



$$\tanh(0+0) = 0$$

$$\tanh(0+1) = \tanh(1+0) \approx 0.76$$

$$\tanh(1+1) \approx 0.96$$

x	\rightarrow	y
$(0,0)$	\rightarrow	0
$(1,0)$	\rightarrow	$-1 + 2 \times 0.76 = 0.52 > 0$
$(0,1)$	\rightarrow	$= -0.08$
$(1,1)$	\rightarrow	$-2 + 2 \times 0.96 < 0$

FFNN

$$\begin{bmatrix} 2.4 & 0.8 & -1 \\ 1.8 & 2 & -0.7 \\ 0 & -0.6 & 0.4 \end{bmatrix} \begin{matrix} W \\ f(x) \\ \end{matrix} = \begin{bmatrix} 2.2 \\ 3.1 \\ -0.6 \end{bmatrix} \begin{matrix} \text{health} \\ \text{sports} \\ \text{science} \end{matrix}$$

$W_{\text{health}}^T [2.4, 0.8, -1]$, $W_{\text{sports}}^T [1.8, 2, -0.7]$, $W_{\text{science}}^T [0, -0.6, 0.4]$

$$\text{softmax} \left(\begin{bmatrix} 2.2 \\ 3.1 \\ -0.6 \end{bmatrix} \right) = \begin{bmatrix} 0.21 \\ 0.77 \\ 0.02 \end{bmatrix} \begin{matrix} \text{health} \\ \text{sports} \\ \text{science} \end{matrix}$$

$P(y|x)$
exponentiate then normalize

$$\text{softmax}(Wf(x)) = P(y|x)$$

$$e_{i^*} \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$$

gold label

$$L(x, i^*) = \log P(y=i^*|x) = \log(\text{softmax}(Wz) \cdot e_{i^*})$$

$$= \log \left(\frac{\exp(Wz) \cdot e_{i^*}}{\sum_j \exp(Wz) \cdot e_j} \right)$$

$$\Sigma = g(Vf(x))$$

$\begin{matrix} \nearrow R^{d \times 1} \\ \nwarrow R^{d \times n} \quad \nearrow R^{n \times 1} \end{matrix}$

$$\frac{\partial L}{\partial V_{ij}} = \frac{\partial L}{\partial \Sigma} \cdot \frac{\partial \Sigma}{\partial V_{ij}}$$

$\begin{matrix} [1 \dots d] [1 \dots n] \\ R^{1 \times d} \quad R^{d \times 1} \end{matrix}$

$$= \frac{\partial g(a)}{\partial a} \frac{\partial a}{\partial V_{ij}}$$

$$a = Vf(x)$$

$$\frac{\partial \Sigma}{\partial V} \quad R^{d \times n}$$