

- 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

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

$\underbrace{\hspace{1cm}}$ 2D Tensor.

Colour Images

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

R G B

Images use,

Tensor

like a matrix
but with arbitrary
dimensions.

TENSORS //

Convolutions

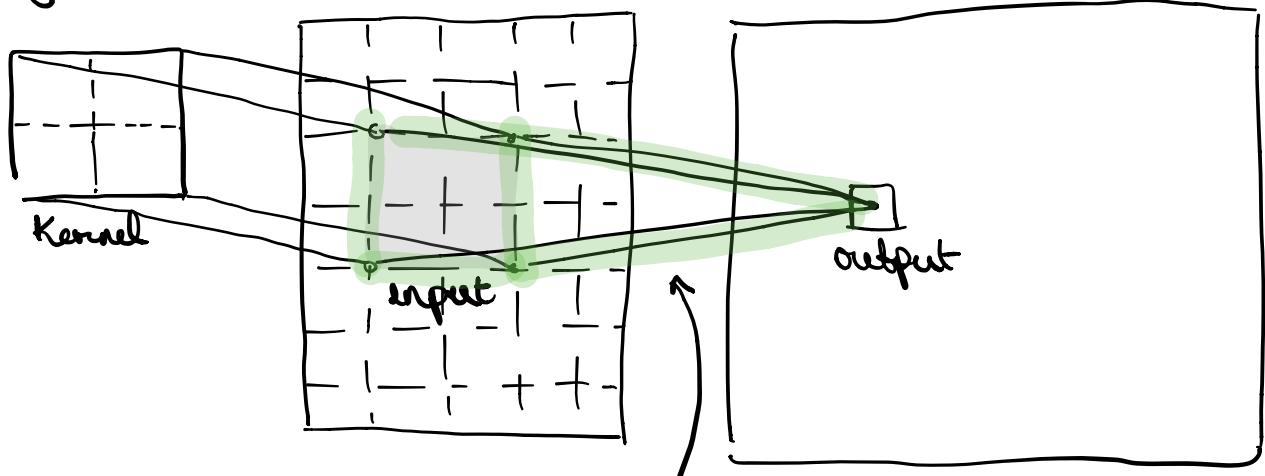
- ◊ DL applies convolutions to tensors.
- Convolutions are small tensors that can be applied to small x-sections of other tensors.
→ when used to detect patterns can be referred to as "filters".

$$\left[\begin{array}{cc} 1 & 1 \\ -1 & -1 \end{array} \right] \} \text{ A convolution.}$$

Applying convolutions to tensors
is done by array-style multiplication

$$\left[\begin{array}{ccc} 1 & 2 & \dots \\ 3 & 4 & \dots \\ \dots & \dots & \dots \end{array} \right] \left[\begin{array}{cc} 1 & 1 \\ -1 & -1 \end{array} \right] \quad 1(1) + 2(1) + 3(-1) + 1(-1)$$

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

