

**Lecture FYS5429,
February 20, 2024**

FY55429/9429 FEB 20

$$A = U \Sigma V^T$$

$$A \in \mathbb{R}^{m \times m}$$

$$U \in \mathbb{R}^{m \times m}$$

$$U^T U = U U^T = I$$

$$U = \begin{bmatrix} u_0 & \dots & u_{m-1} \\ I & & \end{bmatrix}$$

$$I = \sum_{k=0}^{m-1} u_k u_k^T$$

$$P = U_0 \bar{U}_0^T + U_1 \bar{U}_1^T$$

$$\bar{V}^T V = V \bar{V}^T = \mathbf{1}$$

$$V \in \mathbb{R}^{n \times n}$$

$$\Sigma = \begin{bmatrix} \Gamma_0 & \Gamma_1 & \cdots & \Gamma_{p-1} \\ & & & \circ \end{bmatrix}$$

$$j = 0, 1, 2, 3$$

$$n = 4$$

$$x(0) = \beta_0$$

$$x(1) = \beta_1$$

$$x(2) = \beta_2$$

$$x(3) = \beta_3$$

$$k = 0, 1, 2$$

$$m = 3$$

$$w(0) = \alpha_0$$

$$w(1) = \alpha_1$$

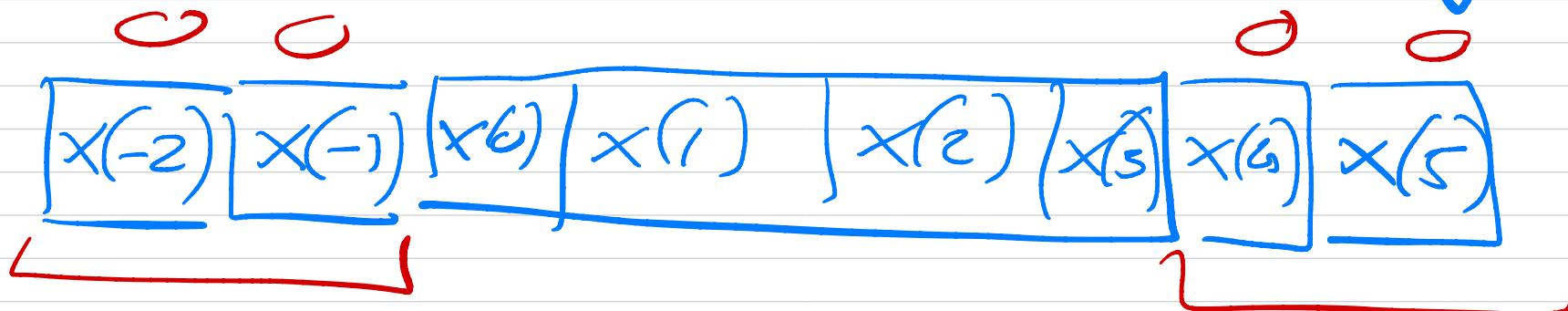
$$k=m-1, w(2) = \alpha_2$$

$$y(i) = \sum_{k=0}^{k=m-1} w(k) x(i-k)$$

$$y(c) = w(c)x(c) + w(1)x(-1) + w(2)x(-2)$$

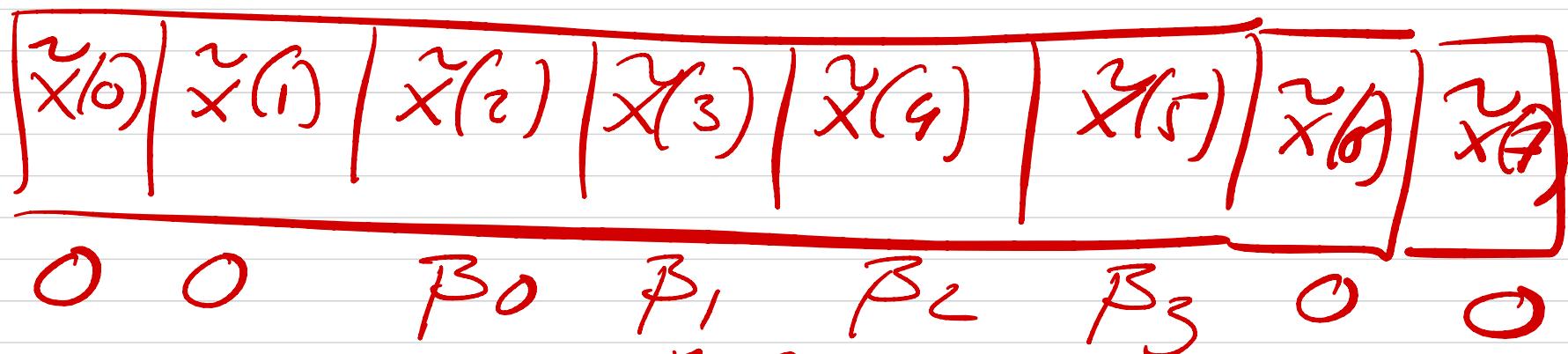
$\alpha_0 \beta_0$

introduce padding

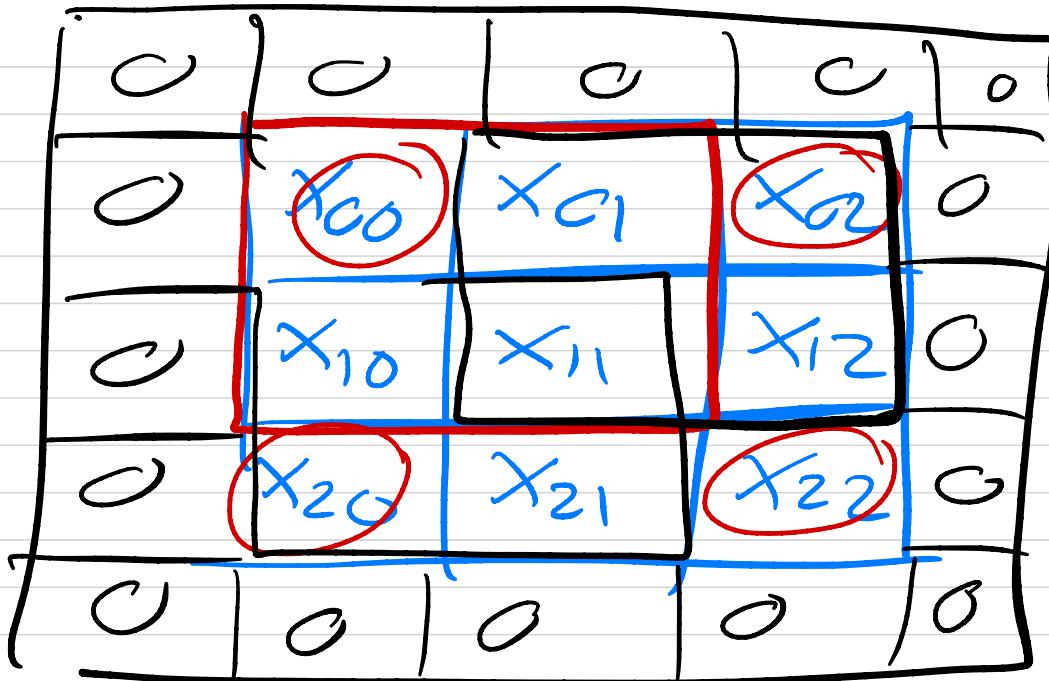


$P = 2 \Rightarrow 2P$ additional zeros

$x \Rightarrow \tilde{x}$



$$\Rightarrow y(i) = \sum_{k=0}^{k=m-1} w(k) \times (i + (m-1) - k)$$



$$S = 1$$

$$P = 1$$

Parameters of conv stage

- K number of filters
- F their spatial extent
- S stride
- P amount of padding

- input volume

$$W_1 \times H_1 \times D_1$$

width height \nwarrow depth

- a Filter produces a new volume

$$W_2 \times H_2 \times D_2$$

$$W_2 = (W_1 - F + 2P) / S + 1$$

$$H_2 = (H_1 - F + 2P) / S + 1$$

$$D_2 = K$$

common settings

$$F = 3$$

$$S = 1$$

$$P = 1$$

$$F = 5$$

$$S = 1$$

$$P = 2$$

$$F = 5$$

$$S = 2$$

$P = \text{whatever}$
fits

$$F = 1$$

$$S = 1$$

$$P = 0$$

Example :

input $32 \times 32 \times 3$

$k = 10$ 5×5 filter, $S = 1$, $P = 0$

Parameters to train

$$5 \times 5 \times 3 + \frac{1}{bias\ parameter} = 76$$

bias parameter

$$k=10 \Rightarrow 76 \cdot 10 = 760$$

parameters to train with
Back propagation.

New dimension

$$H_2 = W_2 = (w, -F + 2P) / S=1 + 1$$

$$\Rightarrow H_2 = W_2 = 28$$

We have $(28 \times 28 \times 3) \times 10$
images⁻¹



Pooling

