

- Keras is a specification for deep learning models.

- ML usually focuses on tabular data.

↳ dl can also be applied to images.

— images are different from tabular data

Black & White Images

$$\begin{bmatrix} 0 & 2 & 3 & 4 \\ 0 & 4 & 3 & 0 \\ \dots & & & \\ 0 & 1 & 1 & 1 \end{bmatrix}$$

2D Tensor.

Colour Images

$$\begin{bmatrix} 1 & 3 & 3 & 3 \\ 2 & 1 & 0 & 0 \\ \dots & & & \\ 4 & 5 & 5 & 5 \end{bmatrix}$$

B
G
R

Images use,

Tensor

like a matrix
but with arbitrary
dimensions.

TENSORS

Convolutions

- DL applies convolutions to tensors.

— Convolutions are small tensors that can be applied to small x-sections of other tensors.

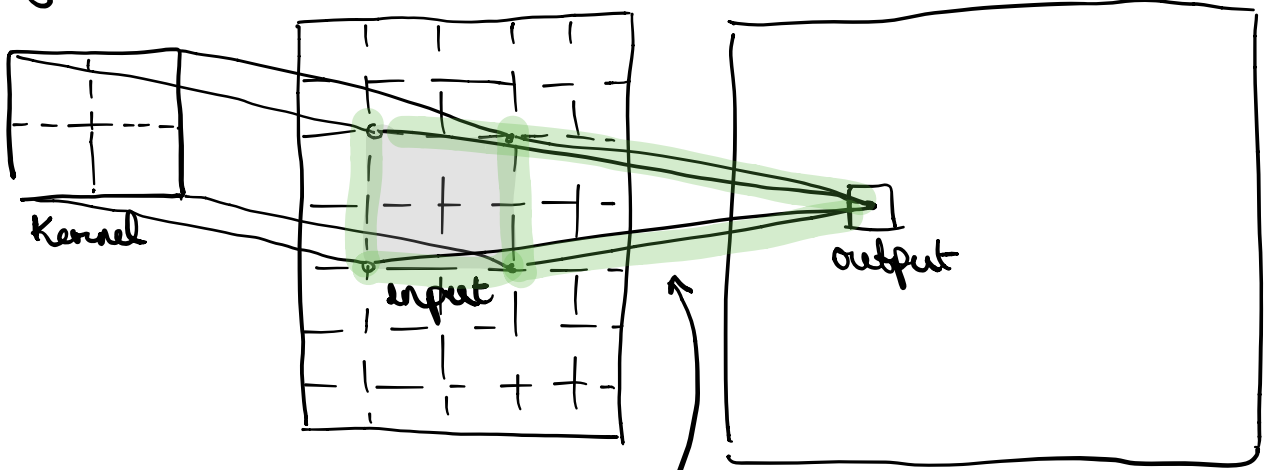
→ when used to detect patterns can be referred to as "filters".

$$\begin{bmatrix} 1 & 1 \\ -1 & -1 \end{bmatrix} \} \text{ A convolution.}$$

Applying convolutions to tensors is done by array-style multiplication

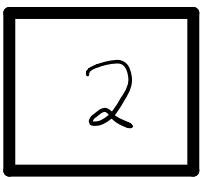
$$\begin{bmatrix} 1 & 2 & \dots \\ 3 & 4 & \dots \\ \dots & \dots & \dots \end{bmatrix} \begin{bmatrix} 1 & 1 \\ -1 & -1 \end{bmatrix} \quad \begin{aligned} &1(1) + 2(1) \\ &+ 3(-1) + 4(-1) \end{aligned}$$

Diagram of Applying a Tensor



Filters are computed/chosen using gradient descent/backpropagation → optimization techniques.

A mapping of where a certain (filter) pattern can be found in the input



Input Img.

| | | | | | |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 2 | 2 | 2 | 0 |
| 0 | 0 | 0 | 0 | 2 | 0 |
| 0 | 0 | 2 | 2 | 2 | 0 |
| 0 | 0 | 2 | 0 | 2 | 2 |

LAYER #1

(circles)
Filter #X

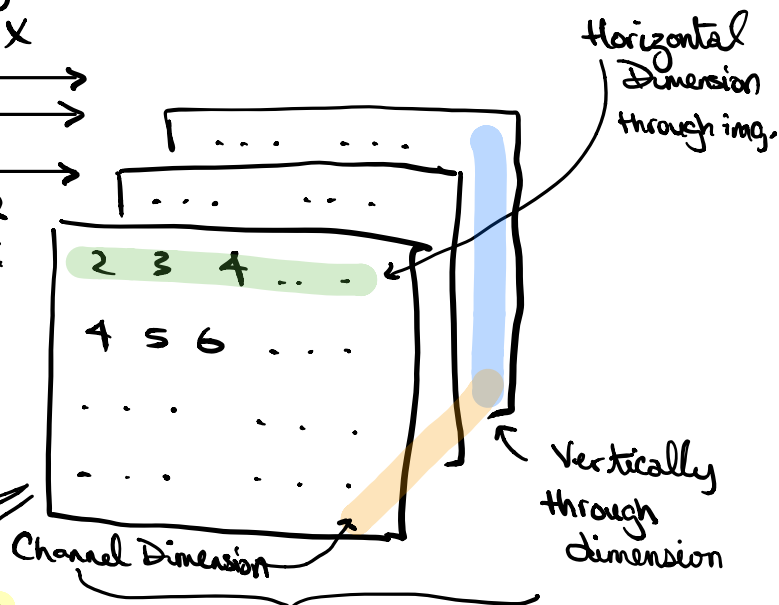
Filter #2
(horizontal lines)

Filter #1
(vertical lines)

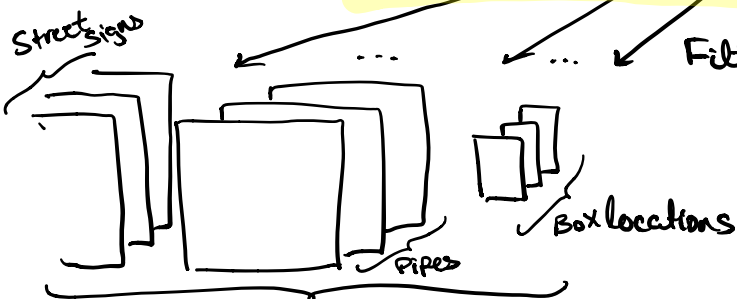
LAYER #2

Filter 4

A 3D Tensor (output)



Representation of image in all it's (3 dimensions?) maybe 2.



1D Tensor.