FYS5429, FEB 15, 2023

CNN

ODE

$$x_{t+1} = x_t + \Delta t \times \text{ODEmethod}$$

$$\frac{dx}{dt}\Big|_{x=x_t}$$

$$\frac{dx}{dt} = f(x, t)$$

$$t \Rightarrow t = \{t_0, t_1, \ldots t_n\}$$

$$\Delta t = \frac{t_n - t_0}{n}$$

$$x \Rightarrow x = \{x_0, x_1, \ldots x_n\}$$

Euler's method

$$x_{i+1} = x(t+\Delta t) \simeq x_i + \Delta t\, f(x_i, t_i)$$

$$f(x_i, t_i) = \frac{dx}{dt}\Big|_{t=t_i}$$

$$t_i = t_0 + i\Delta t$$

$$i = \{0, 1, 2, \ldots n\}$$

Basics of CNNs

I

a	b	c	d
e	f	g	h
i	j	k	l

3x4

W

w	x
y	z

2x2

stride = 1

aw+bx ey+fz	bw+cx +fy+gz	cw + dx + gy+hz
ew+fx +iy+jz	fw +gx jy + zk	gw+hx +ky +lz

2 X 3 matrix

output assume a symmetric
matrix N = 7
input 7x7
assume a filter of dim 3x3

$F = 3$

output size

$(N-F)/\text{stride} + 1$

hyperparameter.

$N=7$, $F=3$ $S = \text{stride} = 1$

$(7-3)/1 + 1 = 5 \Rightarrow 5\times5$ output.

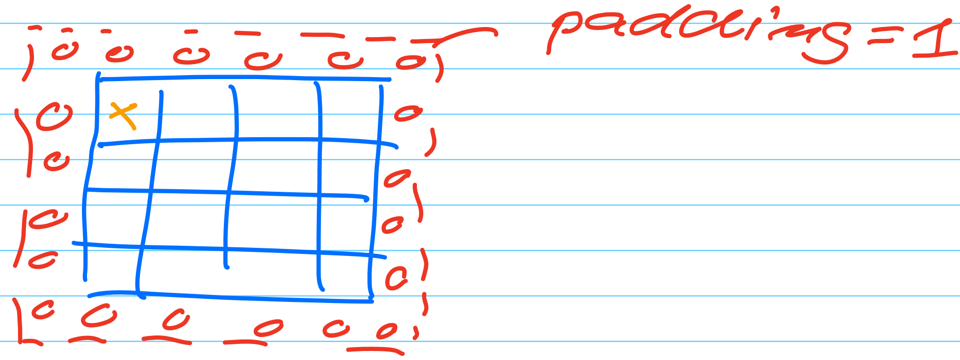
$N=7$ $F=3$, $\text{stride}=2$

$(7-3)/2 + 1 = 3$

$S=3$

$(7-3)/3 + 1 = 2.33$ not possible

Additional hyperparameter is padding P



Convolution as another way of doing matrix-vector multiplication.

Example

$$\begin{bmatrix} i_{00} & i_{01} & i_{02} \\ i_{10} & i_{11} & i_{21} \\ i_{20} & i_{21} & i_{22} \end{bmatrix} \circledast \begin{bmatrix} w_{00} & w_{01} \\ w_{10} & w_{11} \end{bmatrix}$$

$$3 \times 3 \qquad\qquad 2 \times 2$$

$$S = 1 \qquad p = 0$$

$$= \left[\begin{array}{c|c} i_{00} w_{00} + i_{01} w_{01} & i_{01} w_{00} + i_{02} w_{01} \\ i_{10} w_{10} + i_{11} w_{11} & + i_{11} w_{10} + i_{12} w_{11} \\ \hline i_{10} w_{00} + i_{11} w_{01} & i_{11} w_{00} + i_{12} w_{01} \\ + i_{20} w_{10} + w_{11} i_{21} & + i_{21} w_{10} + i_{22} w_{11} \end{array}\right]$$

$$I' = [i_{00}\ i_{01}\ i_{02}\ i_{10}\ i_{11}\ i_{12}\ i_{20}\ i_{21},\ i_{22}] \in \mathbb{R}^9$$

$$W' = \begin{bmatrix} w_{00} & w_{01} & 0 & w_{10} & w_{11} & 0 & 0 & 0 & 0 \\ 0 & w_{00} & w_{01} & 0 & w_{10} & w_{11} & 0 & 0 & 0 \\ 0 & 0 & 0 & w_{00} & w_{01} & 0 & w_{10} & w_{11} \\ 0 & 0 & 0 & 0 & w_{00} & w_{10} & 0 & 0 \end{bmatrix}$$

$$w' \in \mathbb{R}^{4 \times 9}$$

$$w' * I' = O' \in R^{4}$$