Deep Learning Module

Deep Learning for Handwritten Digit Recognition using MNIST Dataset

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1. Data Loading and Preprocessing

We begin by loading the MNIST dataset from Keras, which provides a convenient interface to access various datasets, including MNIST. The dataset comprises 28x28 grayscale images of handwritten digits (0-9). We preprocess the data by normalizing the pixel values to a range of 0 to 1 and splitting it into training, validation, and testing sets.

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2. Baseline Model with Traditional Machine Learning Algorithms

As a baseline model, we start with logistic regression, a simple yet effective algorithm for classification tasks. We flatten the input data to fit the logistic regression model and evaluate its performance metrics on both validation and test sets.

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3. Ensemble of Machine Learning Algorithms

To enhance performance, we employ an ensemble approach using decision trees, random forest, and support vector machines (SVM) with soft voting. This ensemble model leverages the strengths of individual classifiers to improve overall accuracy.

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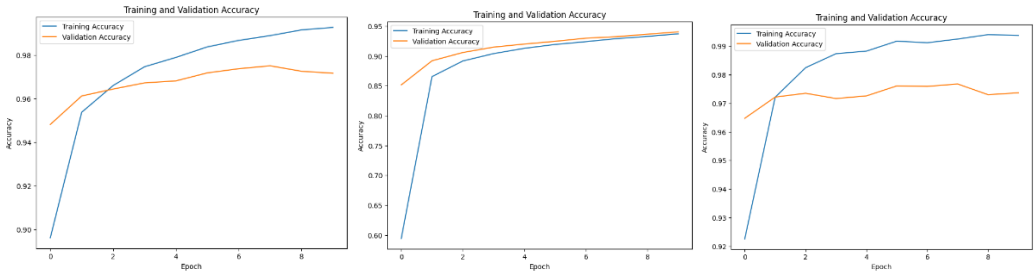
4. Neural Network Model Design

We design and compare three neural network architectures with varying complexities. Each model is trained on the MNIST dataset, and its performance is evaluated using metrics such as accuracy, precision, recall, and F1 score.



More details on the code

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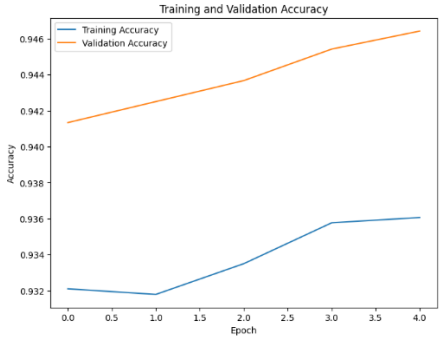
5. Hyperparameter Tuning and Overfitting Mitigation

To optimize the second model performance which was the best and mitigate overfitting, we employ hyperparameter tuning using Keras Tuner and incorporate dropout regularization. By tuning hyperparameters, we aim to improve model accuracy while preventing overfitting



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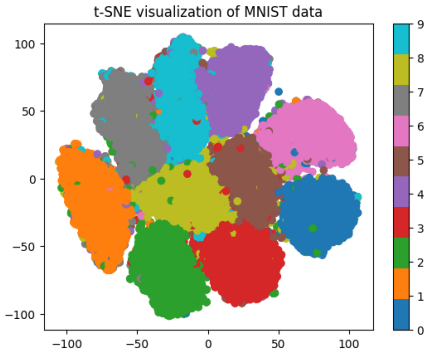
6. Feature Transformation and Visualization

We explore feature transformation techniques such as PCA for dimensionality reduction and visualize the high-dimensional MNIST data using t-SNE. These techniques provide insights into the underlying structure of the data and help in understanding the performance of machine learning models.



Conclusion

In this deep learning module, we implemented various machine learning and deep learning techniques for handwritten digit recognition using the MNIST dataset. Through thorough experimentation and analysis, we gained insights into model performance, hyperparameter tuning, and feature visualization. Our findings provide valuable knowledge for further advancements in the field of deep learning and pattern recognition.