NEURAL SYSTEMS EXECUTIVE SUMMARY

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PROBLEM: One of the fundamental and most basic tasks in the field of computer vision is to accurately detect the clothing items in the photographs, and it has different applications like in online shopping, stock management, and fashion trend analysis. The image classification algorithms are usually tested on the Fashion-MNIST dataset, which is made up of the 28x28 grayscale images of 10 fashion categories. The aim of the project is to experiment and compare the overfitting as well as the drawbacks of several neural architectures on this dataset.

FINDINGS: Two distinct types of neural networks were used: the Artificial Neural Network (ANN) and the Convolutional Neural Network (CNN) which underwent the entire training and evaluation procedure.

Basic Models: The first implementations of both models were trained. The basic ANN's testing resulted in an accuracy of 87.69%, while the basic CNN test yielded 91.45%. The winner in terms of performance was the CNN, most probably due to its ability to effectively identify spatial hierarchies in the image data. The confusion matrices confirmed that both models had problems with the visually similar classes such as "Shirt," "Coat," and "Pullover," and they even showed considerable confusion between "T-shirt/top" and "Shirt."

Enhanced Models: The models were improved among others by using Batch Normalization, adding layers, and data augmentation (RandomHorizontalFlip and RandomRotation) as training methods. The increased ANN was given a test score of 88.92%, showing a 3.92% increase over its basic models. The upgraded CNN was awarded a test score of 92.02%, signifying a progress of 2.02% over its initial score. The enhanced CNN, by the margin of 3.10%, was still leading in performance over the enhanced ANN.

Here's a summary of the final test results:

Model	Accuracy (%)	Loss	Improvement from Baseline (%)
Enhanced ANN	**88.92**	**0.3049**	**+3.92**
Enhanced CNN	**92.02**	**0.2202**	**+2.02**

The meticulous confusion analysis of the enhanced models indicated that while both still tended to confuse similar classes, the enhanced CNN, in general, presented lower absolute confusion numbers and percentages for many of the difficult pairs as compared to the enhanced ANN. Thus, the enhanced CNN experienced less confusion between "Shirt" and "Pullover," "Coat" and "Pullover," and the footwear categories ("Sandal," "Sneaker," "Ankle boot"). But, the enhanced CNN had somewhat more confusion between "Shirt" and "Coat."

Here are the confusion matrices for the enhanced models:

Enhanced ANN and CNN Confusion Matrix:
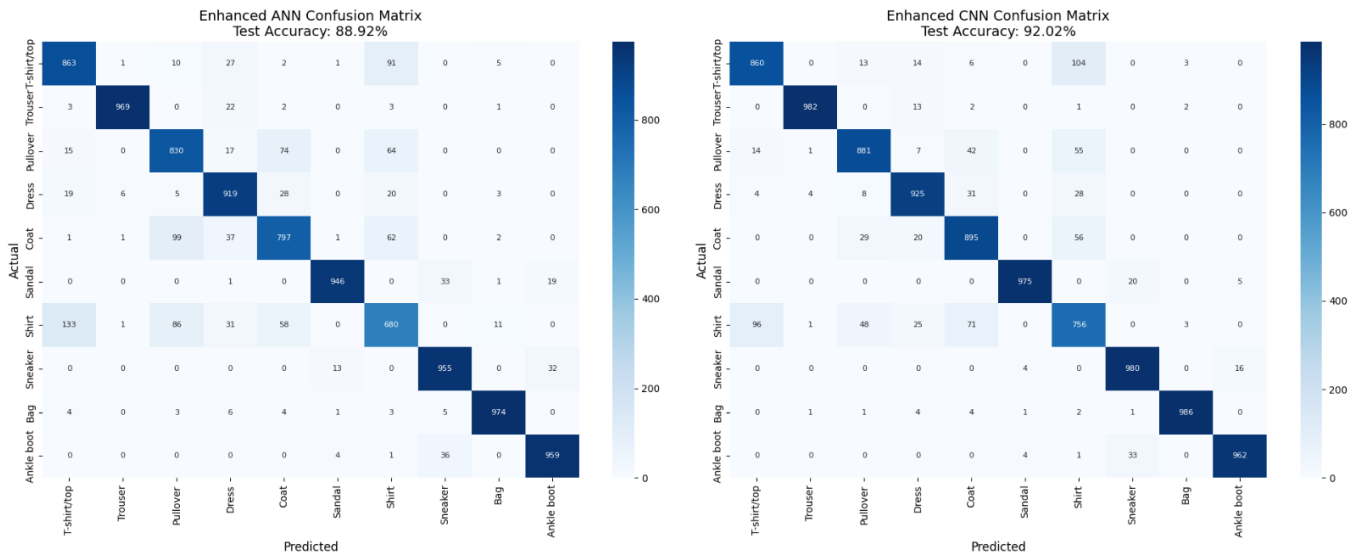
RECOMMENDATIONS: It is the proposal to utilize the Enhanced CNN model for Fashion-MNIST image classification that hinges upon the superior performance and better handling of visually similar classes. The enhanced ANN might have shown a good improvement, but the CNN architecture is fundamentally more capable of image data because of its spatial feature learning through convolutional layers.

The following course of actions could be taken:

- Testing the improved data augmentation methods with higher sophistication.
- Considering various CNN architectures like ResNet and VGG among others.
- The enhanced CNN model came through hyperparameter tuning for getting better results.
- The classes that are most frequently confused with each other ("Shirt", "T-shirt/top", "Coat", "Pullover") have been studied to possibly improve the discrimination between them using hard negative mining or more sophisticated loss functions.

CONCLUSION: The enhanced CNN model naturally was the best in performance on the Fashion-MNIST dataset with a test accuracy of 92.02%. Such improvements as, for instance, data augmentation together with the adoption of the complicated CNN architecture, proved to be helpful in terms of raising classification accuracy and also unconfusing the visually similar clothing items.