f(a) $\tanh(x) = \dfrac{e^{x}-e^{-x}}{e^{x}+e^{-x}}$

Quotient Rule

$$\frac{d}{dx}\left(\frac{e^{x}-e^{-x}}{e^{x}+e^{-x}}\right) = \frac{(e^{x}+e^{-x})(e^{x}+e^{-x})}{(e^{x}+e^{-x})^{2}} - \frac{(e^{x}-e^{-x})(e^{x}-e^{-x})}{(e^{x}+e^{-x})^{2}}$$

$$= 1 - \left(\frac{e^{x}-e^{-x}}{e^{x}+e^{-x}}\right)^{2}$$

$$\frac{e^{x}-e^{-x}}{e^{x}+e^{-x}} = \tanh(x)$$

$$= 1 - [\tanh(x)]^{2}$$

$$\frac{d\tan(x)}{dx} = 1 - [\tanh(x)]^{2}$$

b) $\mathrm{ReLu}(x) = \max(0, x)$

$$\frac{d\,\mathrm{ReLu}(x)}{dx} = \begin{cases} 0 & \text{if } x \leq 0 \\ 1 & \text{if } x > 0 \end{cases}$$

0 is undefined

1.2

$$o = w_0 + w_1(x_1 + x_1^2) + \dots + w_n(x_n + x_n^2)$$

$$\frac{dE}{dw_1} = \sum (out_x - o_x)\frac{d}{dw_1}(out - (w_0 + w_1 x_{ix} + w_1 x_{ix}^2 + \dots$$

$$+ w_n x_{nx} + w_n x_{nx}^2)) = \sum_{x \in X} (out_x - o_x)(-x_{ix} - x_i^2$$

1.3

a)

$$y_5 = h(h((w_{31})(x_1) + (w_{32})(x_2)) \circ w_{53} + h((w_{41})(x_1) + (w_{42})(x_2)) \circ w_{54})$$

b)

$$Y_5 = h(W^{(2)} h(W^{(1)} X))$$

c) $h_s(x) = \frac{1}{1+e^{-x}}$ $\qquad h_{(t)}(x) = \frac{e^x - e^{-x}}{e^x + e^{-x}}$

$$h_t(x) = \frac{e^x - e^{-x} + (e^{-x} - e^{-x})}{e^x + e^{-x}} = \frac{e^x + e^{-x}}{e^x + e^{-x}} - \frac{2e^{-x}}{e^x + e^{-x}}$$

$$= 1 - \frac{2}{e^x(e^x + e^{-x})} = 1 - \frac{2}{e^{2x}+1}$$

$h_s(x)$ symmeteric over orgin

$$1 - h_s(x) = h_s(-x)$$

$$1 - \frac{1}{1+e^{-x}} = \frac{1}{1+e^x}$$

$$h_t(x) = 1 - 2h_s(-2x)$$

$$= 1 - 2(1 - h_s(2x))$$

$$h_t(x) = 2h_s(2x) - 1$$

1.4 $E(\vec{w}) = \frac{1}{2}\sum_{d \in D}\sum_{k \in outputs}(t_{kd} - o_{kd})^2 + \gamma\sum_{i,j} w_{ji}^2$

γ - constant

$\cancel{w_{ji} \quad w_{ji}} - [illegible] (t_{kd} - o_{kd}) \quad \cancel{+2\gamma \sum_{i,j} w_{ji}}$

$$w_{ji} = w_{ji} + \eta\delta_j x_{ji} + 2\gamma\sum_{i,j} w_{ji}$$