NS COURSEWORK EXECUTIVE SUMMARY

NAME: NANDAN KODI

P NO: P2937669

INTRODUCTION:

The manipulation will assess the Fashion category in the **Fashion-MNIST dataset** from the three different viewpoints while applying two different neural networks as classifiers: a basic **Artificial Neural Network (ANN)** and a complex **Convolutional Neural Network (CNN).** The main aim of the study is to perform a comparison that will reveal the strengths and weaknesses of ANN and CNN regarding the specific task. The entire process incorporates the essential machine learning steps like data preprocessing, model selection, and training. The meticulous evaluation of model performance is carried out using measures like test accuracy and confusion matrices. A summary of the findings highlighting the performance differences and proposing data-driven approaches to the innovation requirement of the course is provided at the end of the report.

EXPERIMENTAL METHODOLOGY:

The methodological approach began with preprocessing of the **Fashion-MNIST dataset**, which included normalization of pixel values and separating the data into distinct training, validation, and testing sets. Two main architectures were created: a simple Artificial Neural Network (ANN) and a more complex Convolutional Neural Network (CNN). At first a preliminary study was conducted to evaluate the impact of training duration where both models were trained for more epochs **10, 20, 30, 40 and 50** to see the trend in performance. After this preliminary investigation, a more systematic hyperparameter search procedure was employed to further improve performance. This consisted of testing separately a range of learning rates (**0.01, 0.001, and 0.0001**), different numbers of dense layer units (**64, 128, and 256**), and three activation functions (ReLU, Tanh, and Sigmoid).Each test had one parameter changed while the others were kept constant in order to accurately assess its effect on test accuracy. After determining the best performing value for each hyperparameter, final, optimized versions of the ANN and CNN were built. The process terminated with a thorough evaluation of those final models using confusion matrices for detailed error analysis and visualizations for peak classification performance comparison.

RESULT AND ANALYSIS:

An experiment performed to compare the performance of different training schedules was the first one to reveal the superior learning capability of the CNN. After **30 epochs**, the CNN's test accuracy reached its highest point of **0.9076**, which was a significant difference in contrast to the maximum performance of the ANN at **20 epochs** which was **0.8852**. This lead was maintained by a very careful process of tuning hyperparameters. The last tuned ANN got a test accuracy of **0.8781**. This was obtained by using the best parameters discovered - a learning rate of **0.0001** (which alone gave an accuracy of **0.8652**), **256** dense units (giving **0.8821** alone), and the 'relu' activation function (yielding **0.8828** alone). In contrast, the final tuned CNN returned a very different picture, and its final accuracy reached **0.9034**. The model was tuned with the best parameters: a learning rate of **0.001** (with individual parameter

0.8741), **256** dense units (with individual parameter **0.9067**), and a 'tanh' activation function (with individual parameter **0.9065**). The findings thus affirmed that the CNN architecture consistently yielded higher accuracy in classification, especially after going through thorough optimization.

Summary of Best Performance from Tuning Experiments

Hyperparameter Tuned	ANN Best Accuracy	ANN Optimal Value/Function	CNN Best Accuracy	CNN Optimal Value/Function
Epochs	0.8852	20	0.9076	30
Learning Rate	0.8652	0.0001(20)	0.8741	0.001(30)
Dense Units	0.8821	256(20)	0.9067	256(30)
Activation Function	0.8828	relu(20)	0.9065	tanh(30)

RECOMMENDATIONS:

The **Convolutional Neural Network (CNN)** is the clear winner model for the classification problem of Fashion-MNIST due to its unmatched precision from beginning to end and its improved speed after tuning. Any further use or higher-end application involving this dataset must be solely occupied by the CNN architecture to ensure the best possible results. Random rotations, flips, and zooms as **data augmentation** techniques will help the model to generalize more and thus pushing the model to go even further in its performance. Moreover, applying dropout regularization to the dense layers of the CNN will not only help to avoid **overfitting** but also might increase the test accuracy.

CONCLUSION:

The Convolutional Neural Network (CNN) has been clearly proven through the experimental results to be very good for this task. The CNN showed great accuracy in all its tests with a total of **0.9076** as its best performance in the first round of trials against **0.8852** being the best score for ANN. This difference in performance was supported with a thorough hyperparameter tuning process, during which the final optimized CNN got a test accuracy of **0.9034** and the best-tuned ANN was only able to reach **0.8781**. The conclusions generalize that even though hyperparameter tuning supplies tiny increments in performance, still the choice of network architecture is the most critical factor, and the CNN's design is already the best for getting high accuracy on the Fashion-MNIST image dataset.