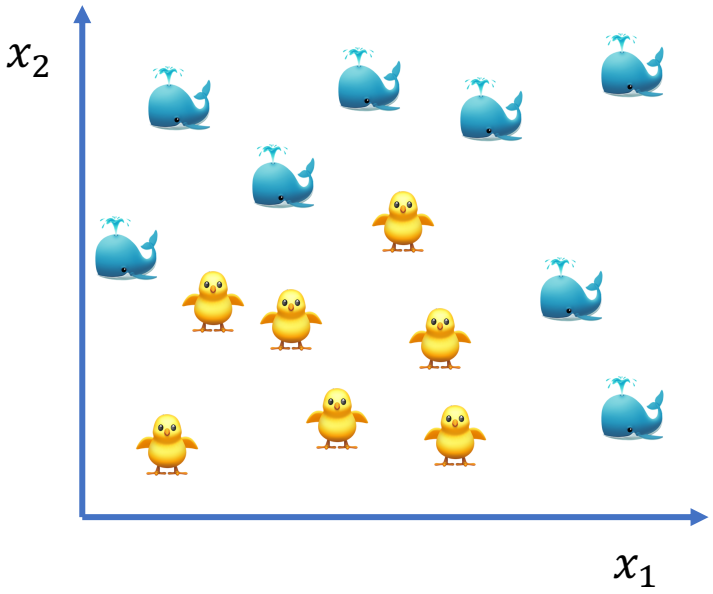
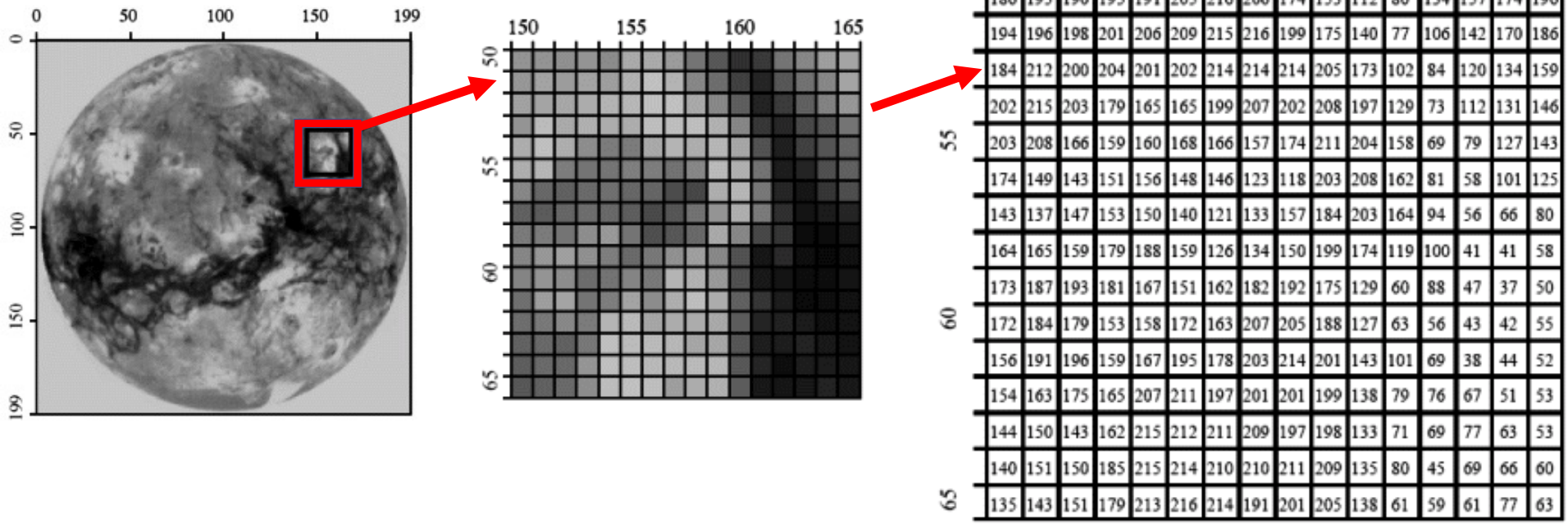
Doğrusal Olmayan İfadeler



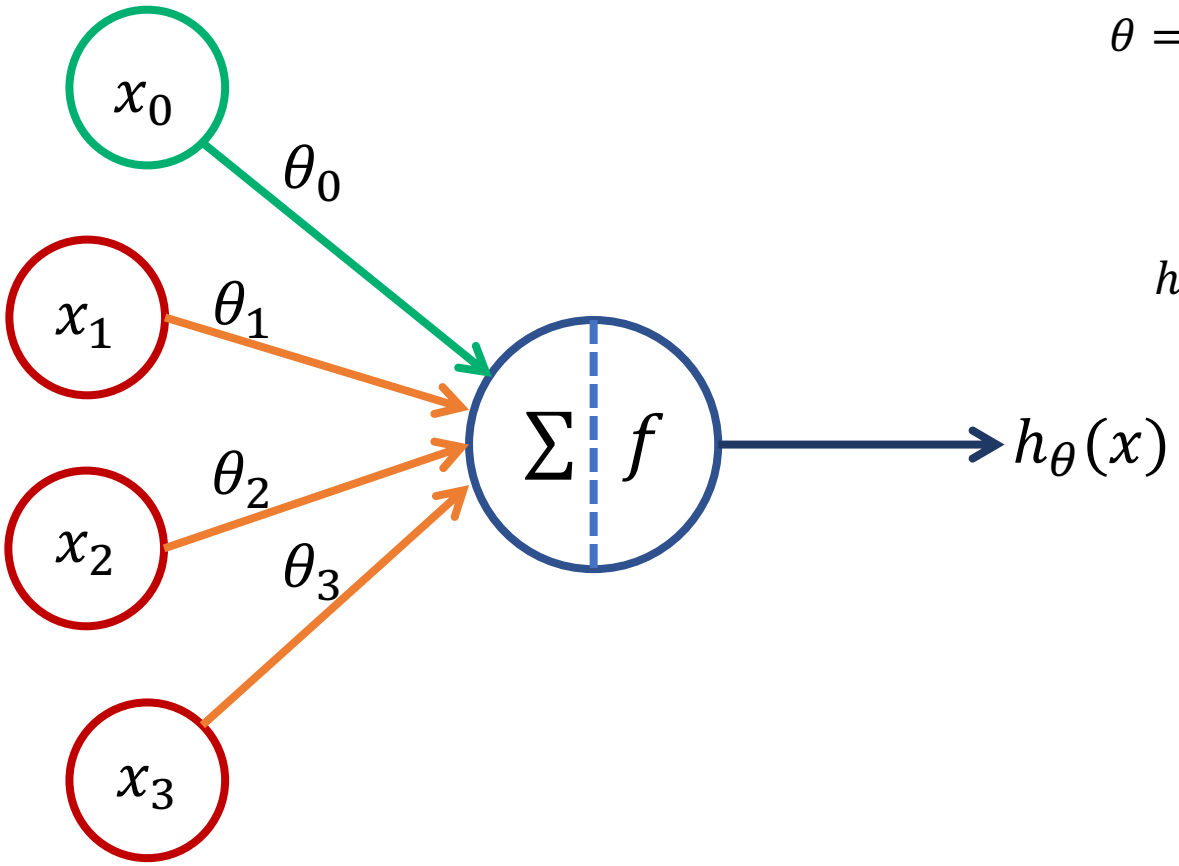
$$\sigma(\theta_0 + \theta_1 x_1 + \theta_2 x_2 + \theta_3 x_1 x_2 + \theta_4 x_1^2 + \theta_5 x_2^2 + \theta_6 x_1^2 x_2 + \cdots) \qquad O(?)$$

Doğrusal Olmayan İfadeler



	150	155	160	165
50	183 183 181 184 177 200 200 189 159 135 94 105 160 174 191 196			
	186 195 190 195 191 205 216 206 174 153 112 80 134 157 174 196			
	194 196 198 201 206 209 215 216 199 175 140 77 106 142 170 186			
55	184 212 200 204 201 202 214 214 214 205 173 102 84 120 134 159			
	202 215 203 179 165 165 199 207 202 208 197 129 73 112 131 146			
	203 208 166 159 160 168 166 157 174 211 204 158 69 79 127 143			
	174 149 143 151 156 148 146 123 118 203 208 162 81 58 101 125			
60	143 137 147 153 150 140 121 133 157 184 203 164 94 56 66 80			
	164 165 159 179 188 159 126 134 150 199 174 119 100 41 41 58			
	173 187 193 181 167 151 162 182 192 175 129 60 88 47 37 50			
	172 184 179 153 158 172 163 207 205 188 127 63 56 43 42 55			
	156 191 196 159 167 195 178 203 214 201 143 101 69 38 44 52			
65	154 163 175 165 207 211 197 201 201 199 138 79 76 67 51 53			
	144 150 143 162 215 212 211 209 197 198 133 71 69 77 63 53			
	140 151 150 185 215 214 210 210 211 209 135 80 45 69 66 60			
	135 143 151 179 213 216 214 191 201 205 138 61 59 61 77 63			

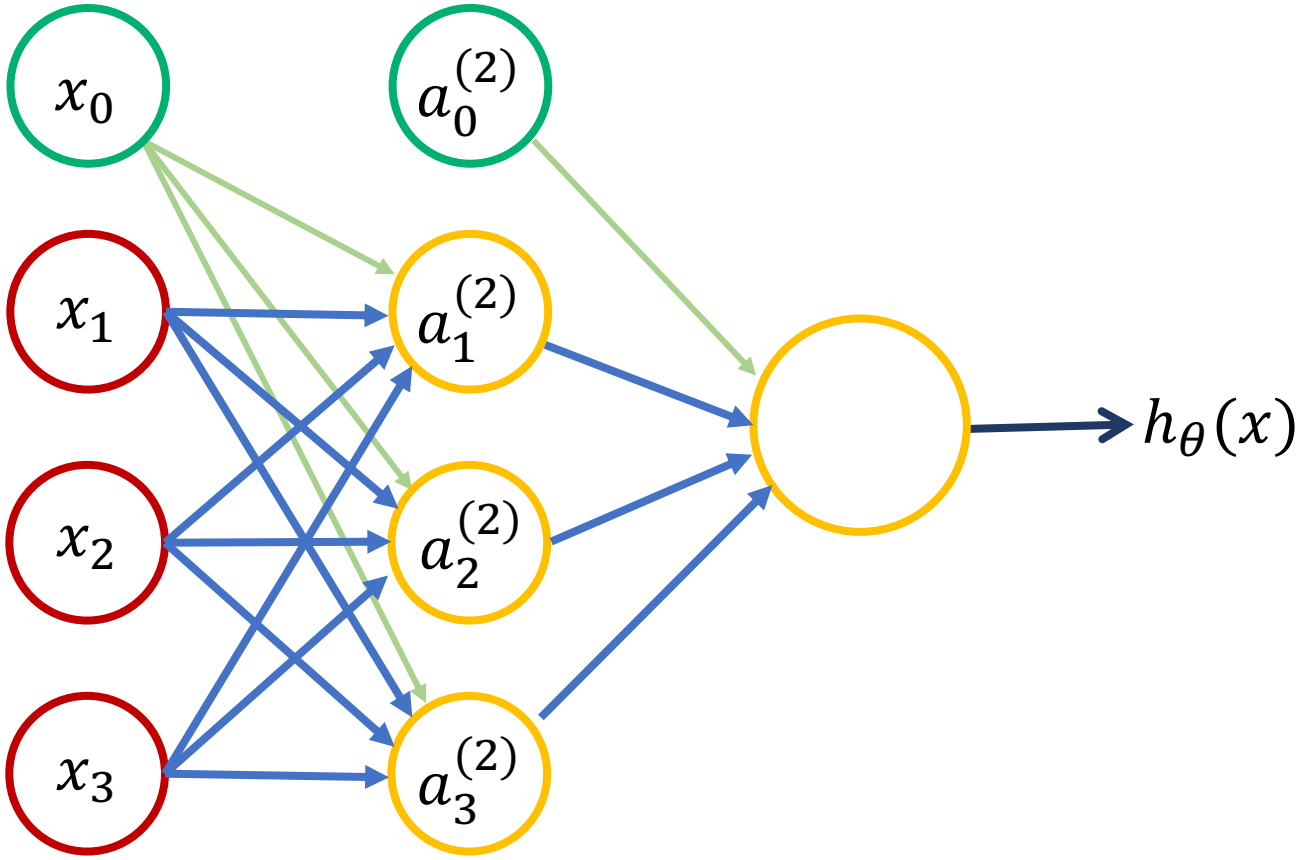
Nöron (Lojistik Birim)



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

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

Yapay Sinir Ağı (Neural Network)

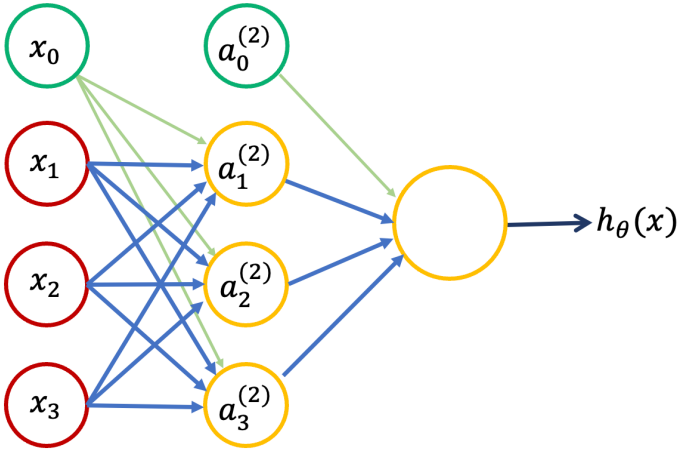


Katman 1
(Giriş Katmanı)

Katman 2
(Gizli Katman)

Katman 3
(Çıkış Katmanı)

Yapay Sinir Ağı (Neural Network)



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

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

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

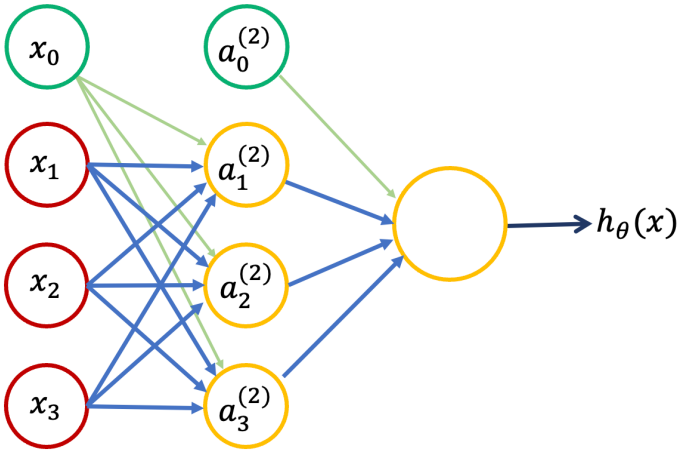
$$a_2^{(2)} = g(\Theta_{20}^{(1)} x_0 + \Theta_{21}^{(1)} x_1 + \Theta_{22}^{(1)} x_2 + \Theta_{23}^{(1)} x_3)$$

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

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

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

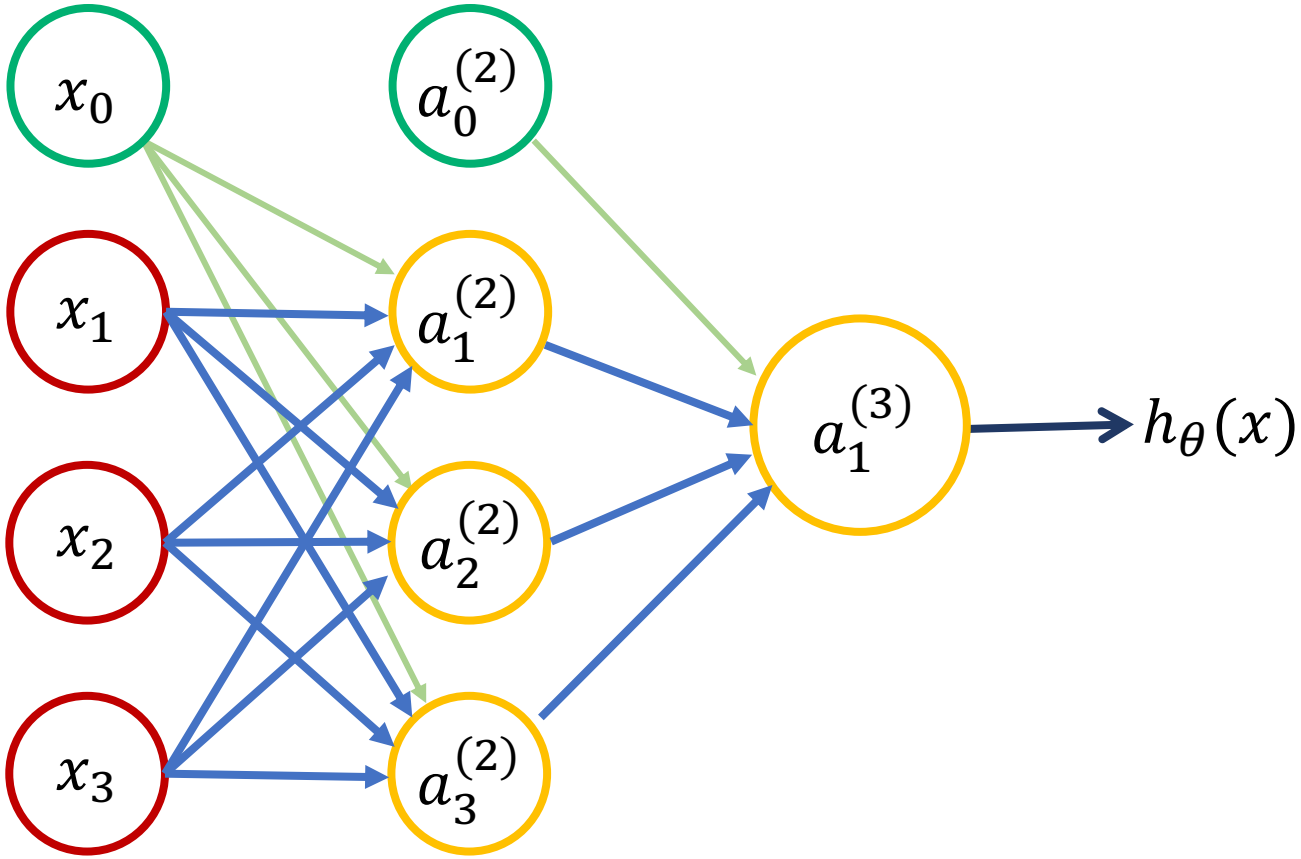
İleri Yayılma (Vektörleştirme)



$$a^{(1)} = x$$
$$z^{(2)} = \Theta^{(1)} a^{(1)}$$
$$a^{(2)} = g(z^{(2)})$$
$$a_0^{(2)} = 1$$
$$z^{(3)} = \Theta^{(2)} a^{(2)}$$
$$h_\theta(x) = a^{(3)} = g(z^{(3)})$$

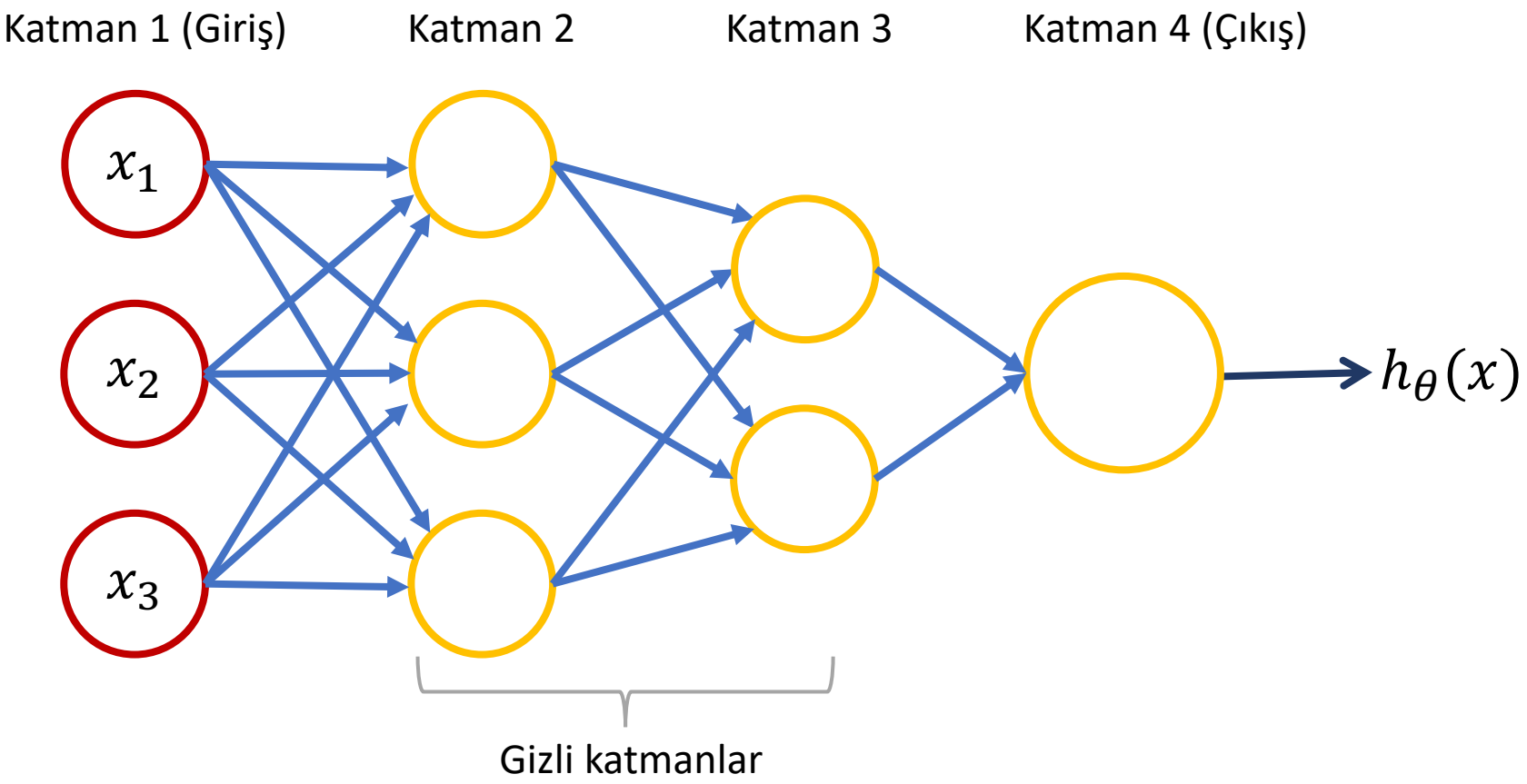
$$a_1^{(2)} = g(\Theta_{10}^{(1)} x_0 + \Theta_{11}^{(1)} x_1 + \Theta_{12}^{(1)} x_2 + \Theta_{13}^{(1)} x_3)$$
$$a_2^{(2)} = g(\Theta_{20}^{(1)} x_0 + \Theta_{21}^{(1)} x_1 + \Theta_{22}^{(1)} x_2 + \Theta_{23}^{(1)} x_3)$$
$$a_3^{(2)} = g(\Theta_{30}^{(1)} x_0 + \Theta_{31}^{(1)} x_1 + \Theta_{32}^{(1)} x_2 + \Theta_{33}^{(1)} x_3)$$
$$h_\theta(x) = a_1^{(3)} = g(\Theta_{10}^{(2)} a_0^{(2)} + \Theta_{11}^{(2)} a_1^{(2)} + \Theta_{12}^{(2)} a_2^{(2)} + \Theta_{13}^{(2)} a_3^{(2)})$$

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)

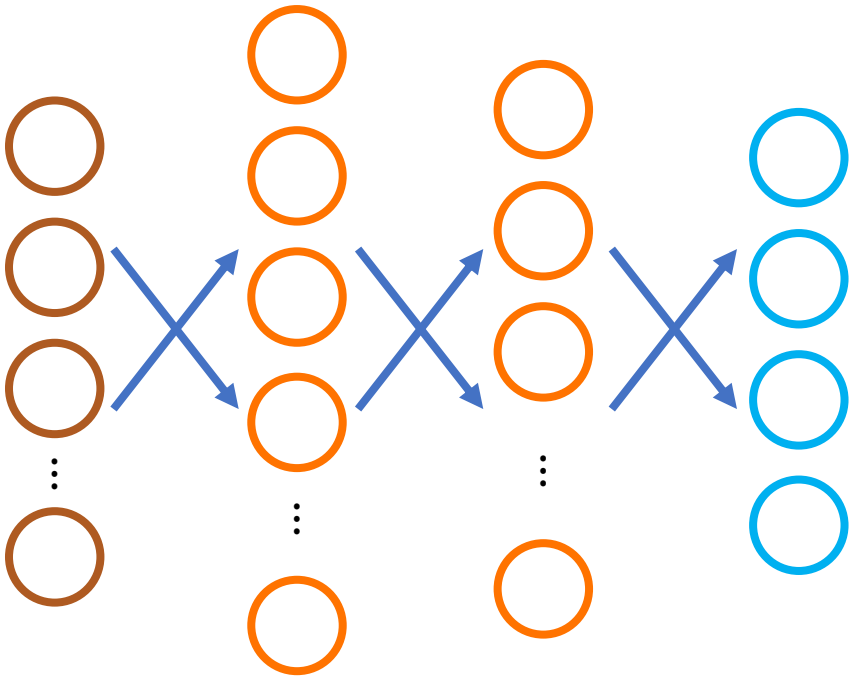
XNOR Çözümü (OR)

XNOR Çözümü (NOT)

XNOR Çözümü (NOT x_1 AND NOT x_2)

YSA ile Çoklu Sınıflandırma

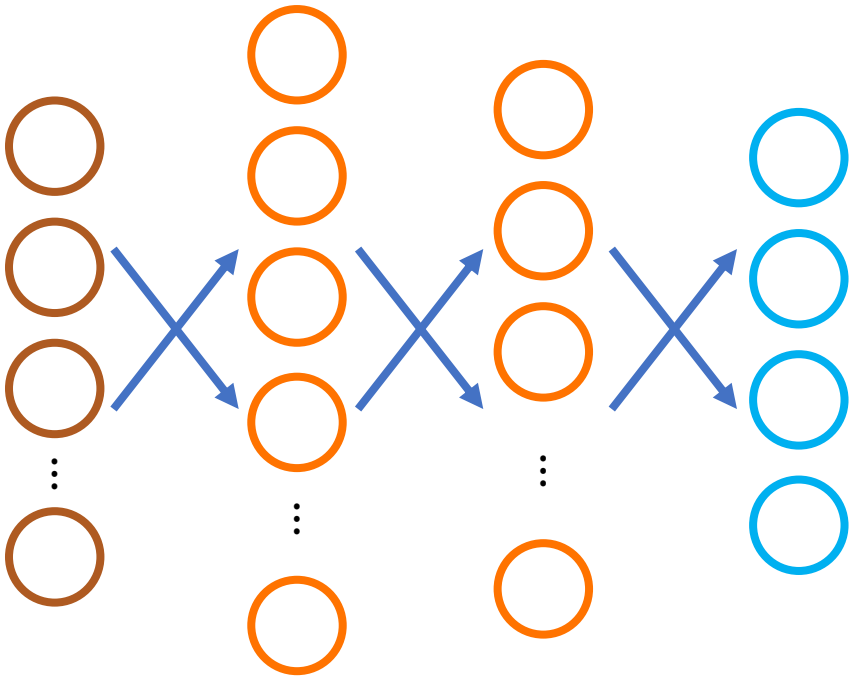
Kedi: 1, Civciv: 2, Tavşan: 3, Sincap: 4



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

YSA ile Çoklu Sınıflandırma

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



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