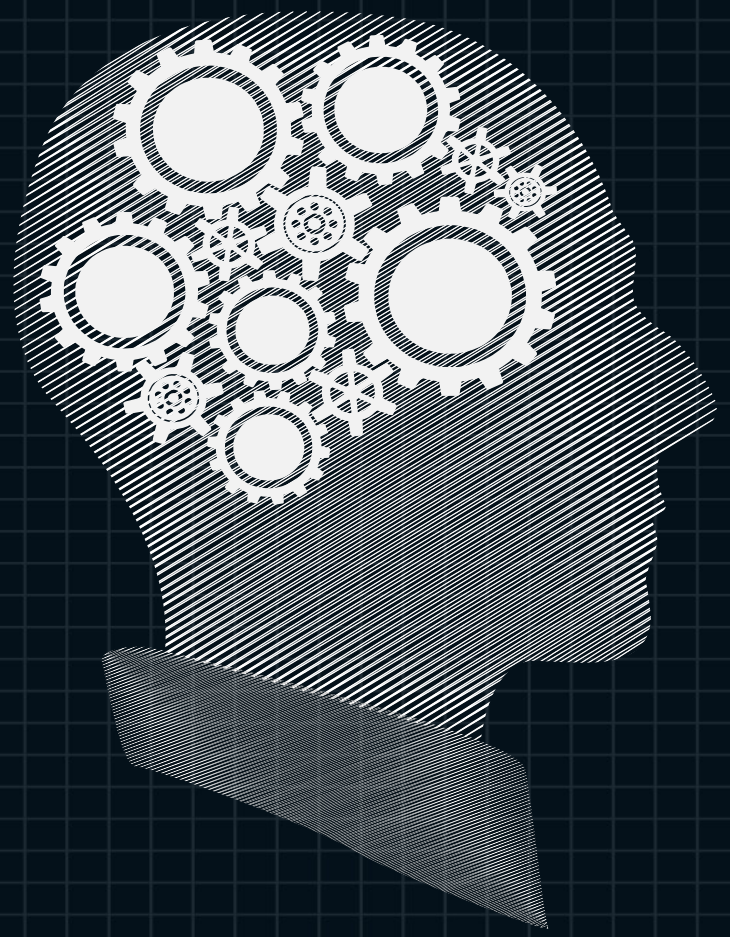
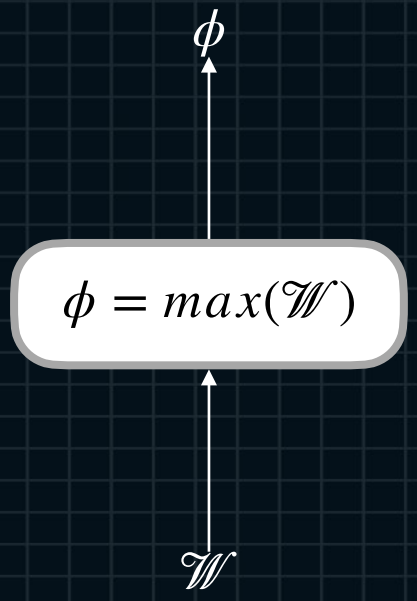


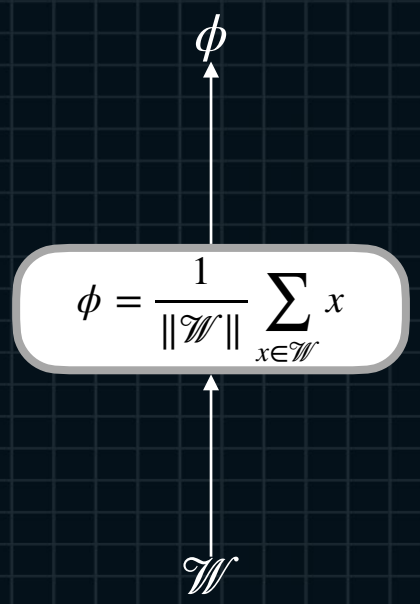
Forward Propagation of Neural Networks

Lecture.6
Pooling Layers

Lecture.6
Pooling Layers

- Max/Average Pooling





Lecture.6 Pooling Layers

- Max Pooling Layers

$$\vec{\phi} = (\phi_1 \quad \phi_2 \quad \phi_3 \quad \phi_4)$$

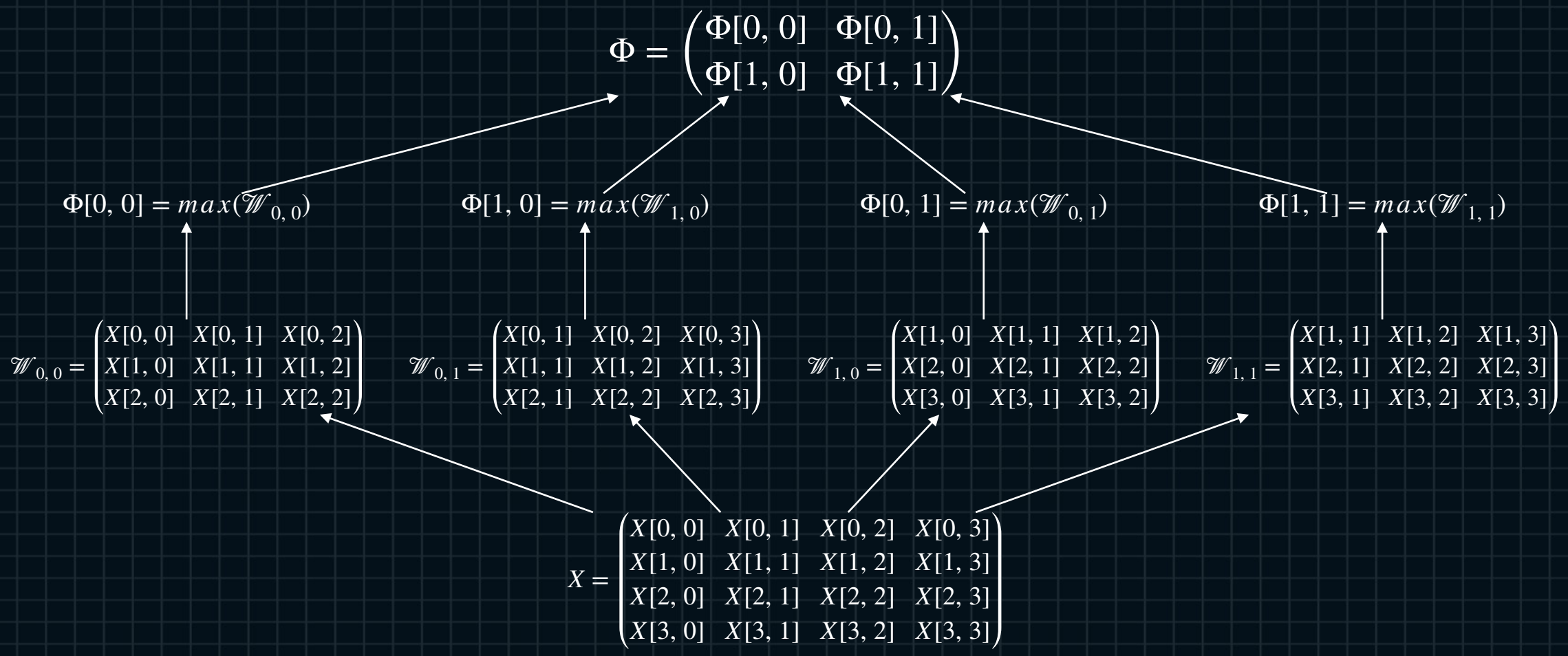
$$\phi_0 = max(\mathscr{W}_0) \qquad \phi_1 = max(\mathscr{W}_1) \qquad \phi_2 = max(\mathscr{W}_2) \qquad \phi_3 = max(\mathscr{W}_3)$$

$$\mathscr{W}_0 = (x_0 \quad x_1 \quad x_2) \qquad \mathscr{W}_1 = (x_1 \quad x_2 \quad x_3) \qquad \mathscr{W}_2 = (x_2 \quad x_3 \quad x_4) \qquad \mathscr{W}_3 = (x_3 \quad x_4 \quad x_5)$$

$$\vec{x} = (x_0 \quad x_1 \quad x_2 \quad x_3 \quad x_4 \quad x_5)$$

Lecture.6 Pooling Layers

- Max Pooling Layers



Lecture.6 Pooling Layers

- Average Pooling Layers

$$\vec{\phi} = (\phi_1 \quad \phi_2 \quad \phi_3 \quad \phi_4)$$

$$\phi_0 = \frac{1}{3}\sum_{i=0}^{2} x_i \qquad \phi_1 = \frac{1}{3}\sum_{i=1}^{3} x_i \qquad \phi_2 = \frac{1}{3}\sum_{i=2}^{4} x_i \qquad \phi_3 = \frac{1}{3}\sum_{i=3}^{5} x_i$$

$$\mathscr{W}_0 = (x_0 \quad x_1 \quad x_2) \qquad \mathscr{W}_1 = (x_1 \quad x_2 \quad x_3) \qquad \mathscr{W}_2 = (x_2 \quad x_3 \quad x_4) \qquad \mathscr{W}_3 = (x_3 \quad x_4 \quad x_5)$$

$$\vec{x} = (x_0 \quad x_1 \quad x_2 \quad x_3 \quad x_4 \quad x_5)$$

Lecture.6 Pooling Layers

- Average Pooling Layers

$$\Phi = \begin{pmatrix} \Phi[0,0] & \Phi[0,1] \\ \Phi[1,0] & \Phi[1,1] \end{pmatrix}$$

$$\Phi[0,0] = \frac{1}{9}\sum_{i=0}^{2}\sum_{j=0}^{2} X[i,j] \qquad \Phi[0,1] = \frac{1}{9}\sum_{i=0}^{2}\sum_{j=1}^{3} X[i,j] \qquad \Phi[1,0] = \frac{1}{9}\sum_{i=1}^{3}\sum_{j=0}^{2} X[i,j] \qquad \Phi[1,1] = \frac{1}{9}\sum_{i=1}^{3}\sum_{j=1}^{3} X[i,j]$$

$$\mathscr{W}_{0,0} = \begin{pmatrix} X[0,0] & X[0,1] & X[0,2] \\ X[1,0] & X[1,1] & X[1,2] \\ X[2,0] & X[2,1] & X[2,2] \end{pmatrix} \quad \mathscr{W}_{0,1} = \begin{pmatrix} X[0,1] & X[0,2] & X[0,3] \\ X[1,1] & X[1,2] & X[1,3] \\ X[2,1] & X[2,2] & X[2,3] \end{pmatrix} \quad \mathscr{W}_{1,0} = \begin{pmatrix} X[1,0] & X[1,1] & X[1,2] \\ X[2,0] & X[2,1] & X[2,2] \\ X[3,0] & X[3,1] & X[3,2] \end{pmatrix} \quad \mathscr{W}_{1,1} = \begin{pmatrix} X[1,1] & X[1,2] & X[1,3] \\ X[2,1] & X[2,2] & X[2,3] \\ X[3,1] & X[3,2] & X[3,3] \end{pmatrix}$$

$$X = \begin{pmatrix} X[0,0] & X[0,1] & X[0,2] & X[0,3] \\ X[1,0] & X[1,1] & X[1,2] & X[1,3] \\ X[2,0] & X[2,1] & X[2,2] & X[2,3] \\ X[3,0] & X[3,1] & X[3,2] & X[3,3] \end{pmatrix}$$

Lecture.6
Pooling Layers

- Padding

$$\begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & X[0,0] & X[0,1] & X[0,2] & X[0,3] & 0 \\ 0 & X[1,0] & X[1,1] & X[1,2] & X[1,3] & 0 \\ 0 & X[2,0] & X[2,1] & X[2,2] & X[2,3] & 0 \\ 0 & X[3,0] & X[3,1] & X[3,2] & X[3,3] & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

$$n'_H = n_H + 2p - f + 1$$

Lecture.6 Pooling Layers

- Strides

$$\mathscr{W}_{i,j} = X\left[i : i + (f-1),\ j : j + (f-1)\right]$$

$$0 \le i \le n_H - f, \quad i = i' \cdot s,\ i' \in \mathbb{W}$$

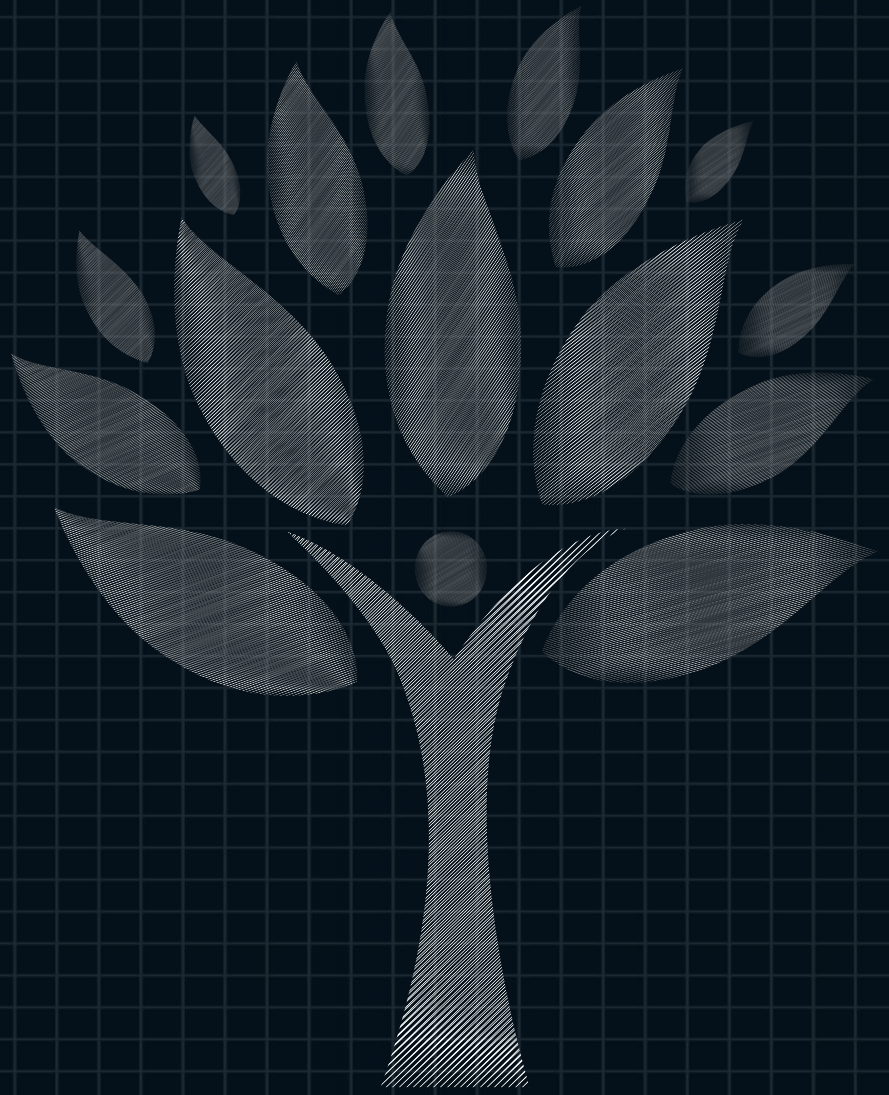
$$0 \le j \le n_H - f, \quad j = j' \cdot s,\ j' \in \mathbb{W}$$

$$n'_H = \left[\frac{n_H - f}{s} + 1\right]$$

Lecture.6 Pooling Layers

- I/O Shapes

$$n'_H = \left[\frac{n_H + 2p - f}{s} + 1 \right]$$



Forward Propagation of Neural Networks

Lecture.6
Pooling Layers