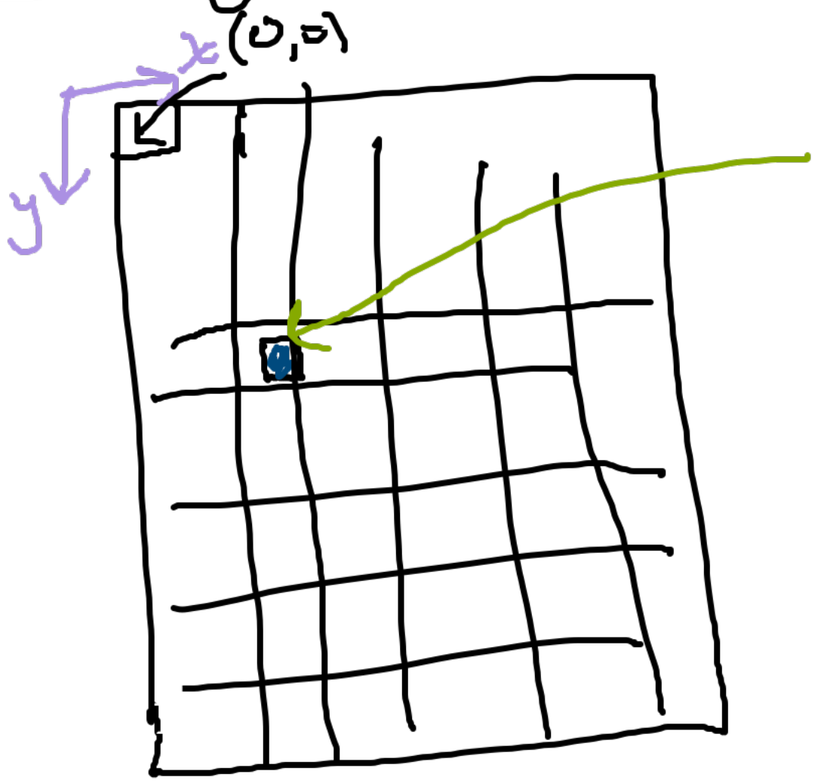
Image



1280 x 720

width height

Pixel: fundamental component of an image

- color / shade
- location

Image

- size / dimension
- type (PNG, JPEG)

Matrices : 2D grid of values arranged in rows and cols

entry

$$A_{3\times 3} = \begin{bmatrix} 17 & 8 & 3 \\ 0 & -3 & 10 \\ 7 & -100 & 8 \end{bmatrix}$$

start at 1

not 0

$A_{1,1} = 17$ ✓

↑↑ indices

row, col

$A_{2,1} = 0$ ✓

$A_{3,2} = -100$ ✓

$A_{i,j}$

i^{th} row

j^{th} col

Matrix Operations : Addition & Subtraction

$$\begin{bmatrix} 1 & 1 & 2 \\ 3 & 5 & 8 \end{bmatrix}_{2\times3} + \begin{bmatrix} 2 & 3 & 5 \\ 7 & 11 & 13 \end{bmatrix}_{2\times3} = \begin{bmatrix} 3 & 4 & 7 \\ 10 & 16 & 21 \end{bmatrix}_{2\times3}$$

$$\begin{bmatrix} 1 & 1 & 2 \\ 3 & 5 & 8 \end{bmatrix} - \begin{bmatrix} 2 & 3 & 5 \\ 7 & 11 & 13 \end{bmatrix} = \begin{bmatrix} -1 & -2 & -3 \\ -4 & -6 & -5 \end{bmatrix}_{2\times3}$$

Scalar Multiplication

$$A_{4\times 3} = \begin{bmatrix} 3 & 1 & 4 \\ 1 & 5 & 9 \\ 2 & 6 & 5 \\ 3 & 5 & 6 \end{bmatrix}$$

$A + A =$ double of A

$\underbrace{A + A + A + \cdots + A}_{\text{hundred times}} = 100A$

$$100A = \begin{bmatrix} 300 & 100 & 400 \\ 100 & 500 & 900 \\ 200 & 600 & 500 \\ 300 & 500 & 600 \end{bmatrix} = A \cdot 100$$

Color Models : mathematical system of describing color

R G B

color space : concrete

RGB ranges : [0, 255] : 0 black
: 255 white

no "absolute" color

RGB : (255, 255, 255) : white

HSV : (0, 0, 100) : white

Hue - saturation - value

Grayscale : range of shades of gray

1 value

[0, 255]

RGB → Gray : $\frac{R+G+B}{3}$

Gray ↛ RGB

Brightness: "darkness" of image or "lightness"

Contrast: difference in brightness

high: large diff. between light & dark areas

$$P_{new} = C \cdot P_{old} + b$$

C: contrast ≥ 1

b: brightness $0 \leq P_{new} \leq 255$

$$I_{out} = C \cdot I_{in} + B$$

B: mat. same dim as I_{in}

all values are b

$$I_{out} = c \cdot I_{in} + B$$

openCV

$$I_{out} = \alpha I_1 + \beta I_2 + \gamma \quad \leftarrow \text{weighted sum}$$

$\beta = 0$

$\alpha = c$

$\gamma = B$

$I_1 = I_{in}$

$$I_{out} = c\, I_{in} + B$$

contrast

brightness

Convolution : Kernel : small square matrix odd dim.

convolve with an image → apply image effect

"small": 3×3, 5×5, ..., 13×13

square: # rows = # cols

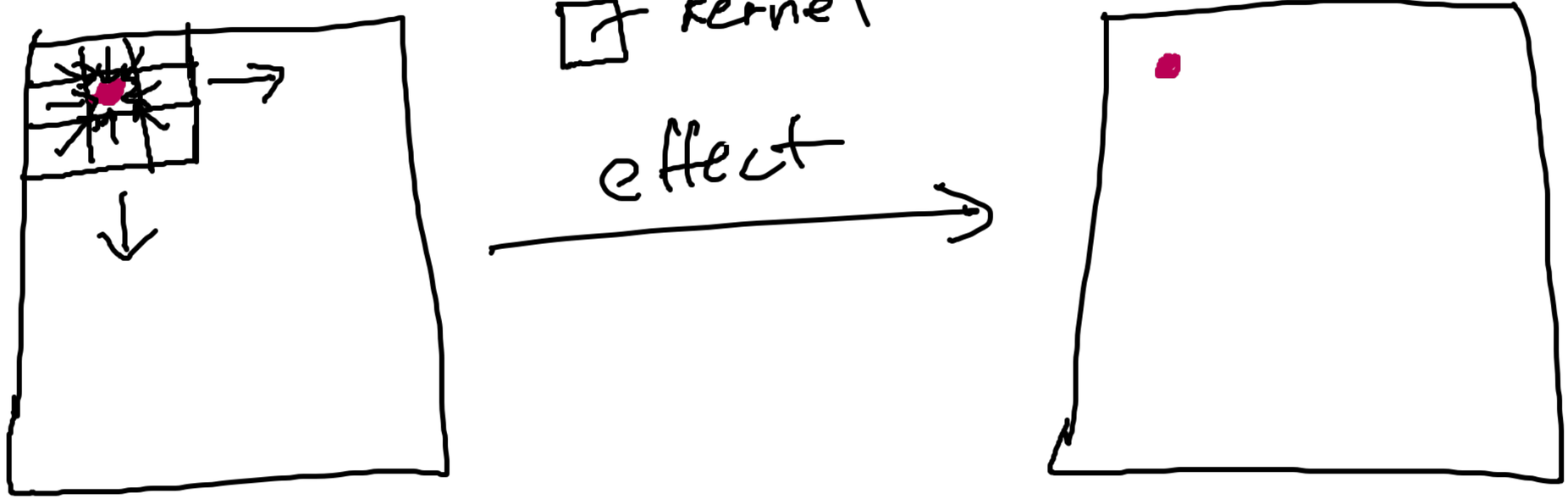
$$K = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}$$

← detects top-bottom edges (horizontal)

sharpening, blurring, edge detection
embossing, etc.

Convolution : math operation to apply a kernel to an image

sliding window



window ⟷ kernel

image

kernel

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 255 & 255 & 255 \\ 255 & 255 & 255 \end{bmatrix} * \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} = \begin{bmatrix} \bigcirc & \bigcirc & \bigcirc \\ -1020 & -1020 & -1020 \\ -1020 & -1020 & -1020 \\ 0 & 0 & 0 \end{bmatrix}$$

$0 \cdot 1 + 0 \cdot 2 + 0 \cdot 1 + 255 \cdot 0 + 255 \cdot 0 + 255 \cdot 0$

$+ 255 \cdot -1 + 255 \cdot -2 + 255 \cdot -1 = -1020$