros(M,N)
for i = 1:M
    for j = 1:N
        Ie(i,j) = cdf(I(i,j))
    end
end
Ie = 255*Ie
```

Histogram Equalization

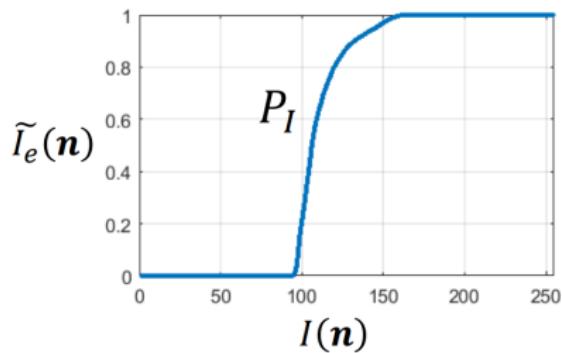
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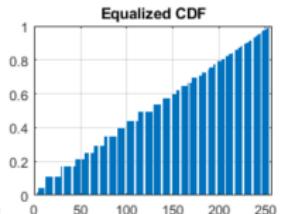
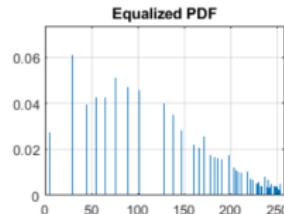
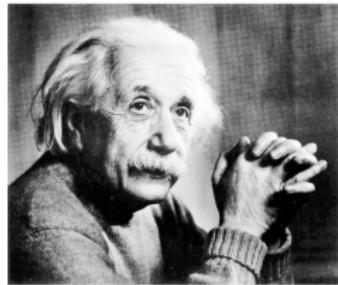
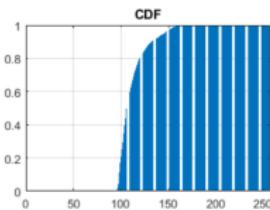
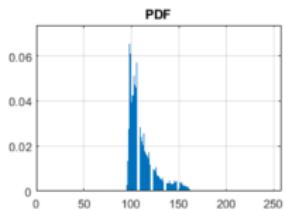
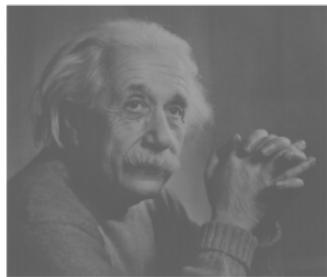
Histogram Equalization

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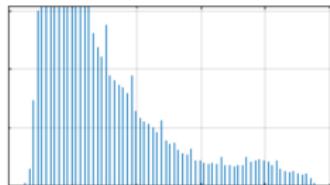
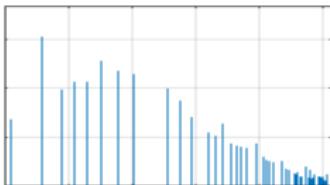
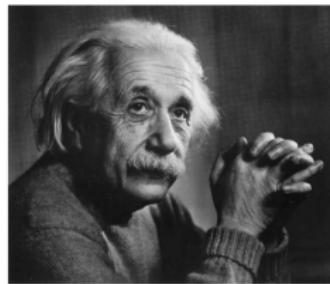
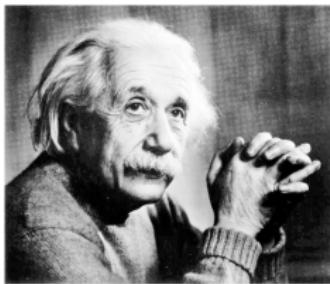
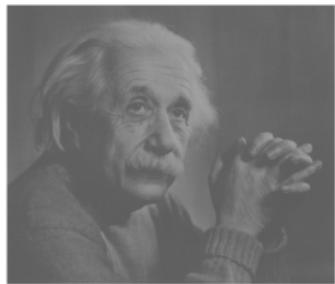


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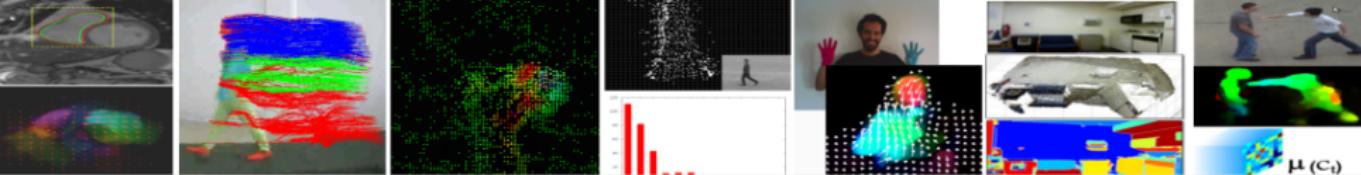
Histogram Equalization



Equalization VS Stretching



Which is the difference?



Thank you for your attention ...



... It's time to wake up ... famarcar@uis.edu.co



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