2.a

$$\frac{\partial L_n(\omega, x_n, y_n)}{\partial \omega_i} = [\sigma(\omega, x_n) - y_n] \cdot \frac{\partial \sigma(\omega, x_n)}{\partial \omega_i}.$$

$$\boxed{L_n = \frac{1}{2}[\sigma(\omega, x_n) - y_n]^2.} \qquad \boxed{\sigma(\omega, x_n) = \frac{1}{1+e^{-\omega^T x}}}$$

$$\frac{\partial \sigma(\omega, x_n)}{\partial \omega_i} = \frac{\partial\left[(1+e^{-\omega^T x_n})^{-1}\right]}{\partial \omega_i} = -\left(1+e^{-\omega^T x_n}\right)^{-2} \cdot \frac{\partial\left(e^{-\omega^T x_n}\right)}{\partial \omega_i}$$

$$= -\left(1+e^{-\omega^T x_n}\right)^{-2} \cdot \frac{\partial\left(e^{-\sum \omega_i x_i}\right)}{\partial \omega_i} = -\left(1+e^{-\omega^T x_n}\right)^{-2} \cdot \left(-x_i e^{-\sum \omega_i x_i}\right)$$

$$\cancel{= \frac{x_i}{1+e^{-\omega^T x_n}}} = \frac{x_i e^{-\sum \omega_i x_i}}{1+e^{-\omega^T x_n}} = x_i \sigma(\omega, x_n) \cdot \frac{e^{-\sum \omega_i x_i}}{1+e^{-\omega^T x_n}}$$

$$= x_i \cdot \sigma(\omega, x_n) \cdot \frac{e^{-\omega^T x_n}}{1+e^{-\omega^T x_n}} = x_i \cdot \sigma(\omega, x_n) \cdot \frac{1+e^{-\omega^T x_n} - 1}{1+e^{-\omega^T x_n}}$$

$$= x_i \sigma(\omega, x_n) \cdot \left[1 - \frac{1}{1+e^{-\omega^T x_n}}\right] = \underline{x_i \cdot \sigma(\omega, x_n) \cdot [1 - \sigma(\omega, x_n)]}$$

So:

$$\underline{\underline{\frac{\partial L_n(\omega, x_n, y_n)}{\partial \omega_i} = [\sigma(\omega, x_n) - y_n] \cdot x_i \cdot \sigma(\omega, x_n) \cdot (1 - \sigma(\omega, x_n))}}$$