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FASHION-MNIST CLASSIFICATION WITH ANN AND CNN MODELS

The report presented here provides a summary of the execution as well as the results of the classification of the Fashion-MNIST images via the use of Artificial Neural Networks (ANN) and Convolutional Neural Networks (CNN). The primary goal was to develop these two network architectures and then measure their performance through a standard image classification task.

OVERVIEW OF NEURAL NETWORK MODELS

Two neural network models were created:

Artificial Neural Network (ANN): A basic feedforward network consisting of three fully connected layers and employing ReLU activation functions. The input layer was flattened so that it corresponds to the 28x28 pixel image size.

Convolutional Neural Network (CNN): A network formed through the series of two convolutional layers, one max pooling layer, and two fully connected layers. Since this model captures spatial hierarchies, it is in general the best choice for image data.

MAJOR FINDINGS

The two models were subjected to training and testing with the Fashion-MNIST dataset. The accuracy and loss on the test set were the metrics to evaluate the performance.

Overall Accuracy (Initial Training):

ANN: 87.26%

CNN: 92.52%

Overall Accuracy (After Hyperparameter Tuning):

Best ANN Accuracy: 86.59% (Batch Size=32, LR=0.001, Optimizer=RMSprop)

Best CNN Accuracy: 91.34% (Batch Size=64, LR=0.001, Optimizer=RMSprop)

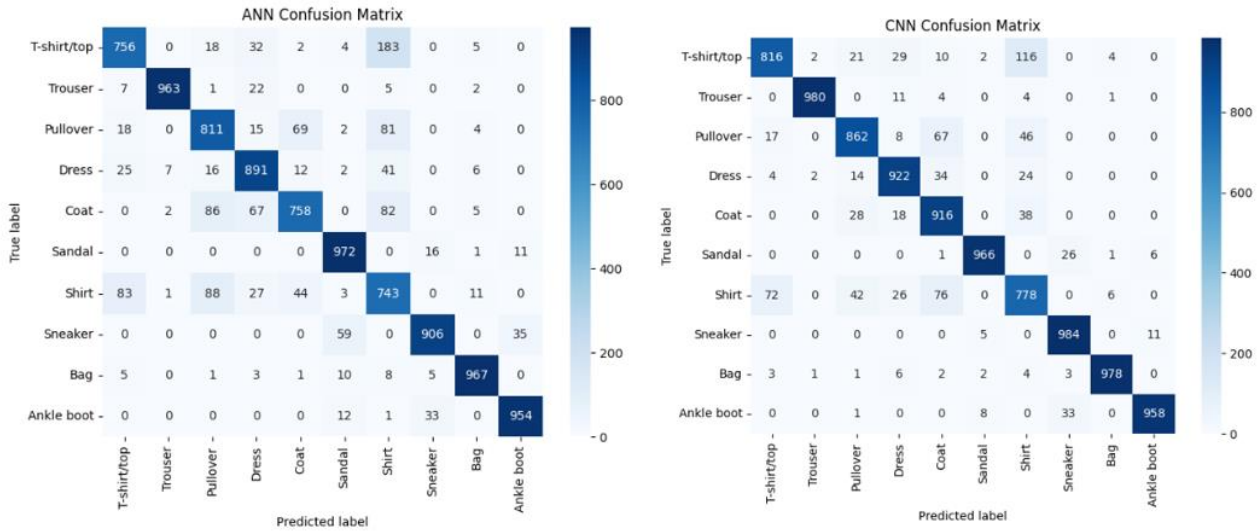
Performance Comparison: At each stage of the evaluation, the CNN model was always better than the ANN model in terms of accuracy. While the initial training showed slightly higher accuracies for both models, the hyperparameter tuning explored different configurations and identified optimal settings that could potentially lead to better performance with more epochs. This built-in analysis learning with a convolutional neural network (CNN) is the most liberal procedure in terms of the computational skill set for reasoning in the spatial domain.

NOTABLE INNOVATIONS

Hyperparameter adjustments brought about a new configuration even if the fundamental frameworks were similar.

Optimizer Selection and Hyperparameter Tuning: The performance of different batch sizes (32, 64), learning rates (0.01, 0.001), and optimizers (SGD, RMSprop) combinations was initially evaluated, and the results were noted. It was found that the ANN with Batch Size=32, LR=0.001, and RMSprop optimizer (86.59% accuracy) had the highest accuracy, while for the CNN the combination of Batch Size=64, LR=0.001, and RMSprop optimizer (91.34% accuracy) was the best. This highlights the point that tuning hyperparameters greatly influences the performance of the model.

Visualization Techniques: Confusion matrices were made for both models to see the classification performance for every class. This made it clear which classes were often mixed up by each model. For example, prior to hyperparameter tuning, the ANN model couldn't tell the difference between 'Shirt' and 'Coat' 44 times, whereas the CNN model made the same mistake 76 times. In case of hyperparameter tuning, the confusion matrices for the best models would be able to show the impact of these misclassifications very clearly.



CONCLUSIONS AND RECOMMENDATIONS

The research gives evidence to the fact that CNNs are to image classification tasks like Fashion-MNIST. It is crystal clear that extracting relevant spatial features is the main factor of their strength. To add another point, it can be said that hyperparameter tuning is of utmost importance in maximizing the model, while the choice of optimizer and learning rate can be very powerful. The confusion matrices were extremely useful in showing the performance of each class, the errors that happened most often, and the places where the model could be improved or data could be added. With the set of hyperparameters tested, the best CNN that performed well reached an accuracy of 91.34% on the test set, thus indicating its great power of telling apart the classes in the Fashion-MNIST dataset.