# CGDI (computer graphics and digital images)

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## Images

↳ Translate what you see.

## Color Perceived

↳ Cone cells → color vision
↳ Rod cells → low light

Three types of cone cells
↳ S, M, L
↗ ↑ ↖
small medium large (wavelength)

## Devices

↳ Screens → leds → additive synthesis
↳ Paper → inks → substractive synthesis.

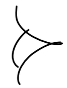
## Additive

↳ Emit Red, Green, Blue light
↙ ↓ ↓
L cones M cones S cones

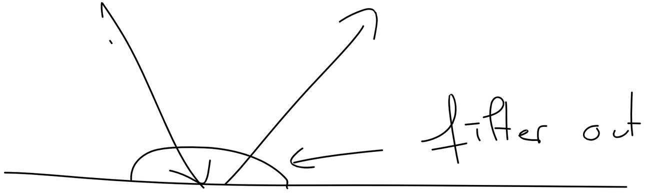
↳ Store the intensity of each light.

## Substractive

white



→ S,M,L



← filter out undesired light.
↑
transparent inks.

- Cyan → absorbs red
- Magenta → absorbs green
- Yellow → absorbs blue

} CMY(K)

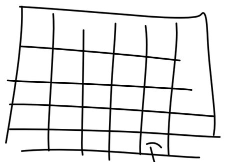
(- Black → absorbs everything)

## Not only Models!

↳ cannot synthesize everything.

↳ CIE
  ↳ XYZ
  ↳ LAB → distance in 3D ~ Perceptive distance.

## Image processing



↳ Raster images. → Pixels
  ↳ brute force
↳ Vector Images.

↳ equations, objects, structure.

↳ requires rendering.

## Processing raster images

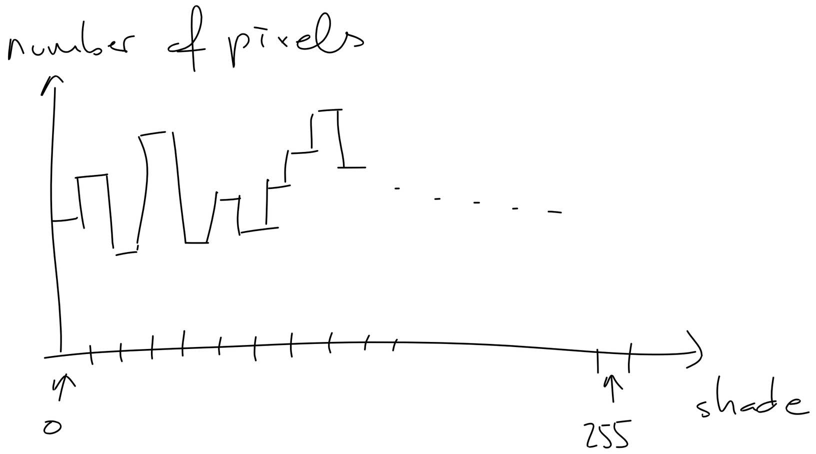
## Global transforms

↳ Grayscale

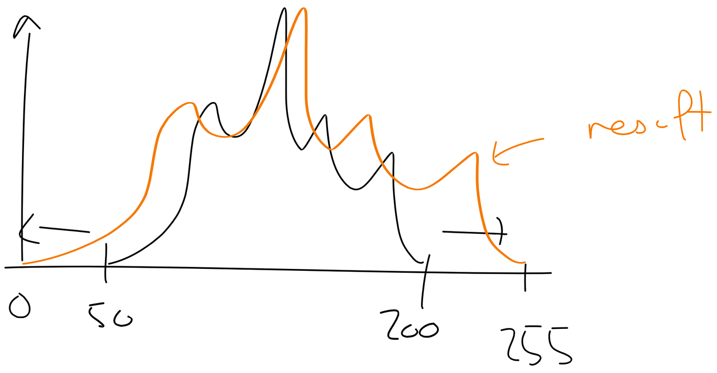
↳ $0{,}21 \times R + 0{,}71 \times G + 0{,}07 \times B$

↳ Thresholding
  ↳ automatic verification.

## Histogram



## Histogram normalization

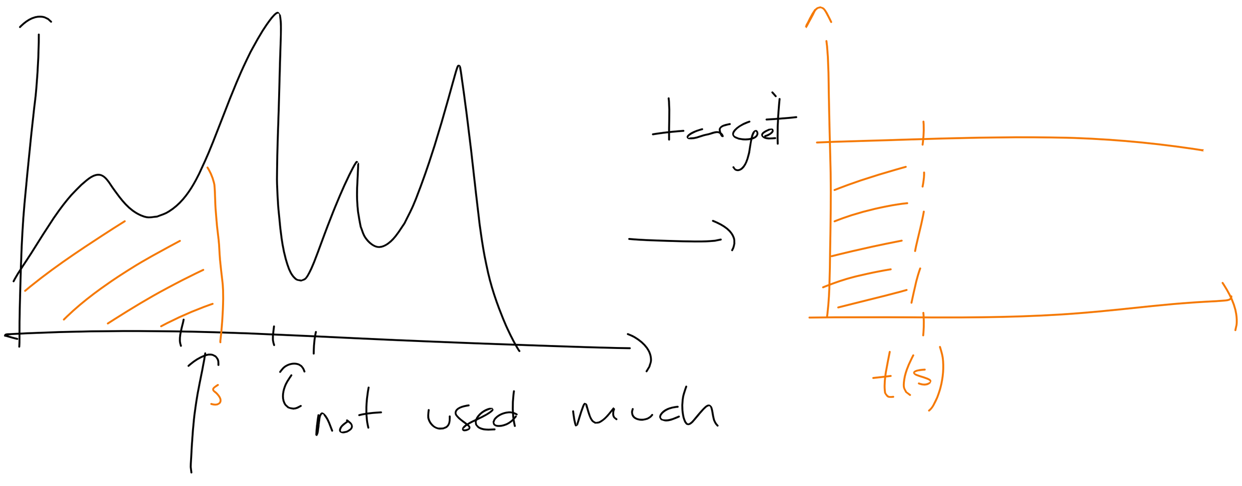


$[50, 200] \rightarrow [0, 255]$

$(-50) \rightarrow [0, 150]$

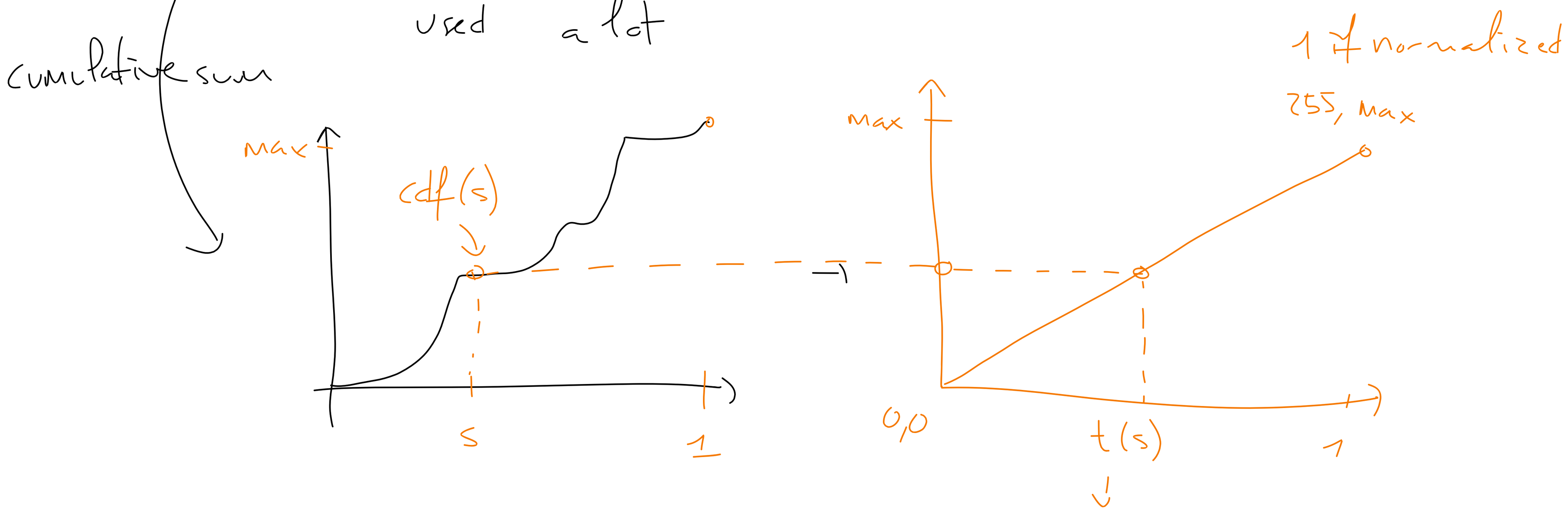
$\times \frac{255}{150} \rightarrow [0, 255]$

## Histogram equalization



cumulative sum

used a lot



shades in [0,255] cdf(s) × 255 / max

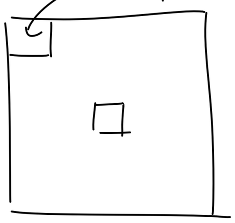
shades in [0,1] cdf(s) / max

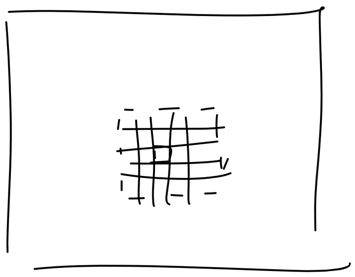
## Linear transformations

- ↳ neighborhood of pixels
- ↳ weighted average of neighboring pixels.

## Kernel

influence of the pixel on it's neighbors





## Convolution !

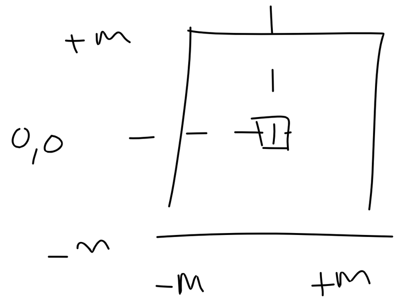
$f, g \quad \mathbb{R}^2 \to \mathbb{R}$

$$(f*g)(x,y) = \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} f(x-s,y-t)\,g(s,t)\,ds\,dt$$

$$= \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} f(x,y)\,g(x-s,y-t)\,ds\,dt$$

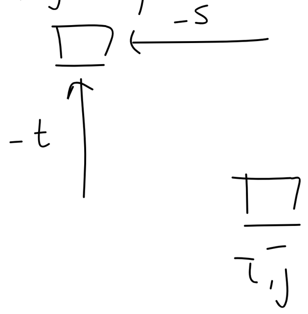
## Images

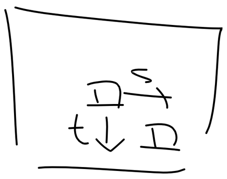
$I * K$



$$(I * K)(\bar{i},\bar{j}) = \sum_{s=-m}^{m}\sum_{t=-m}^{m} I(\bar{i}-s,\bar{j}-t)\,K(s,t)$$

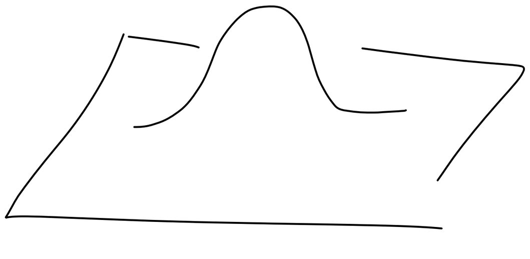
$I(\bar{i}-s,\bar{j}-t)$





## Gaussian blur

$$G(x,y) = e^{-\frac{(x^2+y^2)}{2\sigma^2}}$$



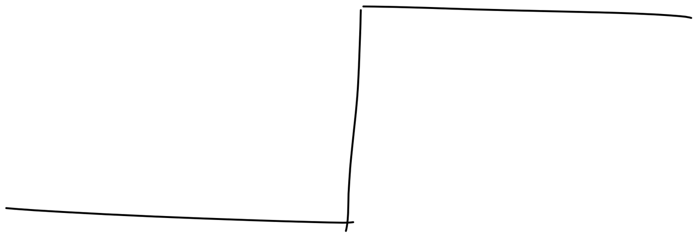
$G_1$ $\boxed{1}$

$G_3$ $\begin{vmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{vmatrix}$

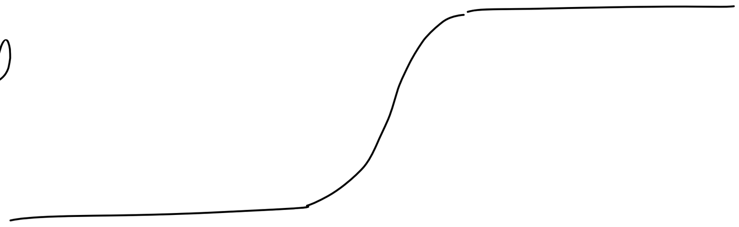
$$G_5 \quad \begin{bmatrix} 1 & 4 & 6 & 4 & 1 \\ 4 & 16 & 24 & 16 & 4 \\ 6 & 24 & 36 & 24 & 6 \\ 4 & 16 & 24 & 16 & 4 \\ 1 & 4 & 6 & 4 & 1 \end{bmatrix}$$

## Sharpen

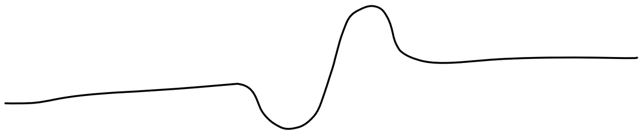
### Original



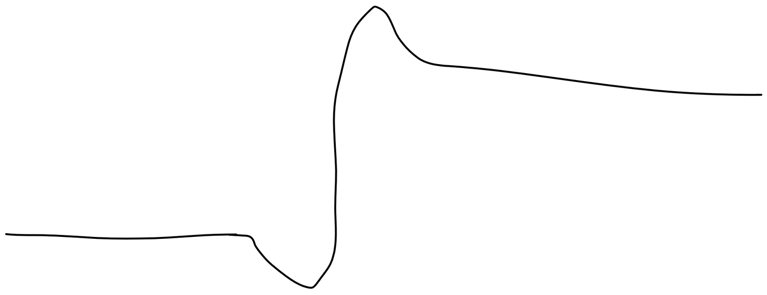
### Blurred



### Difference



### Sharpen



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