T1 $\prod_{n=1}^{N} P(y_n|x_n)$.

$$= -\frac{1}{N} \ln\left(\prod_{n=1}^{N} P(y_n|x_n)\right)$$

$$= \frac{1}{N} \ln\left(\frac{1}{P(y_n|x_n)}\right)$$

$$P(y_n|x_n) = \theta(y_n w^T x)$$

$$= \frac{1}{N} \sum_{n=1}^{N} \ln\left(\frac{1}{\theta(y_n w^T x_n)}\right)$$

$$= \frac{1}{N} \sum_{n=1}^{N} \ln\left(\frac{1+e^{y_n w^T x_n}}{e^{y_n w^T x_n}}\right)$$

$$= \frac{1}{N} \sum_{n=1}^{N} \ln\left(1+e^{-y_n w^T x_n}\right)$$

$$= E_{in}$$

$$E_{in}(w) = \frac{1}{N}\sum_{n=1}^{N} \ln\left(1 + e^{-y_n w^T x_n}\right)$$

$$\nabla E_{in}(w) \quad \frac{d(\ln x)}{dx} = \frac{1}{x}$$

$$\nabla E_{in}(w(t)) = \frac{d\left(\ln\left(1 + e^{-y_n w^T x_n}\right)\right)}{d\left(1 + e^{-w^T y_n x_n}\right)}$$

$$= \frac{1}{1 + e^{-y_n w^T x_n}}$$

$$\frac{d\left(1 + e^{-w^T y_n x_n}\right)}{dw}$$

$$= 0 - y_n x_n e^{-y_n w^T x_n}$$

$$\nabla E_{in}(w(t)) = \frac{1}{N}\sum_{n=1}^{N} \frac{-y_n x_n e^{-y_n w^T x_n}}{1 + e^{-w^T y_n x_n}}$$

$$= \frac{1}{N} \sum_{n=1}^{N} -y_n x_n \theta(-y_n w^T x_n)$$