

# Big Data in Experimental Physics: NN

TAs

August 23, 2020

## 1 Back propagation

As README.md has explained, the computation process is

$$\begin{aligned}v^{(1)} &= W^{(1)}v^{(0)} \\v^{(2)} &= \text{ReLU}(v^{(1)}) \\v^{(3)} &= W^{(2)}v^{(2)}\end{aligned}$$

The loss is computed in the following way

$$E = \frac{1}{2} \sum_i (v_i^{(3)} - y_i)^2$$

To minimize the loss, we can use derivative to update the weights as  $E$  is a function of all weights. The gradient for all the weights can be obtained in a way similar to the following process.

$$\begin{aligned}\frac{\partial E}{\partial v^{(3)}_i} &= v_i^{(3)} - y_i \\ \frac{\partial E}{\partial W_{i,j}^{(2)}} &= \frac{\partial E}{\partial v^{(3)}_i} \frac{\partial v_i^{(3)}}{\partial W_{i,j}^{(2)}} \\ &= \frac{\partial E}{\partial v^{(3)}_i} v_j^{(2)} \\ \frac{\partial E}{\partial v_j^{(2)}} &= \sum_i \frac{\partial E}{\partial v_i^{(3)}} \frac{\partial v_i^{(3)}}{\partial v_j^{(2)}} \\ &= \sum_i \frac{\partial E}{\partial v_i^{(3)}} W_{i,j}^{(2)}\end{aligned}$$

As for the ReLU function,

$$\frac{\partial v_i^{(2)}}{\partial v_i^{(1)}} = \begin{cases} 1 & v_i^{(1)} > 0 \\ 0 & v_i^{(1)} \leq 0 \end{cases}$$

The second half of the problem is to compute

$$\text{argmax}_{i,j} \left| \frac{\partial E}{\partial W_{i,j}^{(1)}} \right|$$