Image statistics

Channel I (R, G, B, L ...)

I_i = intensity at pixel i

$$I_{max} = \underset{i}{\text{maximum}}\; I_i$$

$$I_{min} = \underset{i}{\text{minimum}}\; I_i$$

mean (average) $= \left(\sum_i I_i \right) / N_x N_y$

standard deviation

$$\sigma_I = \sqrt{\left(\sum_i \left(I_i - \bar{I} \right)^2 \right) / N_x N_y}$$

$$= \sqrt{\left(\sum_i I_i^2\right) / N_x N_y - \bar{I}^2}$$

min max ave stddev

histogram

intensity bins

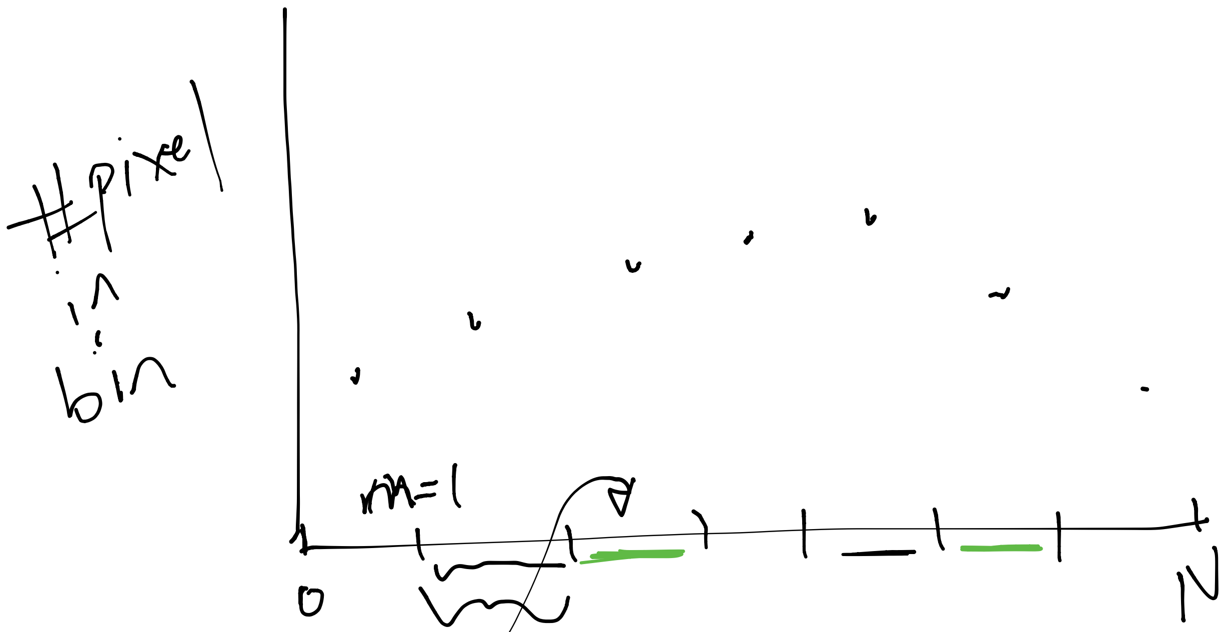
$N = \#$ bins

$$\Delta I = \frac{I_{max} - I_{min}}{N}$$

$$I_{bin}^{m} = I_{min} + m \Delta I$$

$$0 \le m \le N-1$$

$$I^{m}_{bin} \le I < I^{m+1}_{bin}$$



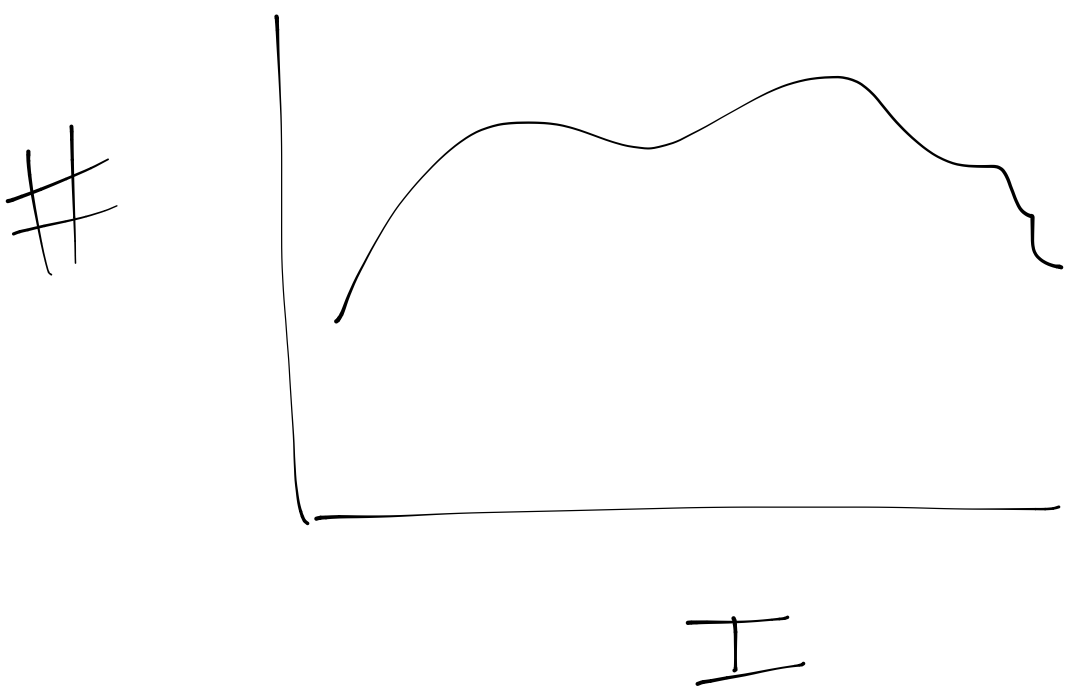
$$I = I_{min} + m \Delta I$$

$$I_{min} + (m+1)\Delta I$$

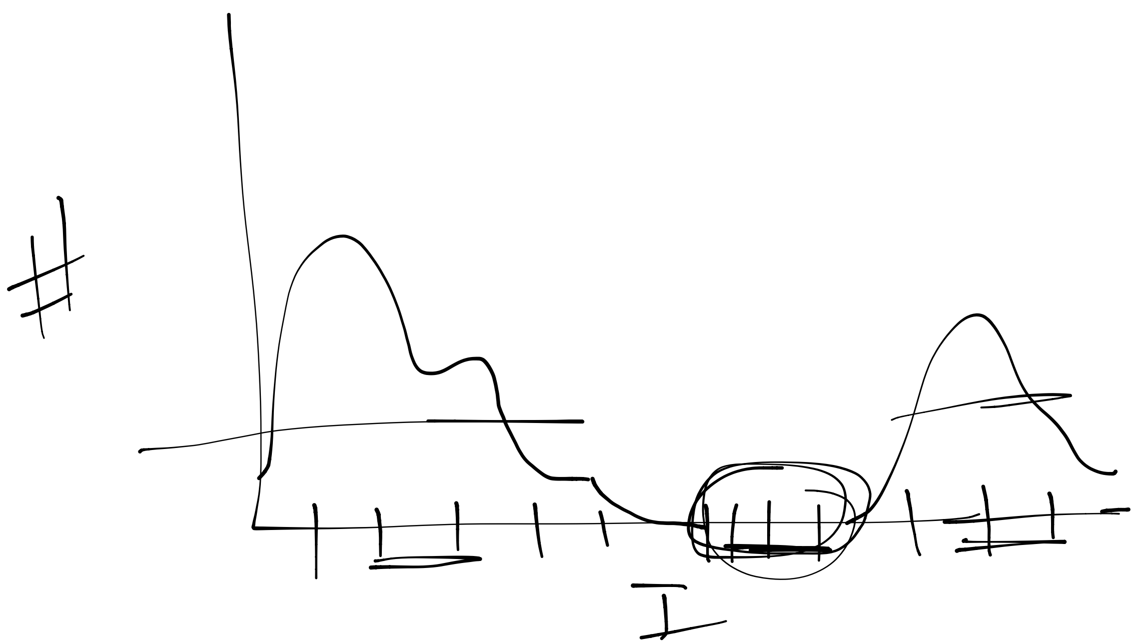
$$m = \left[\frac{(I_i - I_{min})}{\Delta I} \right]$$

$[\ \ ] =$ integer floor

```
std::vector<int> histogram(N, 0);
Loop over i
    calculate m
    histogram[m]++
```



Gaussian



Probability Density Function (PDF)

PDF = histogram / $N_x N_y$

```
std::vector<float>
        PDF(N, 0.0)
```

$$PDF[b] = \frac{histogram[b]}{N_x N_y}$$

$$\sum_{b=0}^{N-1} PDF[b] = 1$$

Cumulative Density

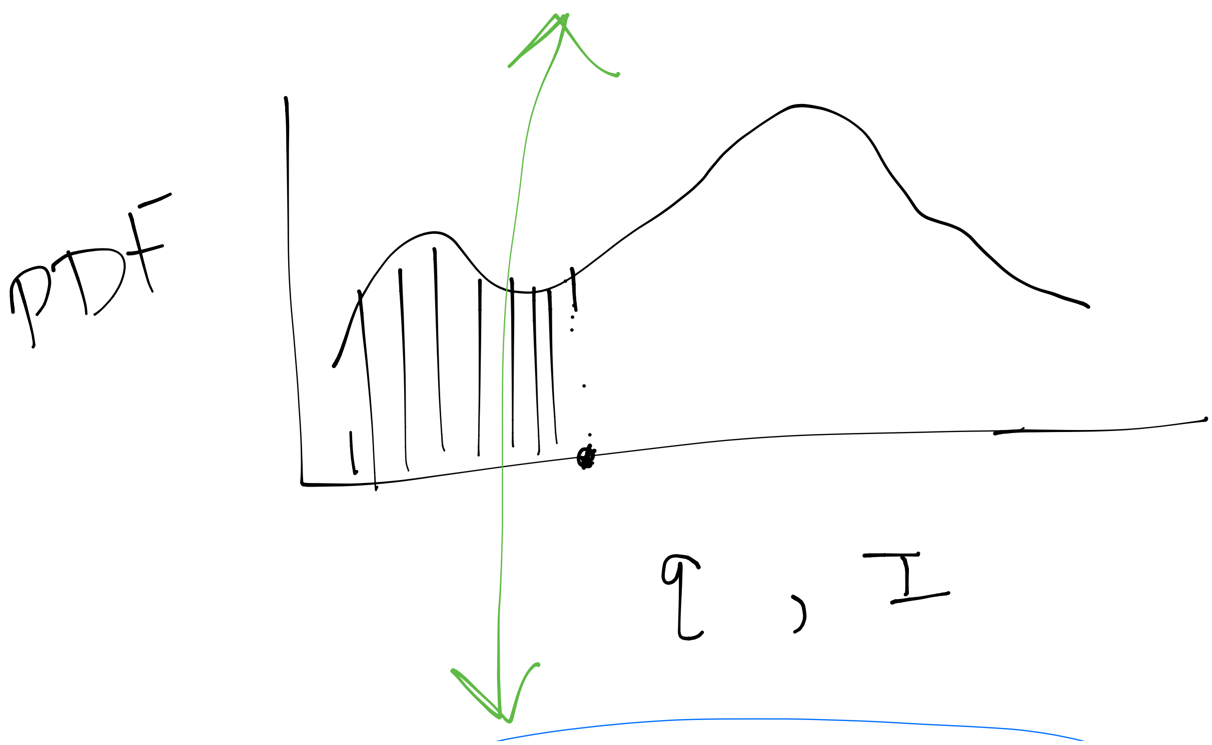
Function (CDF)

```
std::vector<float>
    CDF(N, 0.0)
```

$$CDF[0] = PDF[0]$$

$$CDF[q] = CDF[q-1] + PDF[q]$$

$q > 0$

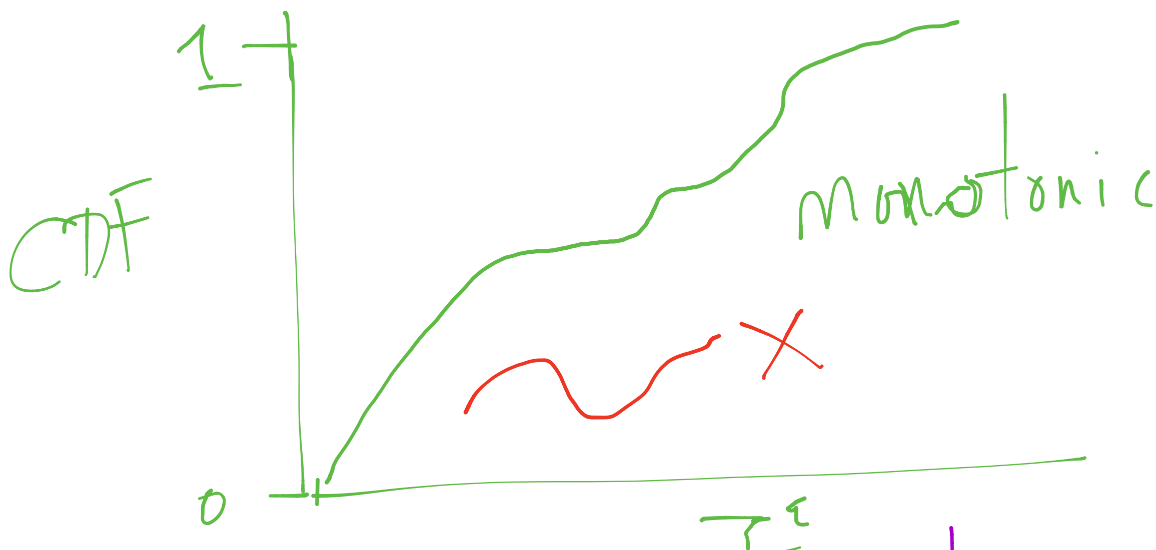


$$\mathrm{CDF}[q] = \sum_{r=0}^{q} \mathrm{PDF}[r]$$

$$\mathrm{CDF}[N-1] = 1$$

$$I^q = I_{min} + q\,\Delta I$$

$$q : I^q \longrightarrow I^q + \Delta I$$



Histogram equalization

1. Given I_i at pixel i

2. Create

$$Q = (I_i - I_{min}) / \Delta I$$

(floating point)

$$\text{int } q = [Q] \quad \text{int } \cancel{f}\text{loor}$$

$$\text{float } w = Q - q$$

weight

$q < N-1$ linear interpolation

$$\boxed{I_i^{eq} = CDF[q](1-w) + CDF(q+1)\, w}$$

$q = N-1$

$$I_i^{eq} = CDF[q]$$

replace I_i by I_i^{eq}