Neural Information Processing Coursework

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This report has an aim to implement Neural network algorithm and Machine Learning concepts that focus on understanding basic theories about neural network and how brain works for delivering information. Moreover, the paper discusses some intuition for how the algorithms are related to the brain.

1 Question 1

This supervised learning algorithm works well by updating weights, which is changed by backpropagation algorithm. First step, feedforward, should calculate output based on input data with weights and activation functions. After calculate output, now it is possible to know about output error, which is the result of target subtracted by output. With this error, we can get modified weights through Delta Rule that is based on back propagation derivation. If the processes are repeated many times, loss function will be decreased. In conclusion, there are some steps to get output and modify weights through repetitive training. Here are some graphs that is recorded such as weights and loss function.

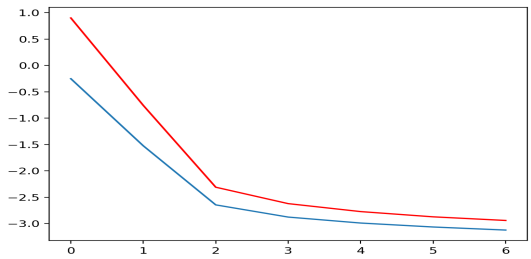

Figure 1: *Two weights of AND gate*

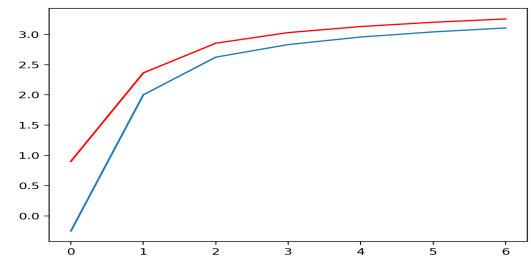

Figure 2: *Two weights of OR gate*

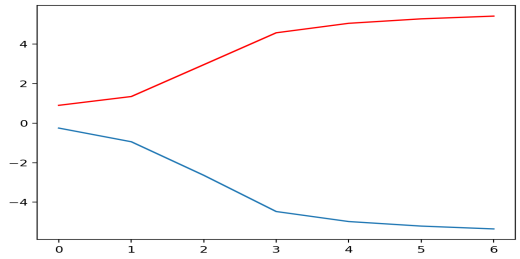

Figure 3: *Two weights of XOR gate*

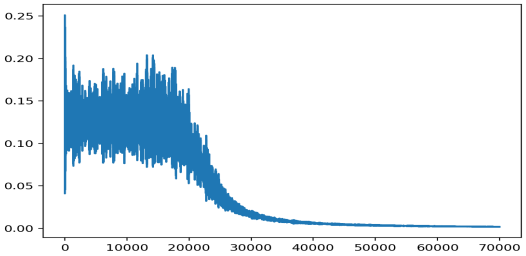

Figure 4: *Loss function*

Above graphs are weights recordings from AND, OR and XOR gates. Depending on the gates, weights look different. Weights is changed even though initial weights is made randomly, because derivative backpropagation find out a suitable value from gradient descent method. To explain more intuitive way, for example, logic gates from the experiment have same input data such as (0,0), (0,1), (1,0), (1,1), but different outputs depends on type of gates. Above each gates' graph data converge into different ways. Even though changing weights are different, each loss function is decreasing. It means, the different changes per each gate are reasonable, and it shows us that this changing have an important role to decrease error rate.

2 Question 2

The supervised learning algorithm seems to mimic the brain. Vital neural networks reinforce the connection called synapses between neurons and neurons that are often used or frequently involved in decision making, and they solve problems faster and more efficiently than ever before when the same problems are given later. In a broad sense, it can be said to be 'adaptation',

and from a human point of view, it is 'learning'. This is called "neural plasticity." Neuronal plasticity or synaptic plasticity is a very comprehensive concept. Following this mechanism, the machine also changes the weight of the synapse, the connection between neurons in a pre-designed neural network. When a child learns for the first time, the parent or the teacher tells the teacher to answer the problem next to the teacher, to let the teacher know the answer, and to study it repeatedly. It is good if the child is right. If child is wrong, it tells him again. The machine is learned by notifying the problem and the correct answer through tens of thousands of times such as XOR (1,0) = 1 and XOR (0,0) = 0. Therefore, supervised learning is part of the brain that is in charge of learning something with answer called Cerebellum. Main role of Cerebellum is learning with answers and fixing errors through the feed forward and feedback function.

Even though the algorithm is related to the brain, there are also some points that are not similar actions comparing to the brain. First, the neural network that I implemented with two functions, feedforward and backpropagation, is not operated in our brain separately (Richards and Lillicrap, 2018). Separate functions work for training as a supervised learning, but it is not exactly same function that the brain does, which means that there is no any strong evidence. Second, different gap between the brain and neural network algorithm is that the way backpropagation is operated. Backpropagation of the brain delivery only local information, but all information contributes to fix front side of weights in algorithm. Furthermore, backpropagation has derivative activation function, but in the brain we do not know how activation function works. Due to the weak evidences that the algorithm is copied like the brain, it has researched to make the algorithm closer to the brain.

3 Question 3

Supervised learning can distinguish different classes perfectly using exact decision boundary, so it is suitable algorithm for classification tasks. Furthermore, the number of classes for classification tasks can be chosen by human. To make data for supervised learning, it needs a label, which means that the answer is clear, so it can make high quality of data. This algorithm's way of training is intuitive and simple, so it is useful the case that simple goal for specific analysis. After finish training, it does not need examples, but need some mathematical formula. Furthermore, it is enough for new inputs to predict and fix weights. One of other advantages is that it includes backpropagation that can fix error between an output and an answer data. However, unsupervised learning and reinforcement algorithms do not usually use backpropagation algorithm.

4 Question 4

During supervised learning, if training has progressed too much called overfitting, it cannot distinguish or judge for right answers. Furthermore, it is hard to get a lot of data with labelled by human, because it takes a lot of time to do this. In this case, data balance that can train fairly for classification tasks is important as that can be likely to get bias after training. In contrast, unsupervised learning and reinforcement learning is do not need to labelling the data.

5 References

Richards, B.A. and Lillicrap, T.P., 2019. Dendritic solutions to the credit assignment problem. Current opinion in neurobiology, 54, pp.28-36.