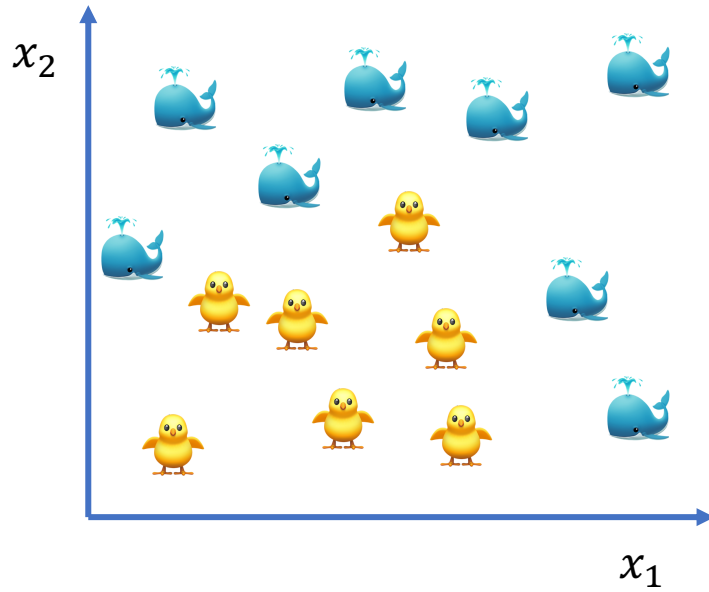


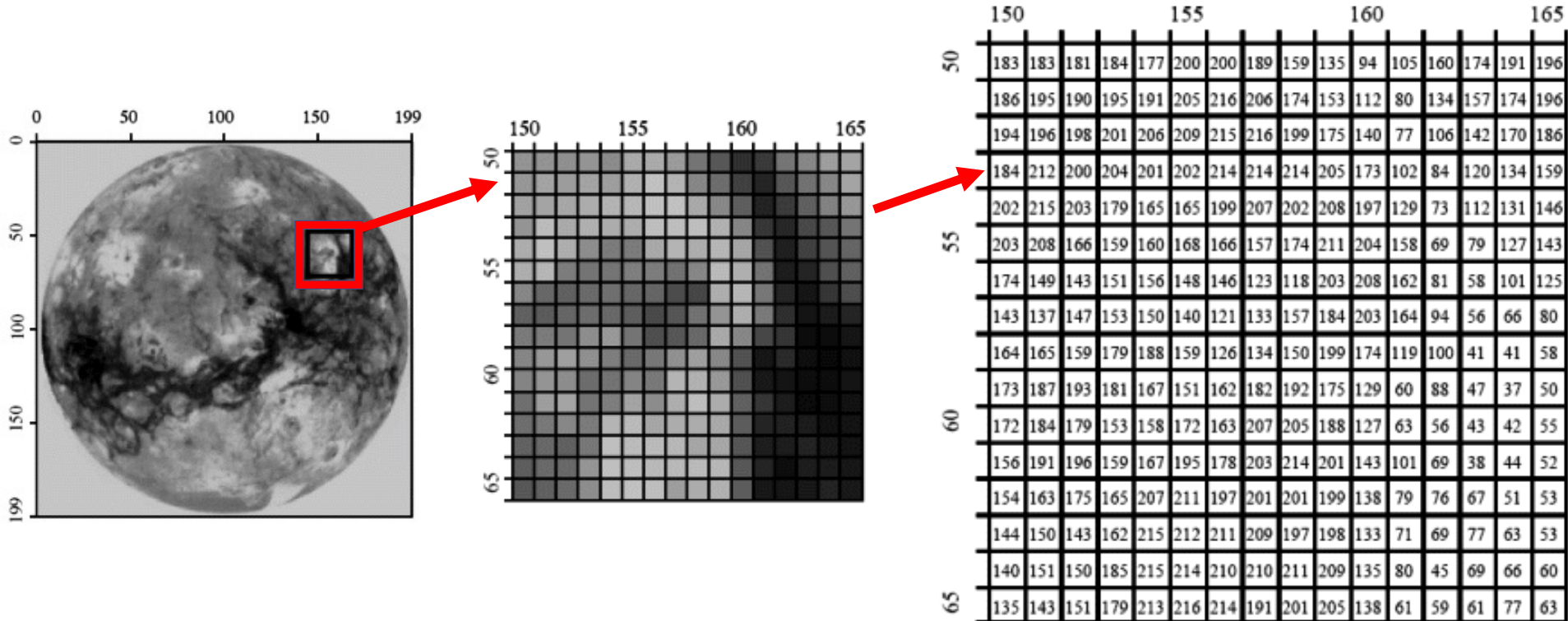
Doğrusal Olmayan İfadeler



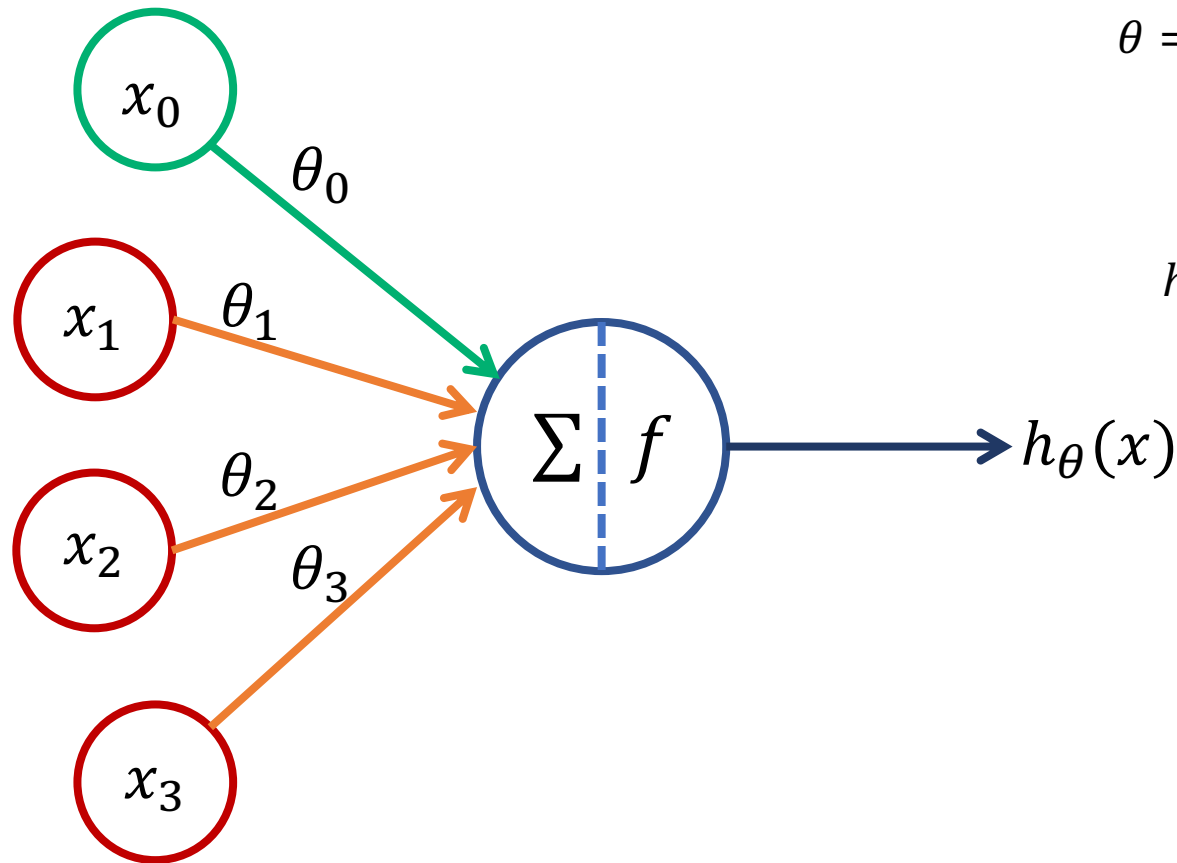
$$\sigma(\theta_0 + \theta_1 x_1 + \theta_2 x_2 + \theta_3 x_1 x_2 + \theta_4 x_1^2 + \theta_5 x_2^2 + \theta_6 x_1^2 x_2 + \dots)$$

$O(?)$

Doğrusal Olmayan ifadeler



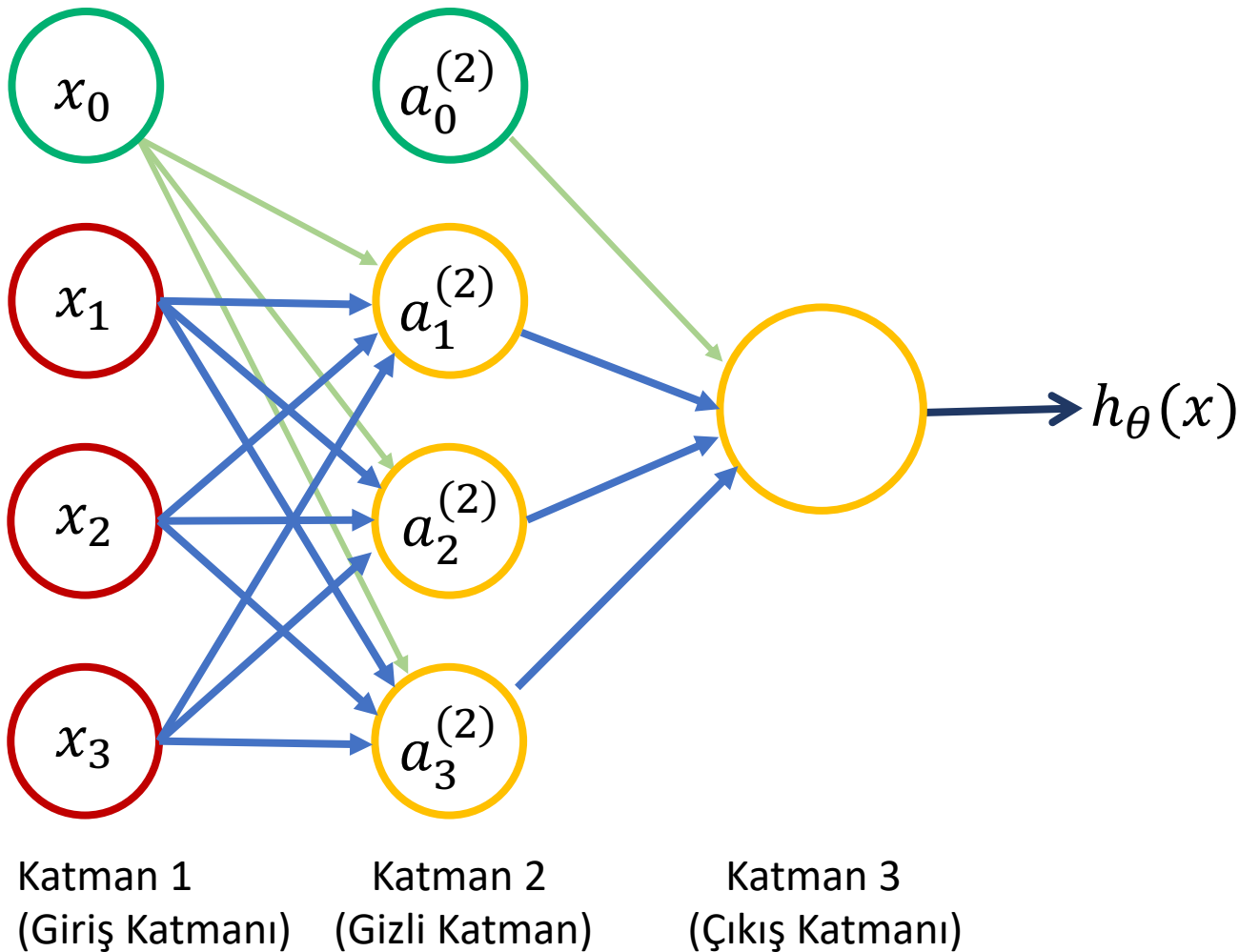
Nöron (Lojistik Birim)



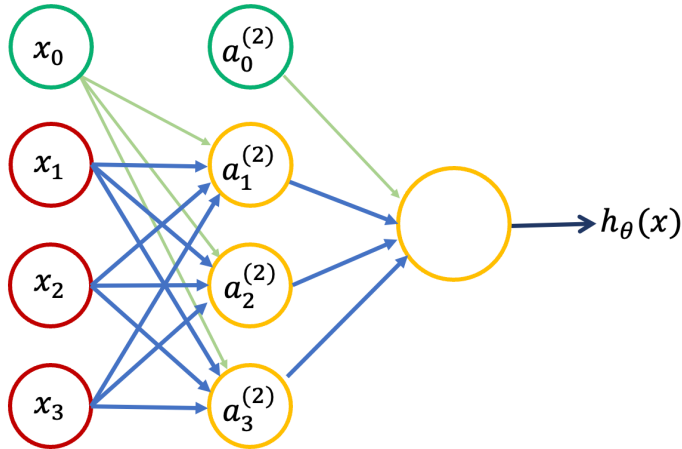
$$\theta = \begin{bmatrix} \theta_0 \\ \theta_1 \\ \theta_2 \\ \theta_3 \end{bmatrix} \quad x = \begin{bmatrix} x_0 \\ x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

$$h_\theta(x) = \frac{1}{1 + e^{-\theta^T x}}$$

Yapay Sinir Ağı (Neural Network)



Yapay Sinir Ağı (Neural Network)



$a_i^{(j)}$: nöron i 'nin j katmanındaki aktivasyonu

$\Theta^{(j)}$: j katmanından $j + 1$ katmanına geçiş parametreleri (ağırlıkları)

$$a_1^{(2)} = g(\Theta_{10}^{(1)} x_0 + \Theta_{11}^{(1)} x_1 + \Theta_{12}^{(1)} x_2 + \Theta_{13}^{(1)} x_3)$$

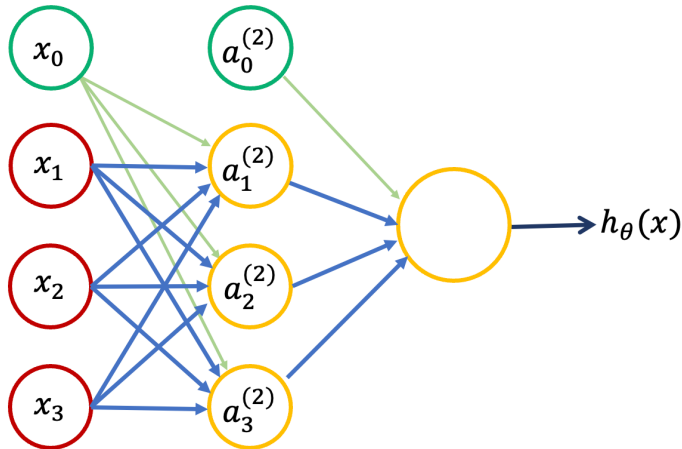
$$a_2^{(2)} = g(\Theta_{20}^{(1)} x_0 + \Theta_{21}^{(1)} x_1 + \Theta_{22}^{(1)} x_2 + \Theta_{23}^{(1)} x_3)$$

$$a_3^{(2)} = g(\Theta_{30}^{(1)} x_0 + \Theta_{31}^{(1)} x_1 + \Theta_{32}^{(1)} x_2 + \Theta_{33}^{(1)} x_3)$$

$$h_\theta(x) = a_1^{(3)} = g(\Theta_{10}^{(2)} a_0^{(2)} + \Theta_{11}^{(2)} a_1^{(2)} + \Theta_{12}^{(2)} a_2^{(2)} + \Theta_{13}^{(2)} a_3^{(2)})$$

Eğer YSA'nın j katmanında 5, $j + 1$ katmanında 3 nöron varsa,
 $\Theta^{(j)}$ matrisinin boyutu 3×6 olacaktır.

İleri Yayılma (Vektörleştirme)



$$a^{(1)} = x$$

$$z^{(2)} = \Theta^{(1)} a^{(1)}$$

$$a^{(2)} = g(z^{(2)})$$

$$a_0^{(2)} = 1$$

$$z^{(3)} = \Theta^{(2)} a^{(2)}$$

$$h_{\theta}(x) = a^{(3)} = g(z^{(3)})$$

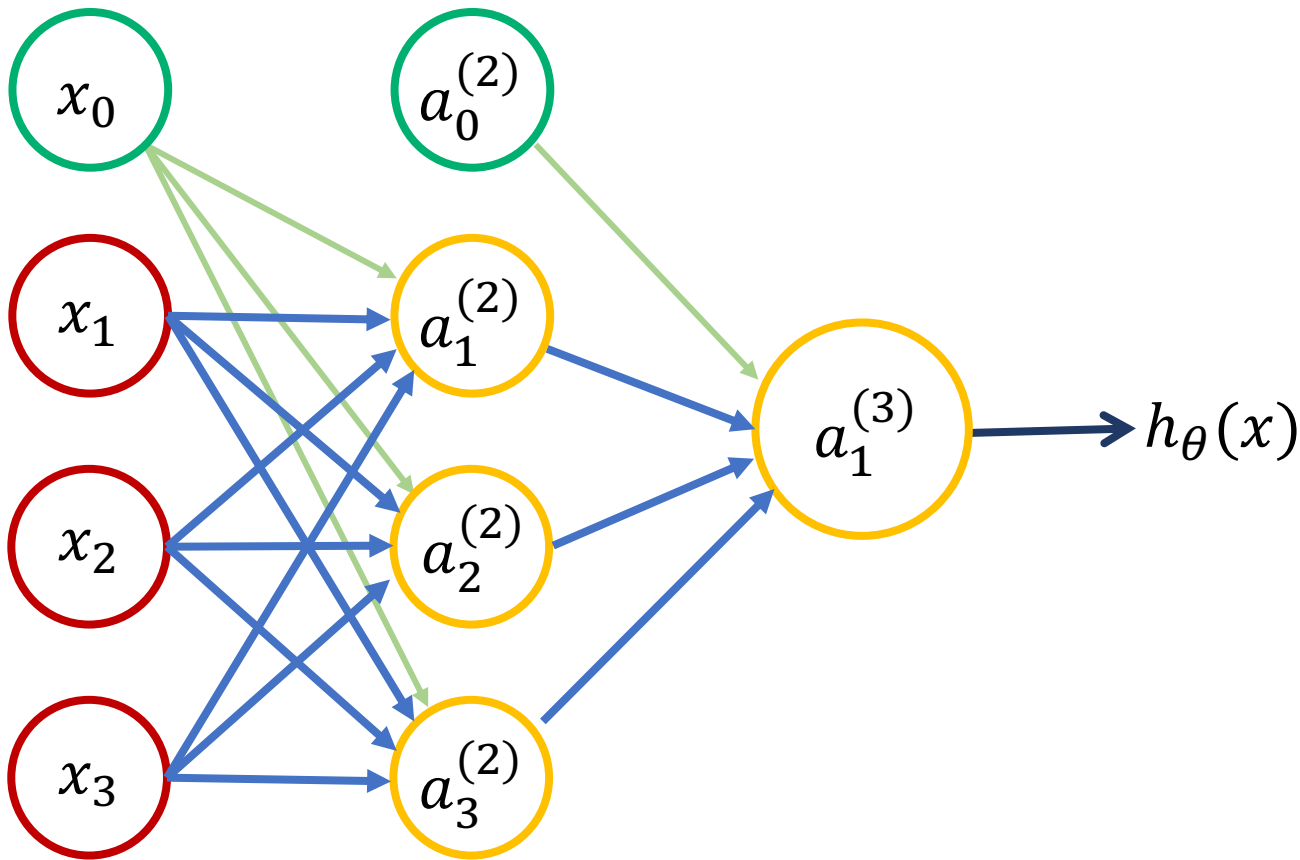
$$a_1^{(2)} = g(\Theta_{10}^{(1)} x_0 + \Theta_{11}^{(1)} x_1 + \Theta_{12}^{(1)} x_2 + \Theta_{13}^{(1)} x_3)$$

$$a_2^{(2)} = g(\Theta_{20}^{(1)} x_0 + \Theta_{21}^{(1)} x_1 + \Theta_{22}^{(1)} x_2 + \Theta_{23}^{(1)} x_3)$$

$$a_3^{(2)} = g(\Theta_{30}^{(1)} x_0 + \Theta_{31}^{(1)} x_1 + \Theta_{32}^{(1)} x_2 + \Theta_{33}^{(1)} x_3)$$

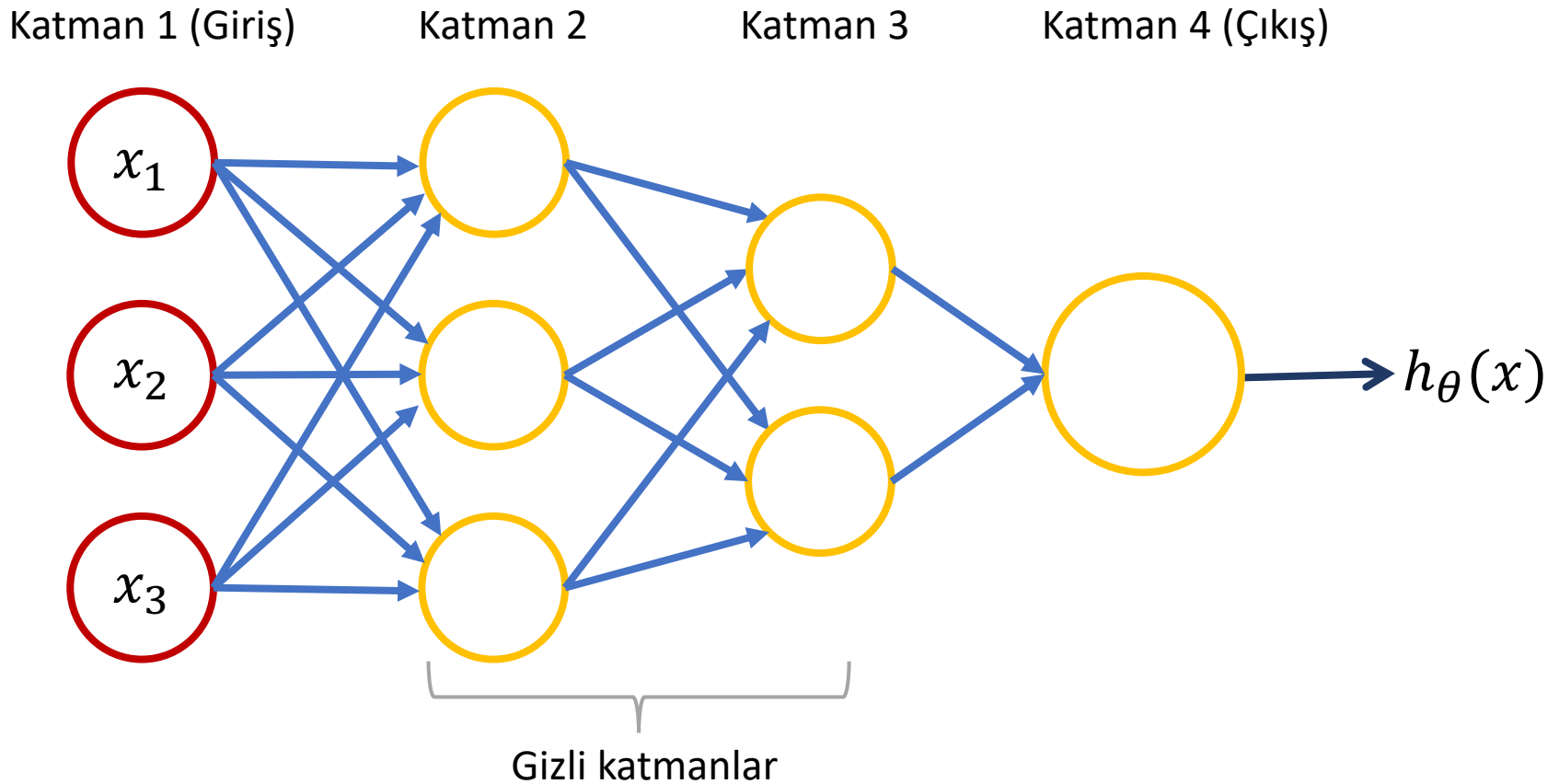
$$h_{\theta}(x) = a_1^{(3)} = g(\Theta_{10}^{(2)} a_0^{(2)} + \Theta_{11}^{(2)} a_1^{(2)} + \Theta_{12}^{(2)} a_2^{(2)} + \Theta_{13}^{(2)} a_3^{(2)})$$

YSA Öğrenilen Parametreler



$$h_\theta(x) = a_1^{(3)} = g(\theta_{10}^{(2)} a_0^{(2)} + \theta_{11}^{(2)} a_1^{(2)} + \theta_{12}^{(2)} a_2^{(2)} + \theta_{13}^{(2)} a_3^{(2)})$$

Çok Katmanlı YSA'lar



XNOR Çözümü (AND)

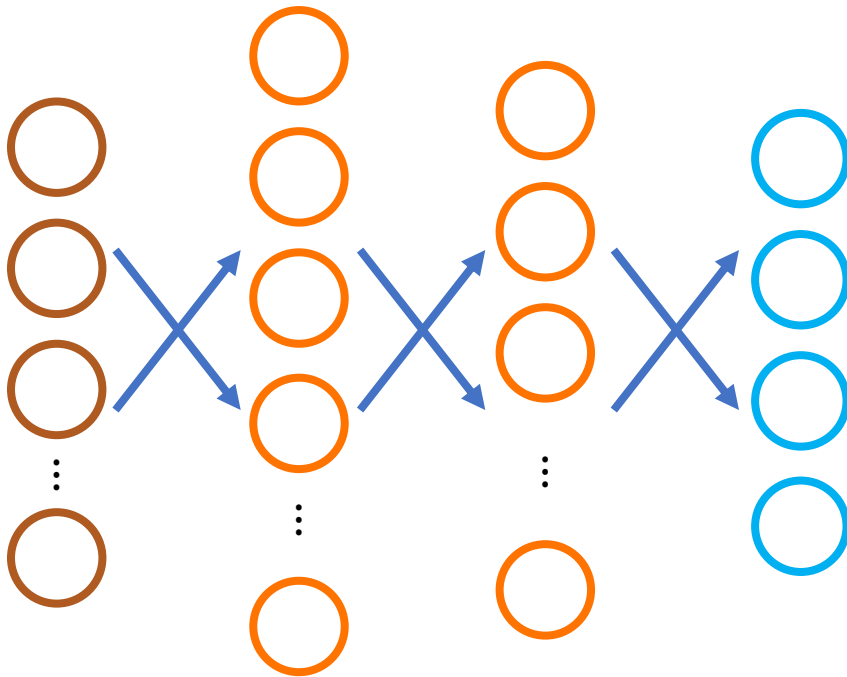
XNOR Çözümü (OR)

XNOR Çözümü (NOT)

XNOR Çözümü ($\text{NOT } x_1 \text{ AND NOT } x_2$)

YSA ile Çoklu Sınıflandırma

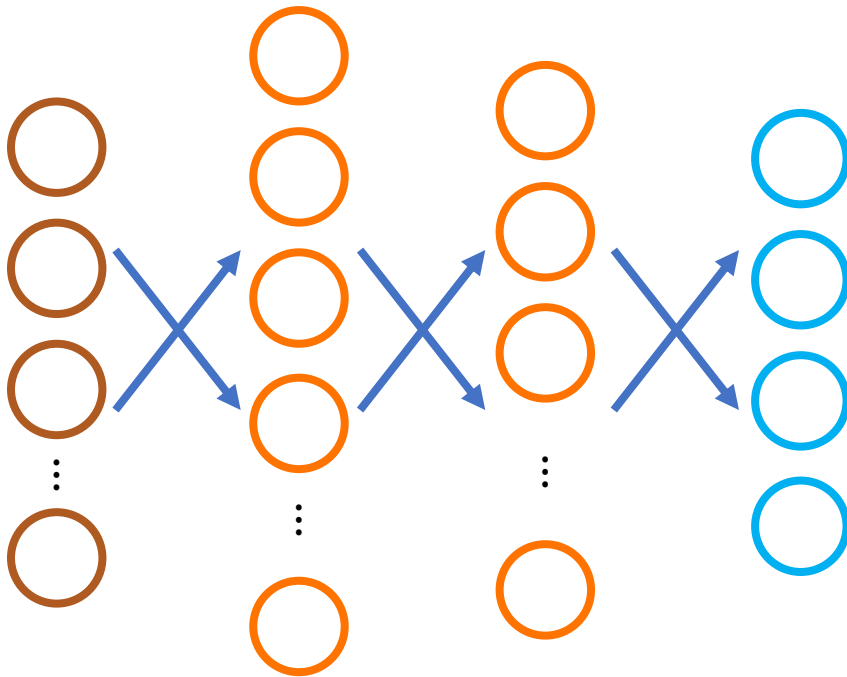
Kedi: 1, Cıvcıv: 2, Tavşan: 3, Sincap: 4



$$h_{\theta}(x) \in \mathbb{R}^4$$

YSA ile Çoklu Sınıflandırma

Kedi: 1, Cıvcıv: 2, Tavşan: 3, Sincap: 4



Eğitim seti: $((x_1, y_1), (x_2, y_2), \dots, (x_m, y_m))$ $y_i \in \left(\begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 0 \\ 1 \\ 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 0 \\ 0 \\ 1 \\ 0 \end{bmatrix}, \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix} \right)$