

Exercise 2

Machine Learning in Graphics & Vision

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1 Task 1

- (a) Classification accuracy of the initialized model on the test dataset is 0.5
- (b) Loss of the initialized model is 0.7149616252170096.
- (c) In the first step of derivation we use the chain rule and the fact that $f'_w(x) = f_w(x)(1 - f_w(x))$.

$$\begin{aligned}\frac{\partial L(\mathbf{x}, t, \mathbf{w})}{\partial \mathbf{w}} &\stackrel{(1)}{=} \frac{1}{N} \sum_{n=1}^N \left[-t_n \frac{1}{f_w(\mathbf{x}_n)} f_w(\mathbf{x}_n)(1 - f_w(\mathbf{x}_n)) \mathbf{x}_n + (1 - t_n) \frac{1}{1 - f_w(\mathbf{x}_n)} f_w(\mathbf{x}_n)(1 - f_w(\mathbf{x}_n)) \mathbf{x}_n \right] \\ &= \frac{1}{N} \sum_{n=1}^N [-t_n(1 - f_w(\mathbf{x}_n)) \mathbf{x}_n + (1 - t_n) f_w(\mathbf{x}_n) \mathbf{x}_n] \\ &= \frac{1}{N} \sum_{n=1}^N [(-t_n + t_n f_w(\mathbf{x}_n) + f_w(\mathbf{x}_n) - t_n f_w(\mathbf{x}_n)) \mathbf{x}_n] \\ &= \frac{1}{N} \sum_{n=1}^N [f_w(\mathbf{x}_n) - t_n] \mathbf{x}_n\end{aligned}$$

(1)

$$\begin{aligned}\frac{\partial f_w(x)}{\partial x} &= \frac{\partial}{\partial x} \left(\frac{1}{1 + e^{-\mathbf{w}^T \mathbf{x}}} \right) = \frac{e^{-\mathbf{w}^T \mathbf{x}}}{(1 + e^{-\mathbf{w}^T \mathbf{x}})^2} = \frac{1 + e^{-\mathbf{w}^T \mathbf{x}} - 1}{(1 + e^{-\mathbf{w}^T \mathbf{x}})^2} = \frac{1}{(1 + e^{-\mathbf{w}^T \mathbf{x}})} - \frac{1}{(1 + e^{-\mathbf{w}^T \mathbf{x}})^2} \\ &= \frac{1}{(1 + e^{-\mathbf{w}^T \mathbf{x}})} \left(1 - \frac{1}{(1 + e^{-\mathbf{w}^T \mathbf{x}})} \right) = f_w(\mathbf{w}^T \mathbf{x})(1 - f_w(\mathbf{w}^T \mathbf{x}))\end{aligned}$$

After 1,000 iterations the loss and accuracy of the model are:

loss = 0.3868595564299156

accuracy = 0.83

(d)

(e)

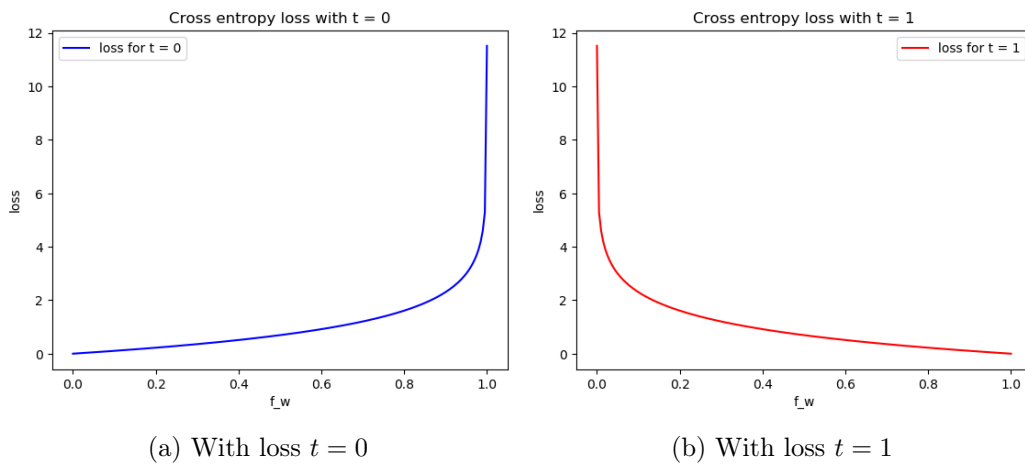


Figure 1: Plot of results from task (d)