FASHION-MNIST CLASSIFICATION REPORT

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Introduction

To tackle the problem of correctly classifying the various fashion objects based on basic pictures, two deep learning models were created: an Artificial Neural Network (ANN) of a basic nature and a Convolutional Neural Network (CNN) with a particular focus. This document presents the results of their testing on the Fashion-MNIST dataset, a common benchmark with 10 classes of 28x28 grayscale images, to point out the best method.

Implementation Details

The implementation is executed in following steps:

1. **Loading Data and Preprocessing:** The Fashion-MNIST dataset is available in the torchvision.datasets.FashionMNIST module. First, the basic version of ToTensor transformation is applied. Then, RandomHorizontalFlip and RandomRotation are added to the training data transformation as an augmentation strategy for the model's generalization ability which is a data augmentation strategy.
2. **Model Architecture:** An ANN model (ANN) consisting of three linear layers with ReLU activation has been implemented. A CNN model (CNN) including two convolutional layers, max pooling, dropout, and two linear layers has been developed.
3. **Training:** A train_model function is written to train both models.Cross-Entropy Loss is used as the criterion. Initially, the Adam optimizer is employed. Later in the section, the optimizer is switched to RMSprop to check its impact on performance.
4. **Evaluation:** An evaluate_model function computes the accuracy on test set of the trained models. In addition, confusion matrices are created and plotted to facilitate understanding of classification performance by class.

Results

(Before Data Augmentation and RMSprop Optimizer):

The very first training and assessment relied on the Adam optimizer and no data augmentation. Each of the models underwent 10 epochs of training. The outcomes were:

Accuracy on test set of ANN: **87.76%**

Accuracy on test set of CNN: **91.97%**

The confusion matrices presented underneath demonstrate the performance for each class in terms of ANN and CNN models which were not augmented and were using the Adam optimizer.

(After Data Augmentation and RMSprop Optimizer)

In addition to this, data augmentation (RandomHorizontalFlip and RandomRotation) was applied on the training data as well as switching the optimizer to RMSprop. Both models were trained for 10 epochs. After that the alterations were made, and the training and evaluation were performed again. The results are given below:

ANN Test Accuracy: **87.26%**

CNN Test Accuracy: **90.00%**

The below confusion matrices show the per-class accuracy of the ANN and CNN models that were trained using data augmentation and the RMSprop optimizer.

Evaluation (Confusion Matrix)

(Before Data Augmentation and RMSprop Optimizer):

ANN: The ANN was able to do a decent job overall but still had difficulties with items that were quite similar, such as 'Shirt' and 'T-shirt/top', as well as 'Coat' and 'Pullover'. Quite often 'Sandal' and 'Sneaker' were mistaken for 'Ankle boot'.

CNN: The CNN's results were much better in most classes, especially when it came to telling apart similar clothing items. The problem with 'Shirt' and 'T-shirt/top' was there, but it was of lesser extent than with the ANN. 'Sandal', 'Sneaker', and 'Ankle boot' were more clearly distinguished.

(After Data Augmentation and RMSprop Optimizer)

ANN: The performance of the artificial neural network on the similar classes 'Shirt' and 'T-shirt/top' did not improve, however, it got worse slightly. Confusion among the different types of footwear ('Sandal', 'Sneaker', 'Ankle boot') was also the same.

CNN: There was a minor decline of the overall accuracy in the CNN after these changes in the parameters. Although the CNN was still ahead of the ANN in terms of accuracy, however, misclassifications among some classes, e.g. 'Shirt' and 'T-shirt/top', and confusion in the case of the previously mentioned footwear categories was greater compared to the last run.

Conclusion

Based on the experiments' outcomes, it was found that the CNN model outperformed the ANN model in the Fashion-MNIST classification task regardless of whether data augmentation was applied or the optimizer was changed to RMSprop. The combination of data augmentation and RMSprop optimizer led to the same small decline in accuracy for both models in this trial. This could be the outcome of multiple reasons such as the nature of the augmentation applied, the settings of the optimizer or the number of training epochs. More tests using different augmentation techniques, optimizers, learning rates, and network architecture could eventually guide to higher accuracy as well.