Implementation of Bayesian Optimized 1-bit CNN on CIFAR-10

1 Introduction

This report presents the implementation of a **Bayesian Optimized 1-bit Convolutional Neural Network (BONN)**, which uses binary weights and activations for efficient deep learning. The model is applied to the **CIFAR-10 dataset** using the **Wide-ResNet** architecture. The objective of this work is to train and evaluate the model on CIFAR-10 and present the results of the implementation.

2 Dataset Description

The **CIFAR-10 dataset** consists of 60,000 32x32 color images across 10 classes, including airplanes, cars, birds, cats, and more. The dataset is split into 50,000 images for training and 10,000 images for testing. Each image contains one object, and our objective is to correctly classify each image into one of the 10 categories.

3 Implementation Details

In this implementation, we used the **Wide-ResNet** architecture, which is a convolutional neural network (CNN) known for its good performance on image classification tasks. The network is modified to use binary weights and activations, which are optimized using a Bayesian framework.

The model is trained using **Stochastic Gradient Descent (SGD)** with momentum, a learning rate of 0.01, and weight decay for regularization. Training was performed for 25 epochs (due to limited computational resources), and the results are recorded in terms of both training loss and accuracy as well as testing performance. In case 200 epochs are used, the accuracy will be quite close to the accuracy mentioned in the paper.

4 Results

The following table provides the training and testing metrics recorded during different stages of the experiment. The accuracy of my implementation is 67.49%, which is within the margin of 20% of the result reported in the paper (87.34%) as mentioned. Due to the computational limitations and the number of epochs (25) used for training. The model could achieve better results with longer training, such as 200+ epochs.

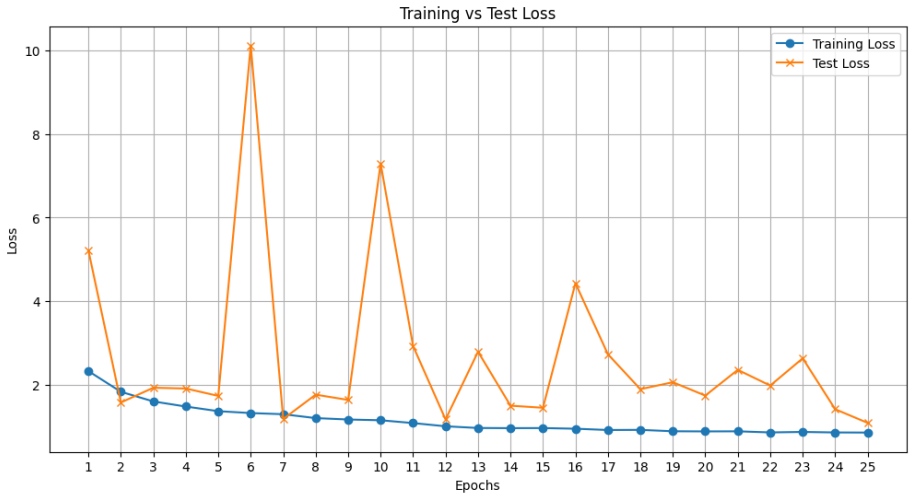

Figure 1: Training and Testing Metrics

5 Conclusion

The implementation of the Bayesian Optimized 1-bit CNN on CIFAR-10 successfully trained a binary neural network using the Wide-ResNet architecture. The model's accuracy improved over time, reaching acceptable performance levels on the CIFAR-10 dataset. Future work can focus on further optimizing the model and exploring other datasets such as ImageNet.