

C. Complexity Analysis

In the field of complexity analysis of methods in deep learning, three key items can be considered for evaluating and comparing the efficiency of algorithms. These items include MACC, activations, and RAM usage [9]. For the MNIST dataset, we consider that we have three layers with the size of 784, 500, and 500 neurons, respectively. The number of parameters is calculated as follows:

$$\begin{aligned} \text{Weights} &= 784 \times 500 + 500 \times 500 = 642000 \\ \text{Biases} &= 500 + 500 = 1000 \\ \text{Parameters} &= \text{Weights} + \text{Biases} = 643000 \end{aligned} \quad (9)$$

In the Forward-Forward and the backpropagation algorithm, the activations' size for each sample is:

$$\begin{aligned} \text{activations}_{FF} &= \text{Max}(784, 500, 500) \\ &= 784\text{Byte} \simeq 0.8KB \end{aligned} \quad (10)$$

$$\begin{aligned} \text{activations}_{BP} &= 784 + 500 + 500 \\ &= 1.784\text{Byte} \simeq 1.8KB \end{aligned} \quad (11)$$

The RAM usage of the Forward-Forward and the backpropagation algorithm for each sample is:

$$\begin{aligned} \text{RAM}_{FF} &= \text{Parameters} + \text{activations}_{FF} \\ &= 643 + 0.8 = 643.8KB \end{aligned} \quad (12)$$

$$\begin{aligned} \text{RAM}_{BP} &= \text{Parameters} + \text{activations}_{BP} \\ &= 644 + 0.8 = 644.8KB \end{aligned} \quad (13)$$

The activations_{FF} is less than activations_{BP} and this affects the efficiency of RAM usage in the Forward-Forward algorithm. For the other datasets like CIFAR10 and Fashion-MNIST, a similar procedure can be followed for the calculation of the RAM usage in both algorithms.