

$$1) \quad y = \ln(x + \sin(x))$$

$$\boxed{y' = (x + \sin(x))^{-1} (1 + \cos(x))}$$

$$y = \sin(x + e^x)$$

$$\boxed{y' = \cos(x + e^x) (1 + e^x)}$$

$$2) \quad E = \frac{1}{2} \sum_n (t_n - y_{5n})^2 \quad \text{Find } \frac{\partial E}{\partial w_{13}}.$$

$$\delta_{5j} = t_j - y_{5j}$$

$$\delta_{4j} = f_4' \sum_n w_{5nj} \cdot \delta_{5n}$$

$$\delta_{3j} = f_3' \sum_n w_{4nj} \cdot \delta_{4n}$$

$$\delta_{2j} = f_2' \sum_n w_{3nj} \cdot \delta_{3n}$$

$$\delta_{1j} = f_1' \sum_n w_{2nj} \cdot \delta_{2n}$$

$$\frac{\partial E}{\partial w_{13}} = \delta_{17} y_{03}$$

3) Forward Propagate:

$$S_1 = (-0.7)(-1.7) + (1.2)(0.1) = 1.31$$

$$h_1 = [1 + e^{-1.31}]^{-1} = 0.7875$$

$$S_2 = (1.1)(-0.6) + (-2)(-1.8) = 2.94$$

$$h_2 = [1 + e^{-2.94}]^{-1} = 0.9498$$

$$S_3 = 0.7875 + 0.9498 = 1.7373$$

$$\hat{y} = [1 + e^{-1.7373}]^{-1} = 0.8503$$

$$L_2 = (0.8503 - 0.5)^2 = 0.1227$$

Back Propagate:

$$\frac{\partial L_2}{\partial \hat{y}} = 2(\hat{y} - y) = 2(0.8503 - 0.5) = 0.7007$$

$$\frac{\partial \hat{y}}{\partial S_3} = \hat{y}(1 - \hat{y}) = 0.8503(1 - 0.8503) = 0.1273$$

$$\frac{\partial S_3}{\partial h_1} = w_5 = -0.2$$

$$\frac{\partial h_1}{\partial S_1} = h_1(1 - h_1) = 0.7875(1 - 0.7875) = 0.1673$$

$$\frac{\partial S_1}{\partial w_1} = x_1 = -0.7$$

$$\frac{\partial L}{\partial w_1} = (0.7007)(0.1273)(-0.2)(0.1673)(-0.7) = \boxed{0.002089}$$