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Learning for Life

Working with Images

Computer Vision

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Agenda

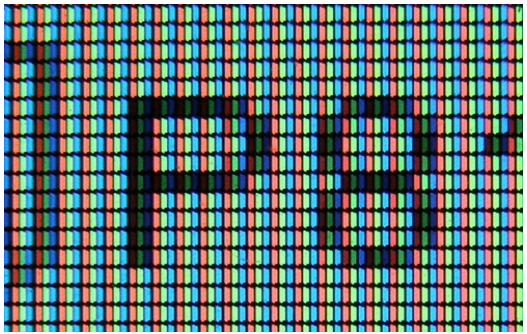
- Basics of Images
- Understanding filtering
- Hands-On

Image basics

Images

PIXELS are ATOMIC ELEMENTS of a digital image.

it is the smallest element of an image represented on the screen.



A pixel can have value ranging from 0 to 255.

Where 0 is black and 255 is white.

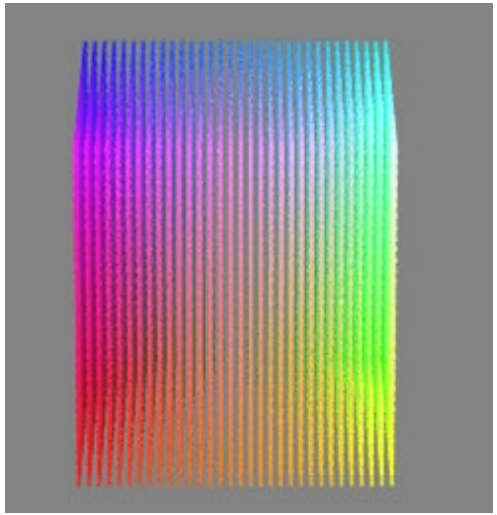
Images - Channels

Images can have different channels.

Examples - RGB, BGR

Here R - Red, G - Green and B - Blue

Grayscale image has just one channel.



RGB Channels

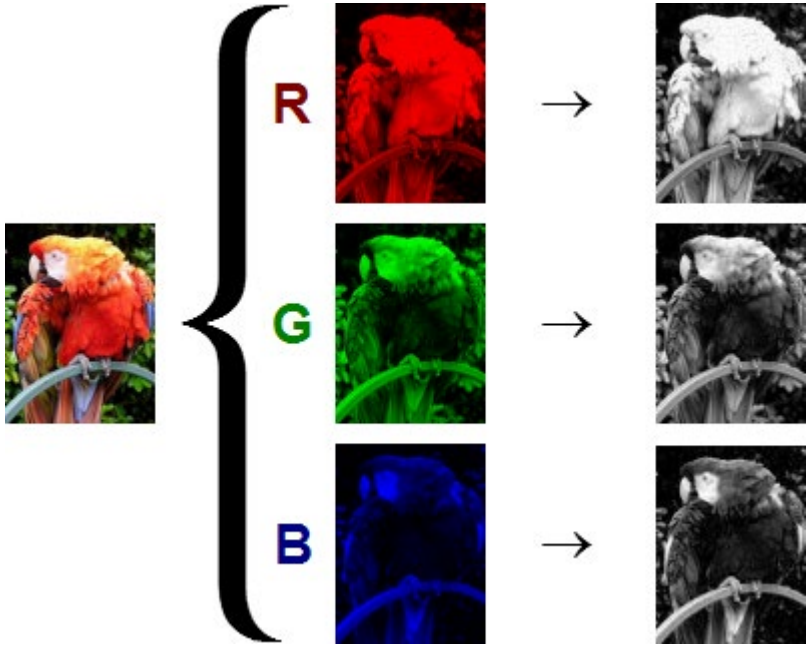


Image - Formats

Some formats: GIF, JPEG, PNG, RAW, TIF, PGM, PBM etc.

Medical Images: DICOM, Analyze, NIFTI etc.

Image representation

This image has 3 channels.

And one channel can be represented like this

2	15	22
33	34	4
21	24	44

Note - this matrix is just for representation purpose, it doesn't truly indicate the numbers and shape of the given image.

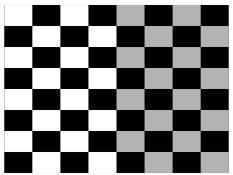
Image Shape- (194, 259, 3)

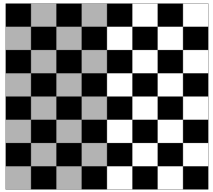
Image Transformation - Filtering

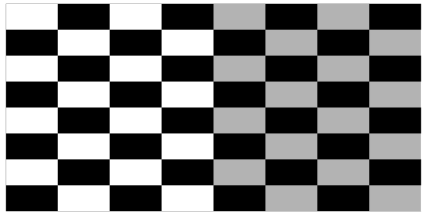
Filtering can be used to transform images like sharpening, blurring, scaling etc.

Affine transformations

Basic image transformations like scale, rotate, translate, mirror etc.

1. 

2. 

3. 

Examples -

1. Identity
2. Reflection
3. Scaling

Feature Extraction from Images - Convolution

How to extract features from images?

Manual feature creation - Old techniques

- SIFT (ScaleInvariant Feature Transform)
- HOG (Histogram of Oriented Gradients) etc.

This is hard and have some issues.

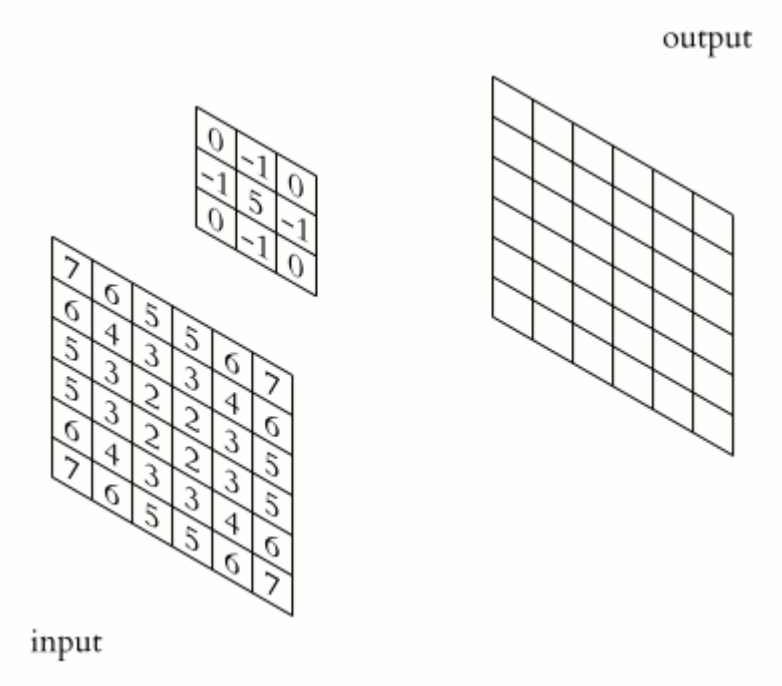
So, We will discuss about a method here - **Convolution**

It is the most important component of CNNs

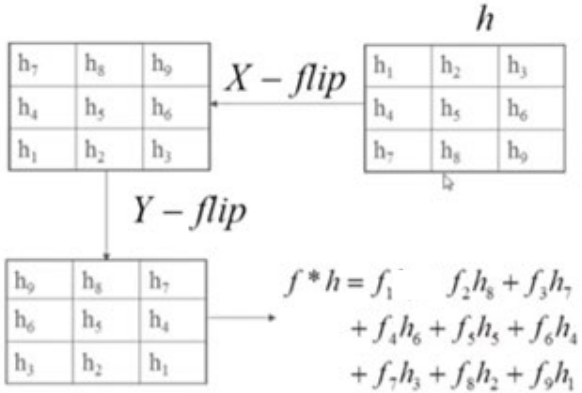
Convolution and Kernels

Convolution is the process of adding each element of the image to its local neighbors, weighted by the kernel.

This is related to a form of mathematical Convolution operation.



Convolution vs Correlation



Convolution:

$$G = h * F \qquad G[i,j] = \sum_{u=-k}^{k} \sum_{v=-k}^{k} h[u,v]F[i-u, j-v]$$

Correlation:

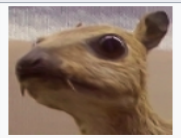
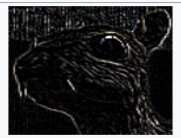
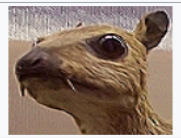
$$G = h \otimes F \qquad G[i,j] = \sum_{u=-k}^{k} \sum_{v=-k}^{k} h[u,v]F[i+u, j+v]$$

Convolution is basically flipping the kernel via X-axis and Y-axis and then performing a correlation with the resultant kernel

Features from kernels

Kernel is also called convolution matrix or mask.
Convolution with different kernels can be used for different image transformations/filtering.

You can use different kernels for different Feature extraction like edge detection, Sharpen, blurring etc.

Operation	Kernel ω	Image result g(x,y)
Identity	$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$	
Edge detection	$\begin{bmatrix} 1 & 0 & -1 \\ 0 & 0 & 0 \\ -1 & 0 & 1 \end{bmatrix}$	
	$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$	
	$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$	
Sharpen	$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$	

Features from kernels

Original

Sharpen

Edge Detect

Stronger Edge Detect

Thank you!

Happy Learning :)