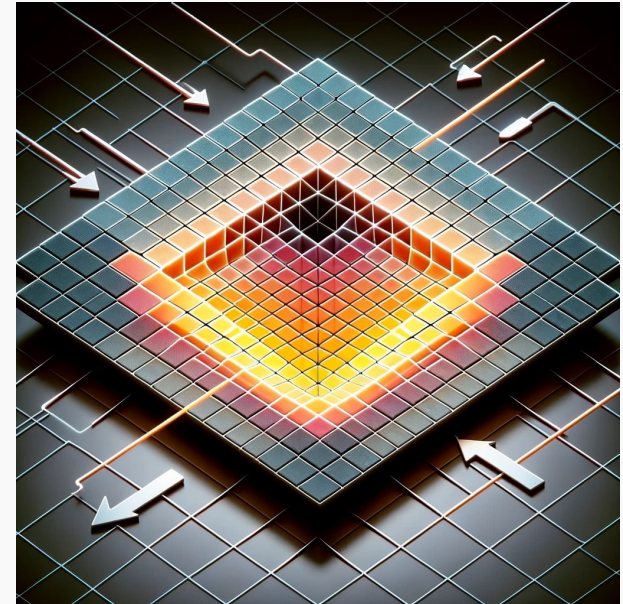


kokchun giang

# **image kernel** – a building block for convolutional neural networks



# convolution to extract feature maps

## Filters (kernels)

→ small matrices that can filter out info from layer matrices (e.g. image)

## Convolution

→ mathematical operator \*  
for images → sliding dot products

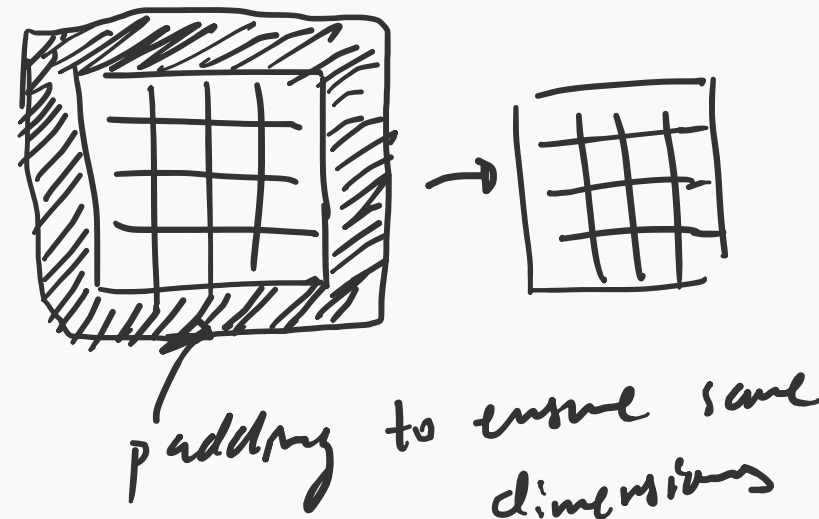
$$\begin{pmatrix} 0 & 2 & 1 & 0 \\ 2 & 1 & 3 & 0 \\ 1 & 0 & 2 & 1 \\ 1 & 1 & 0 & 1 \end{pmatrix} \begin{matrix} \text{edge filter} \\ * \end{matrix} \begin{pmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{pmatrix} =$$

$[4 \times 4] \quad \mathbb{R} * \mathbb{f} \quad [3 \times 3]$

$$= \begin{pmatrix} -2 & -2 & +4 & -3 & -1 & -1 & +2 & -2 \\ -1 & -1 & -2 & -1 & -3 & +8 & -1 \end{pmatrix}$$

$$= \begin{pmatrix} -3 & 8 \\ -5 & 4 \end{pmatrix} \begin{matrix} \text{feature map} \\ \text{valid convolution} \end{matrix}$$

same convolution



→ use many kernels on same image  
→ extract many feature maps  
a network can adjust weights in these filters to find different features through backpropagation