

COMP9444

Neural Networks and Deep Learning

Term 2, 2024



Week 2 Tutorial: Backpropagation

1. **Do you have any questions from the first tutorial? Discuss them with your tutor.**

Note: The solution of Week 1 tutorial (Sample solution along with video) are released on WebCMS. Please watch the video to know solution to all questions of Tutorial 1 in details.

2. **Simple Gradient Descent by Hand**

Consider the simplest possible machine learning task:

Solve $f(x) = wx$ such that $f(1) = 1$, i.e., $f(x) = t$, for $x = 1, t = 1$.

We can solve this by gradient descent using the loss function $E = \frac{1}{2}(wx - t)^2$, with a learning rate $\eta = 0.5$ and initial value $w = 0$.

- (a) Perform the first epoch of training by completing this table:

$$w = 0$$

$$x = 1$$

$$f(x) = ?$$

$$E = ?$$

$$\frac{\partial E}{\partial w} = ?$$

$$w \leftarrow w - ? = ?$$

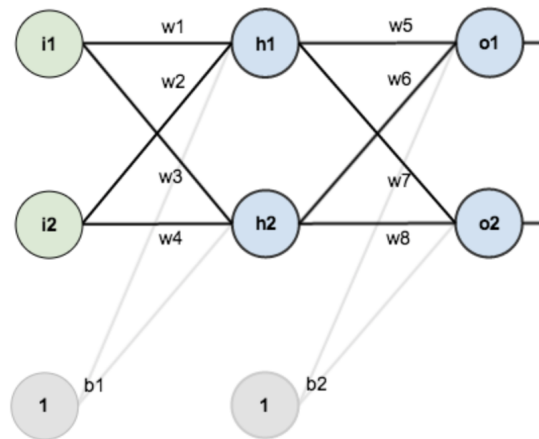
- (b) Repeat these calculations for the second epoch.
- (c) Use the code provided in the Exercise in Lesson 2b on Ed to explore what happens for different values of the learning rate. Discuss your findings in class.

3. **Understanding Backpropagation**

For the given 2-layer network (see figure on the next page) with initial weights and learning rate (η) of 0.5, try to calculate by hand the forward and the backward pass to understand how backpropagation works. Consider a single training set having inputs ($i_1 = 0.05, i_2 = 0.10$) with target values of ($out_{o1} = 0.01, out_{o2} = 0.99$).

$$w_1 = 0.15, w_2 = 0.20, w_3 = 0.25, w_4 = 0.30$$

$$w_5 = 0.40, w_6 = 0.45, w_7 = 0.50, w_8 = 0.55$$



$$b_1 = 0.35, b_2 = 0.60$$

4. Any Other Questions

Any further questions or discussion about PyTorch, other parts of the course, or broader implications of deep learning.