天善智能
TIANSHAN SOFT

AI深度学习之自然语言处理顶级实战课程

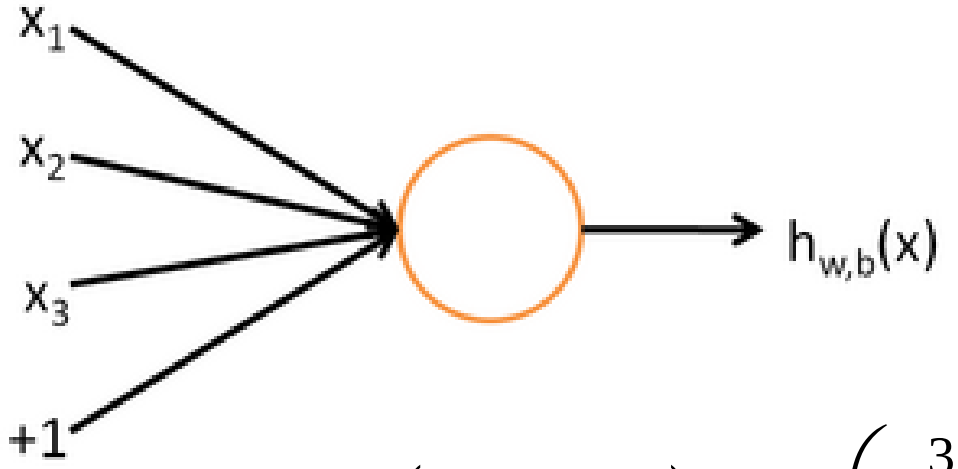
七、深度学习之卷积神经网络

讲师：aopu

自我介绍

- 天善商业智能和大数据社区**aopu** 讲师
- 天善社区ID- **aopu**主页
- https://www.hellobi.com – 学习过程中有任何相关的问题都可以提到技术社区 人工智能 版块。

7、1 神经元



x1、x2 和x3为输入，+1为偏置

$$h_{W,b}(x) = f(W^T x, b) = f\left(\sum_{i=1}^{3} W_i x_i + b\right)$$

F，w，b分别为激活函数，权重，偏置；F常用激活函数有sigmoid，Relu和tanh等。

$$\tanh(z) = f(z) = \frac{e^z - e^{-z}}{e^z + e^{-z}};\quad f'(z) = 1 - (f(z))^2$$

$$sigmoid(z) = f(z) = \frac{1}{1 + e^{-z}};\quad f'(z) = f(z)(1 - f(z))$$

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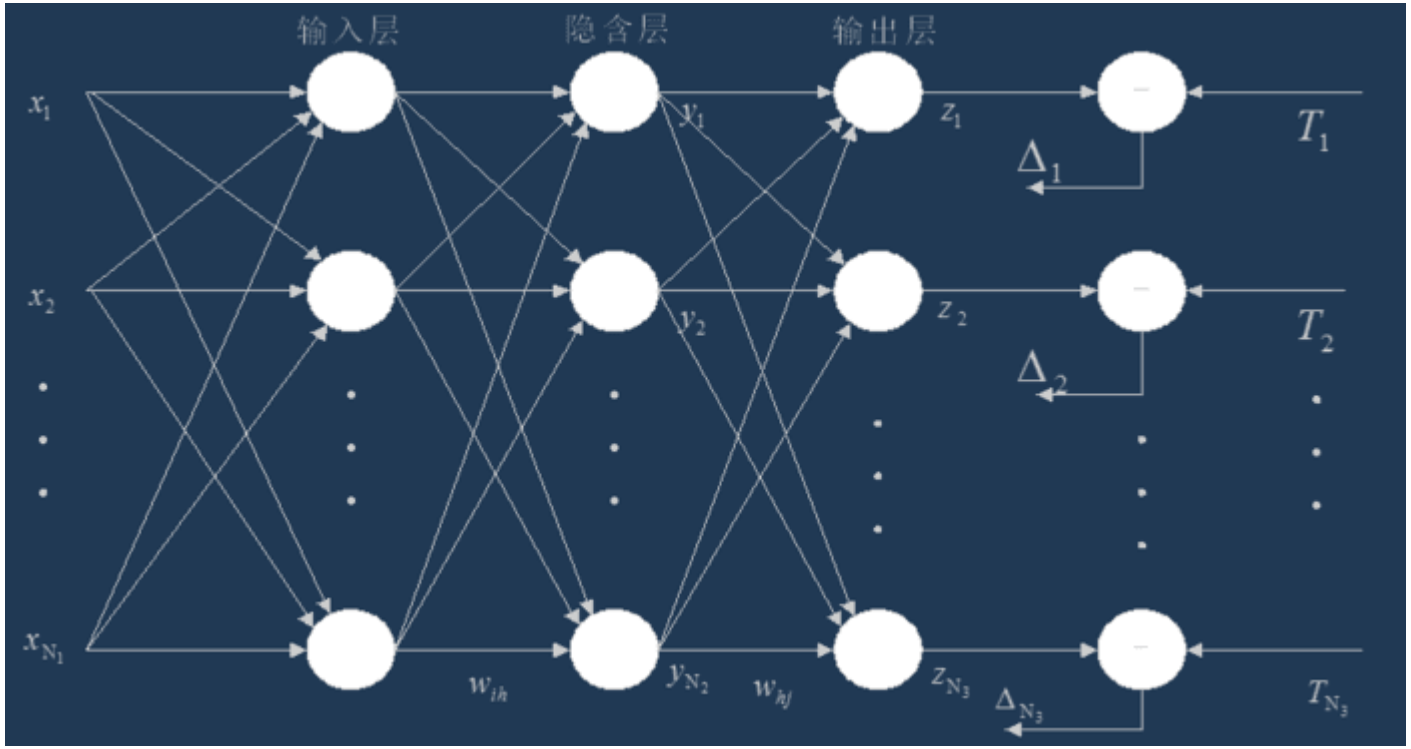

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- 输出层误差

$$E=\frac{1}{2}(d-O)^2=\frac{1}{2}\sum_{k=1}^{\ell}(d_k-O_k)^2$$

隐层的误差

$$E=\frac{1}{2}\sum_{k=1}^{\ell}(d_k-f(net_k))^2=\frac{1}{2}\sum_{k=1}^{\ell}\left(d_k-f\left(\sum_{j=1}^{m}w_{jk}y_j\right)\right)$$

输入层误差

$$E=\frac{1}{2}\sum_{k=1}^{\ell}d_k-f\left[\sum_{j=0}^{m}w_{jk}f(net_j)\right]^2=\frac{1}{2}\sum_{k=1}^{\ell}d_k-f\left[\sum_{j=0}^{m}w_{jk}f\left(\sum_{i=1}^{n}\upsilon_{ij}x_i\right)\right]^2$$

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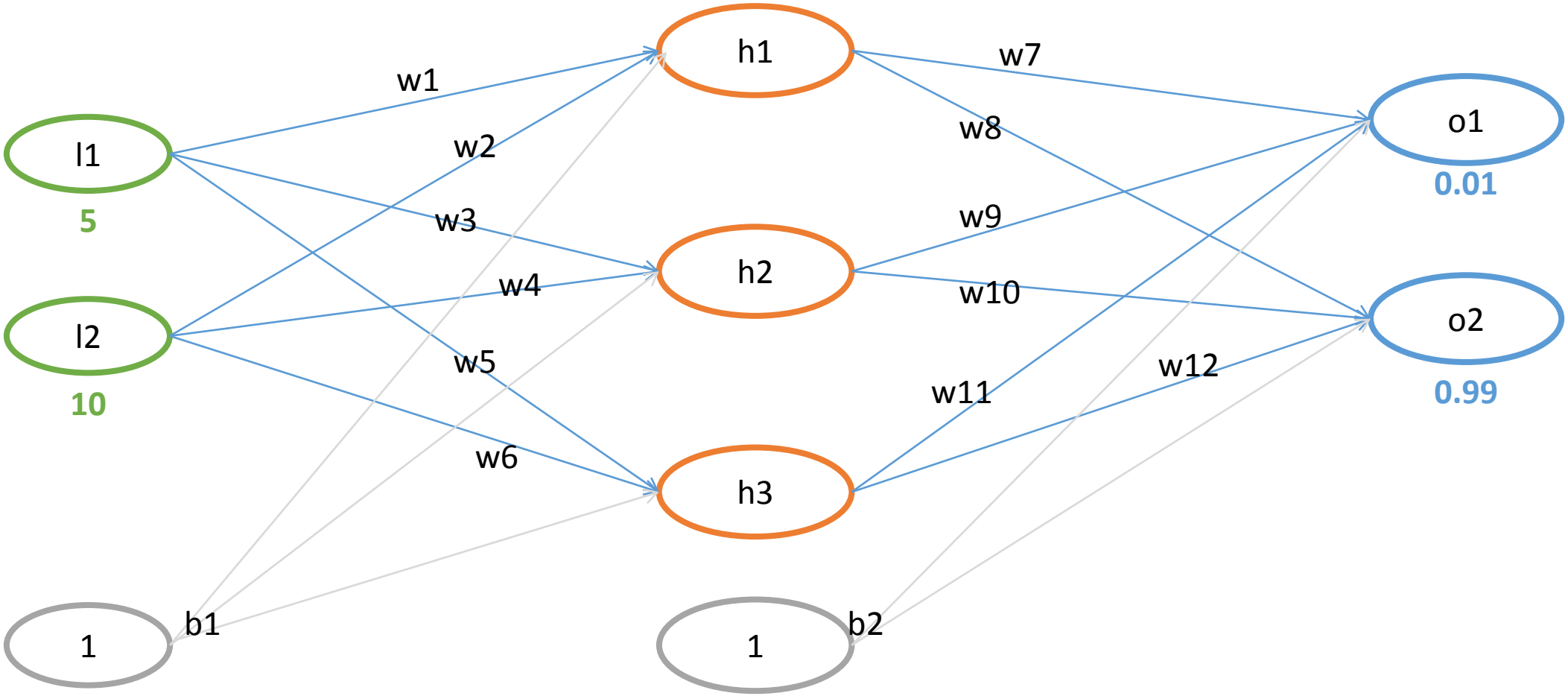

$$w=(0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45,0.5,0.55,0.6,0.65)$$

$$b=(0.35,0.65)$$

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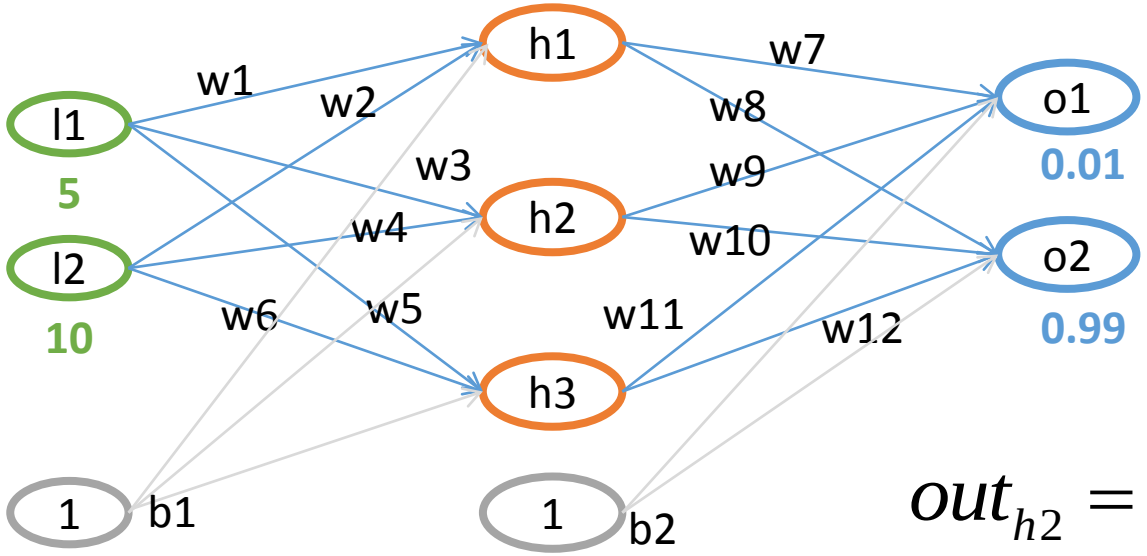

$$net_{h1} = w_1 * l_1 + w_2 * l_2 + b_1 * 1$$

$$net_{h1} = 0.1*5 + 0.15*10 + 0.35*1 = 2.35$$

$$out_{h1} = \frac{1}{1+e^{-net_{h1}}} = \frac{1}{1+e^{-2.35}} = 0.912934$$

$$out_{h2} = 0.979164 \qquad out_{h2} = 0.995275$$

$$b = (0.35, 0.65) \qquad net_{o1} = w_7 * out_{h1} + w_9 * out_{h2} + w_{11} * out_{h3} + b_2 * 1$$

$$w = \begin{pmatrix} 0.1,0.15,0.2,0.25,0.3,0.35, \\ 0.4,0.45,0.5,0.55,0.6,0.65 \end{pmatrix}$$

$$net_{o1} = 0.4*0.912934 + 0.5*0.979164 + 0.6*0.995275 = 2.1019206$$

$$out_{o1} = \frac{1}{1+e^{-net_{o1}}} = \frac{1}{1+e^{-2.1019206}} = 0.891090 \qquad out_{o2} = 0.904330$$

$$E_{total} = E_{o1} + E_{o2} = \frac{1}{2}(0.01 - 0.891090)^2 + \frac{1}{2}(0.99 - 0.904330)^2 = 0.391829$$

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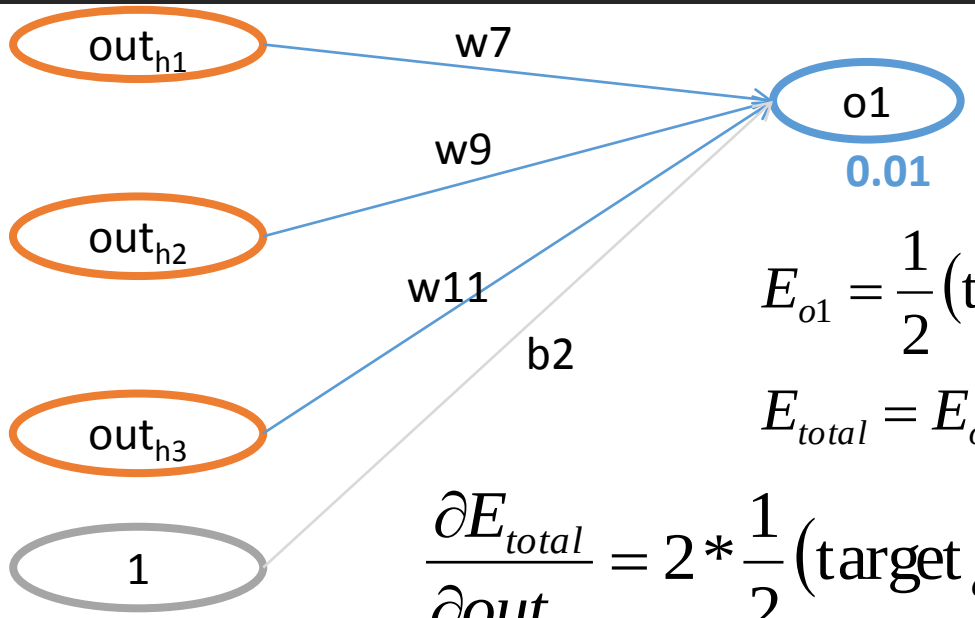

$$E_{o1} = \frac{1}{2}(\text{target}_{o1} - out_{o1})^2$$

$$E_{total} = E_{o1} + E_{o2}$$

$$\frac{\partial E_{total}}{\partial w_7} = \frac{\partial E_{total}}{\partial out_{o1}} * \frac{\partial out_{o1}}{\partial net_{o1}} * \frac{\partial net_{o1}}{\partial w_7}$$

$$\frac{\partial E_{total}}{\partial out_{o1}} = 2 * \frac{1}{2}(\text{target}_{o1} - out_{o1})^{2-1} * -1 + 0 = -(0.01 - 0.891090) = 0.88109$$

$$out_{o1} = \frac{1}{1 + e^{-net_{o1}}}$$

$$\frac{\partial out_{o1}}{\partial net_{o1}} = out_{o1}(1 - out_{o1}) = 0.891090(1 - 0.891090) = 0.097049$$

$$net_{o1} = w_7 * out_{h1} + w_9 * out_{h2} + w_{11} * out_{h3} + b_2 * 1$$

$$\frac{\partial net_{o1}}{\partial w_7} = 1 * out_{h1} * w_7^{(1-1)} + 0 + 0 + 0 = 0.912934$$

$$\frac{\partial E_{total}}{\partial w_7} = 0.88109 * 0.097049 * 0.912934 = 0.078064$$

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$$\frac{\partial E_{total}}{\partial w_1}=\frac{\partial E_{total}}{\partial out_{h1}}*\frac{\partial out_{h1}}{\partial net_{h1}}*\frac{\partial net_{h1}}{\partial w_1}=\left(\frac{\partial E_{o1}}{\partial out_{h1}}+\frac{\partial E_{o2}}{\partial out_{h1}}\right)*\frac{\partial out_{h1}}{\partial net_{h1}}*\frac{\partial net_{h1}}{\partial w_1}$$

$$\frac{\partial E_{o1}}{\partial out_{h1}}=\frac{\partial E_{o1}}{\partial out_{o1}}*\frac{\partial out_{o1}}{\partial net_{o1}}*\frac{\partial net_{o1}}{\partial out_{h1}}=-\left(\text{target}_{o1}-out_{o1}\right)*out_{o1}*\left(1-out_{o1}\right)*w_7$$

$$\frac{\partial E_{o1}}{\partial out_{h1}}=-\left(0.01-0.891090\right)*0.891090*\left(1-0.891090\right)*0.360968=0.030866$$

$$\frac{\partial E_{total}}{\partial w_1}=0.011204$$

$$w_1^{+}=w_1+\Delta w_1=w_1-\eta\frac{\partial E_{total}}{\partial w_1}=0.1-0.5*0.011204=0.094534$$

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$$w_1^+ = 0.094534 \qquad w_2^+ = 0.139069 \qquad w_3^+ = 0.198211$$

$$w_4^+ = 0.246422 \qquad w_5^+ = 0.299497 \qquad w_6^+ = 0.348993$$

$$w_7^+ = 0.360968 \qquad w_8^+ = 0.453383 \qquad w_9^+ = 0.458137$$

$$w_{10}^+ = 0.553629 \qquad w_{11}^+ = 0.557448 \qquad w_{12}^+ = 0.653688$$

$$b_1 = 0.35 \qquad b_2 = 0.65$$

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- 第10次迭代结果: $O=(0.662866,0.908195)$

.第100次迭代结果: $O=(0.073889,0.945864)$

.第1000次迭代结果: $O=(0.022971,0.977675)$

$$w^0=\begin{pmatrix}0.1,0.15,0.2,0.25,\\0.3,0.35,0.4,0.45,\\0.5,0.55,0.6,0.65\end{pmatrix}$$

$$w^{1000}=\begin{pmatrix}0.214925,\ 0.379850,\ 0.262855,\\0.375711,\ 0.323201,\ 0.396402,\\-1.48972,\ 0.941715,\ -1.50182,\\1.049019,\ -1.42756,\ 1.151881\end{pmatrix}$$

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