Transfer Learning using MNIST dataset

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Outline

Introduction

Background

- The dataset we will use is the MNIST dataset, a classic dataset in the machine learning community, which has been around for almost as long as the field itself and has been very intensively studied.
- It is a set of 60,000 training images, plus 10,000 test images, assembled by the National Institute of Standards and Technology (the NIST in MNIST) in the 1980s.

Problem Statement

- The problem we are solving is to classify grayscale images of handwritten digits (28 pixels by 28 pixels) into their 10 categories (0 to 9) using Neural Networks.

Methodology

Data preprocessing

- We splitted the MNIST dataset into MNIST-Even and MNIST-Odd datasets. Table 5 represents the summary of image representation per class for the the MNIST-Even and MNIST-Odd datasets.

Image distribution per class

MNIST-Even	Images	MNIST-Odd	Images
Class 0	980	Class 1	1135
Class 2	1032	Class 3	1010
Class 4	982	Class 5	892
Class 6	958	Class 7	1028
Class 8	974	Class 9	1009

Model Performance

Summary table for model performances

- The table below summarizes the results obtained after 100 epochs of training softmax regression and neural network models and 30 epochs on transfer learning.

Models	MNIST - Even	MNIST - Odd
Softmax Regression	96.02%	95.13%
Neural Network	98.56%	98.34%
Transfer Learning	98.21%	98.06%

Softmax Regression

MNIST-Even

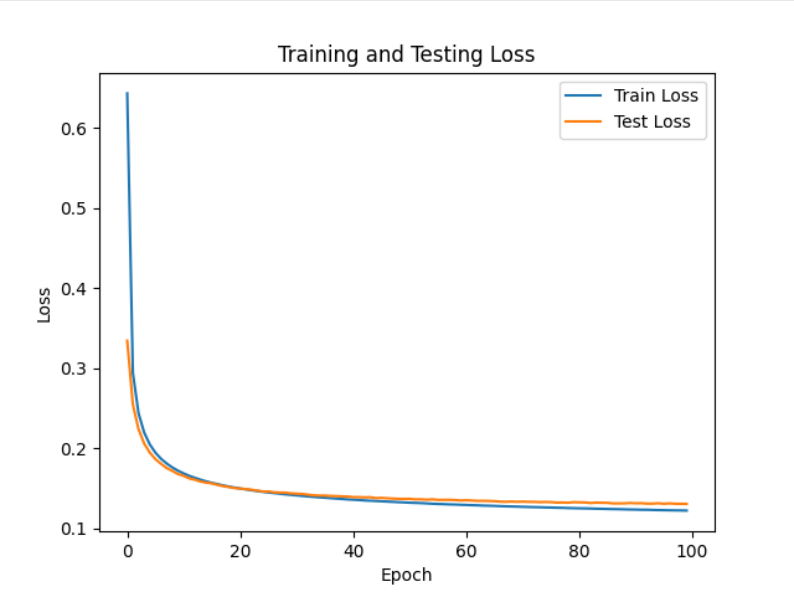

Figure: Loss

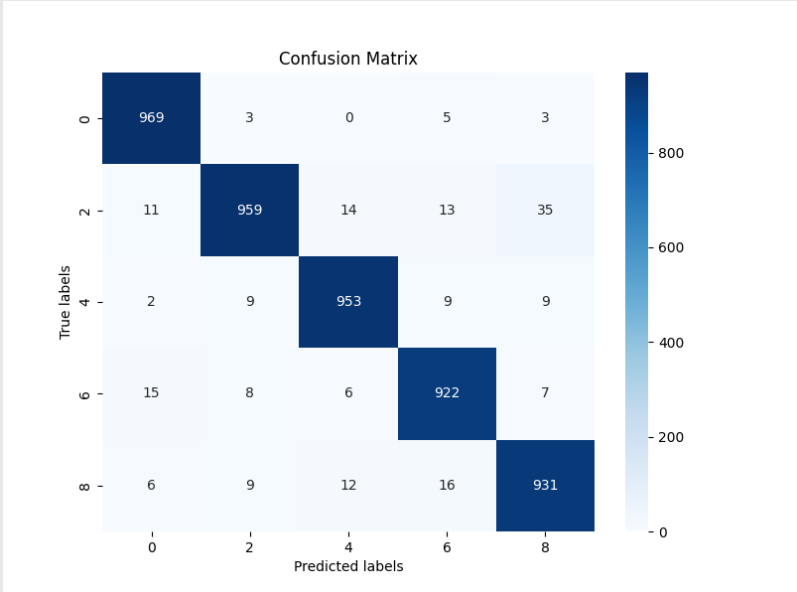

Figure: Performance Metrics

Softmax Regression

MNIST-Odd

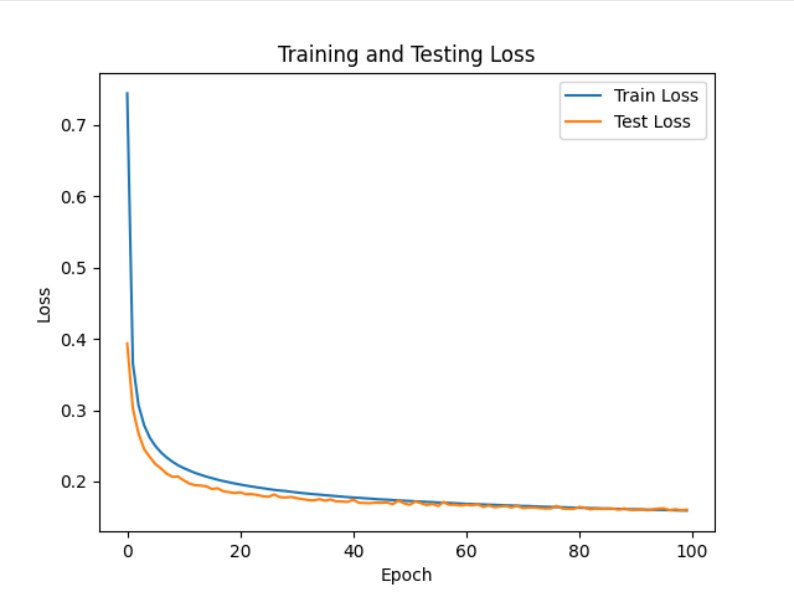

Figure: Loss

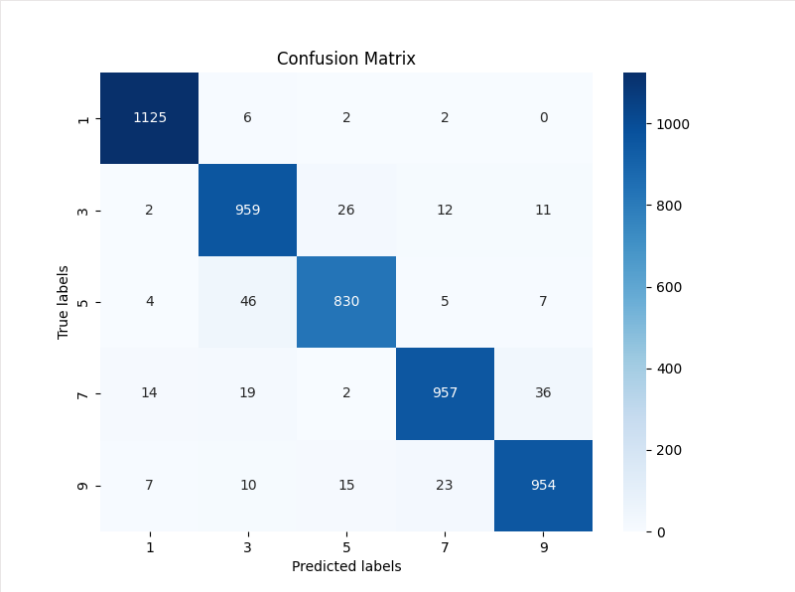

Figure: Performance Metrics

Neural Network

MNIST-Even

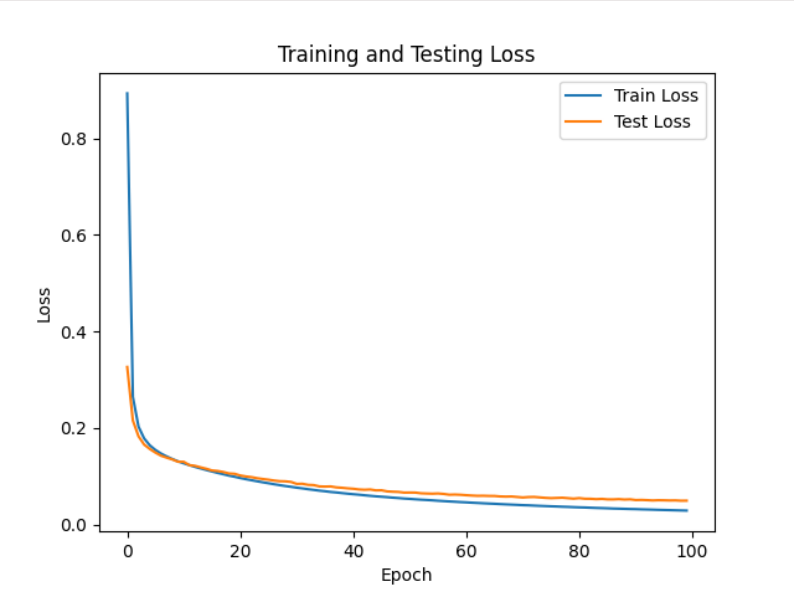

Figure: Loss

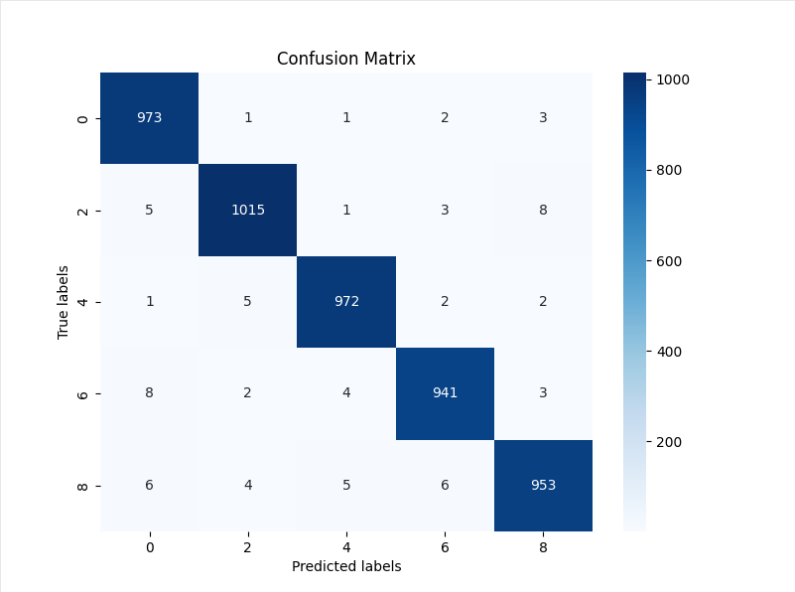

Figure: Performance Metrics

Neural Network

MNIST-Odd

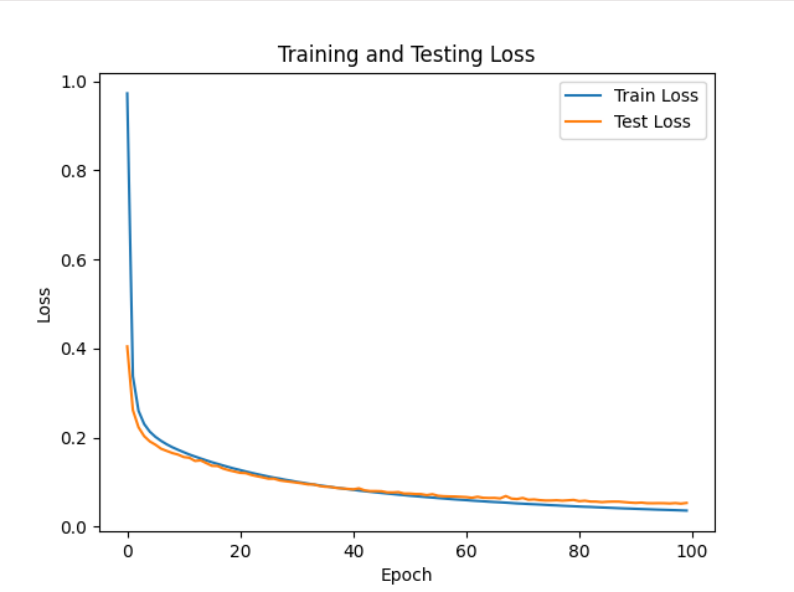

Figure: Loss

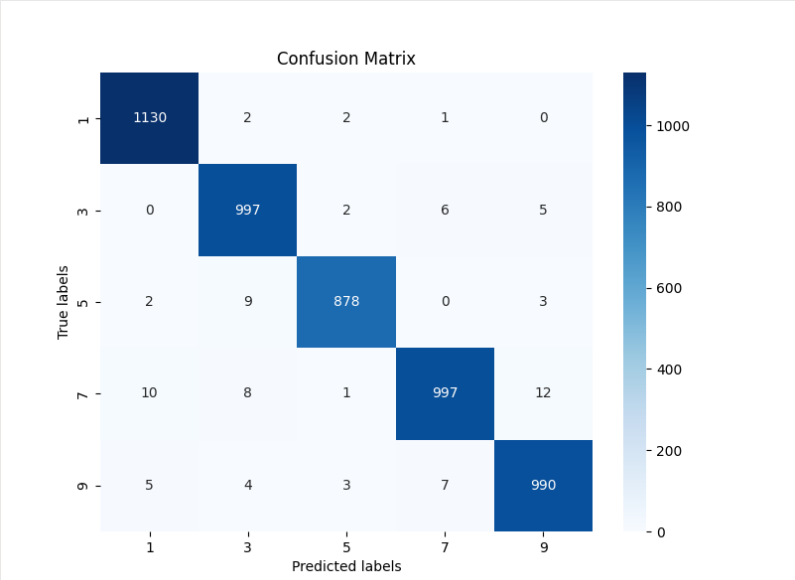

Figure: Performance Metrics

Transfer Learning

MNIST-Even

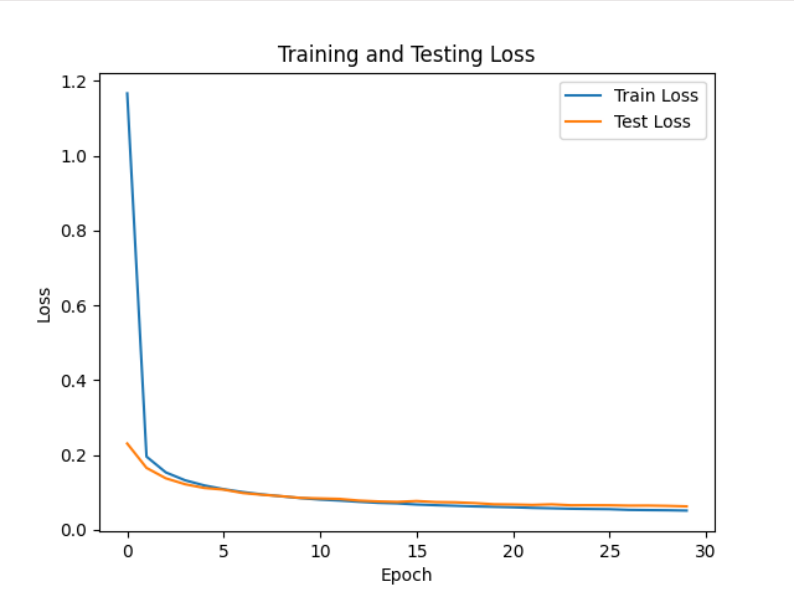

Figure: Loss

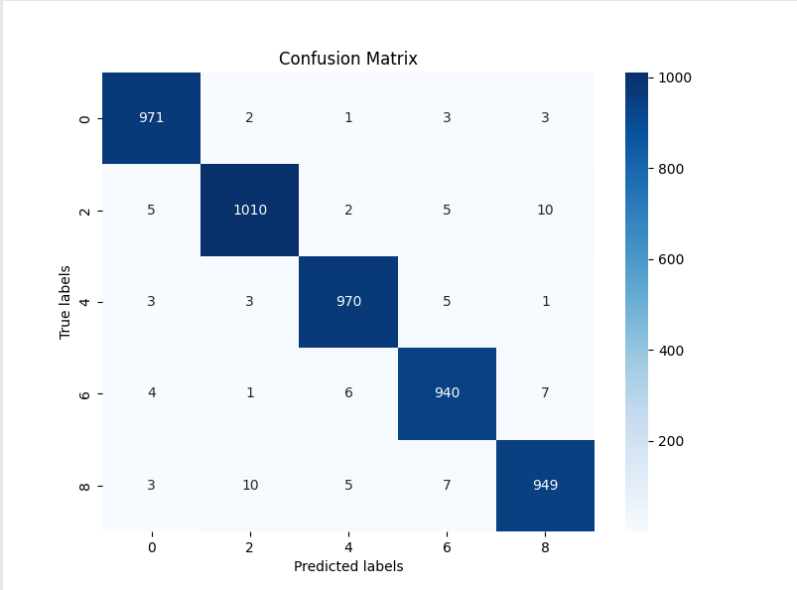

Figure: Performance Metrics

Transfer Learning

MNIST-Odd

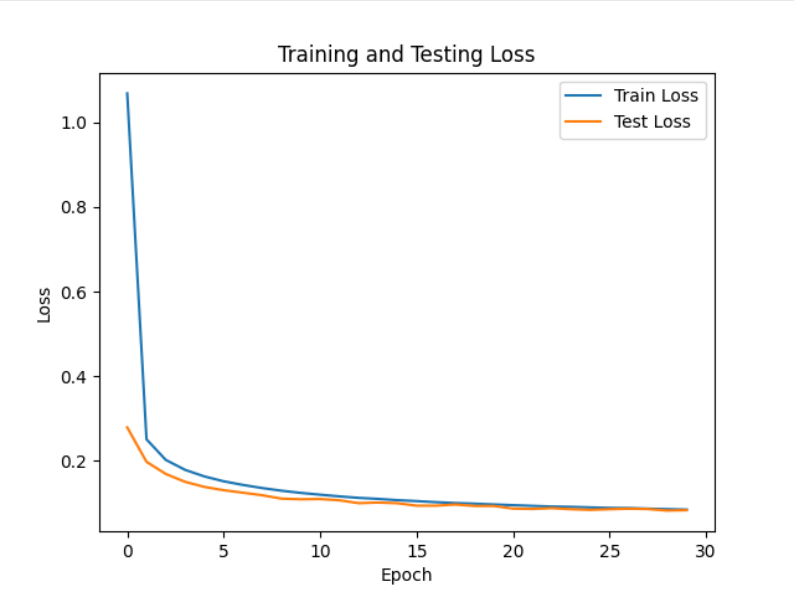

Figure: Loss

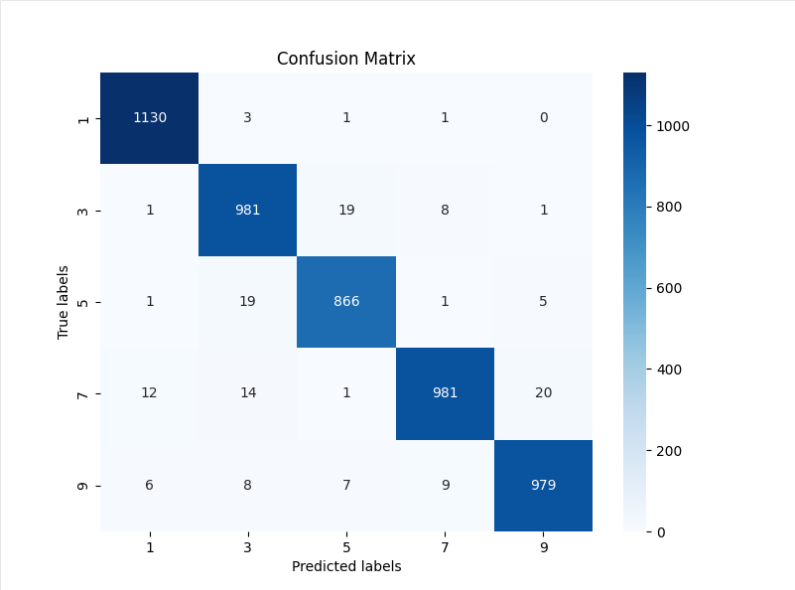

Figure: Performance Metrics

Conclusion

- The main goal of the project was to build a softmax regression and neural network models for image classification using the MNIST dataset putting into consideration the transfer learning technique.

- The results shows a good performance on image classification for all models, however, it can be noted that using neural networks out performs the use of softmax regression even though the difference is not too high.

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References

- https://www.kaggle.com/code/riteshsinha/neural-networks-with-pytorch-mnist
- https://adeveloperdiary.com/data-science/deep-learning/neural-network-with-softmax-in-python/
- https://github.com/pmensah28/TL-From-Scratch

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