Md: Israil Hosen

Roll: 2010876110

Neural Network and Deep Learning Assignment-3

[Code link]

Feature Extraction Power of Pretrained CNN (MobileNetV2)

Before transfer learning, the CNN model (like MobileNetV2) is only trained on the ImageNet dataset, which contains natural images such as animals, vehicles, and other everyday objects. Since it hasn't seen digit-like patterns before, it mainly focuses on general visual features like edges and textures. When we pass MNIST digit images through this model without any additional training, the extracted features are not very useful for telling digits apart. As a result, when we project these features onto a 2D plane using techniques like PCA, t-SNE, or UMAP, the digit classes often appear mixed or scattered, showing poor separation between different numbers. Here are the simple feature visualization before transfer learning is given below:

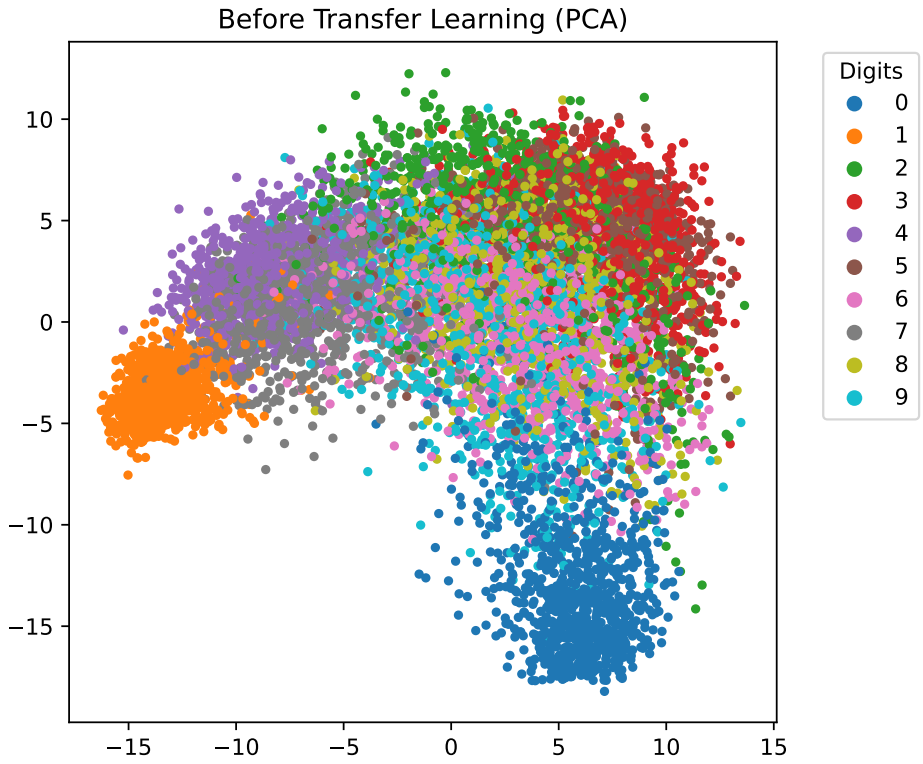

Figure 1: Feature space visualization before transfer learning using PCA

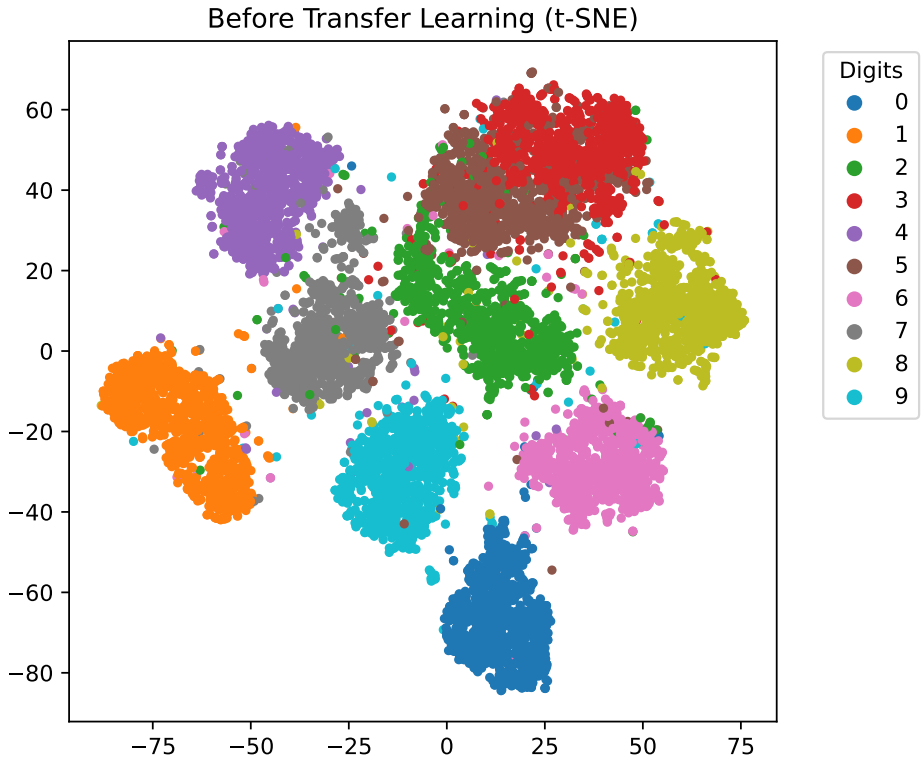

Figure 2: Feature space visualization before transfer learning using t-SNE

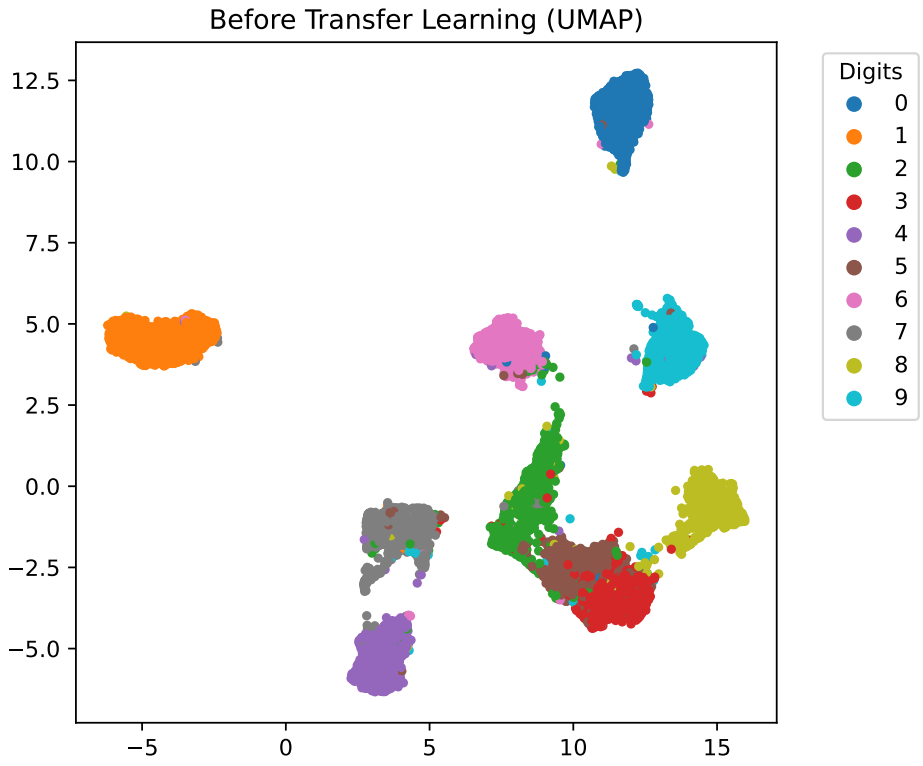

Figure 3: Feature space visualization before transfer learning using UMAP

After transfer learning, the same CNN on the MNIST dataset, its ability to extract meaningful features improves significantly. The model now learns to recognize patterns that are specific to handwritten digits such as loops in 8 or straight lines in 1. This training helps the model form more distinct and organized internal representations of each digit class. When we again reduce the dimensions of these feature vectors for visualization, the difference becomes clear. t-SNE and UMAP now show well-defined clusters for each digit, and even PCA gives better separation. This proves that transfer learning allows the CNN to adapt its knowledge and become highly effective for a new but simpler domain like digit recognition. Here are the simple feature visualization after transfer learning is given below:

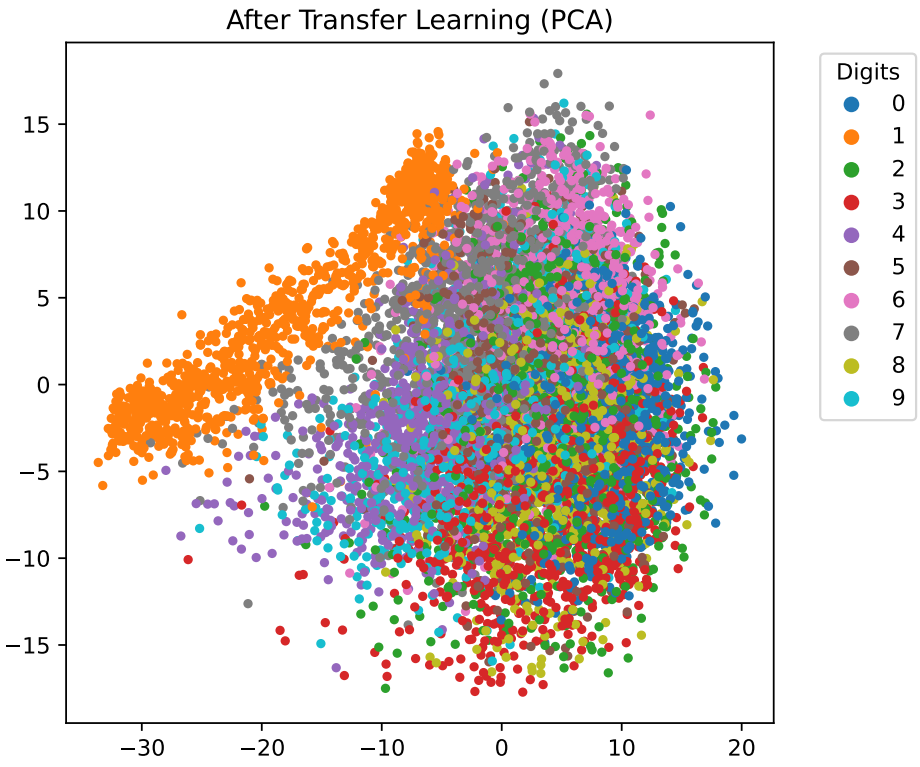

Figure 4: Feature space visualization after transfer learning using PCA

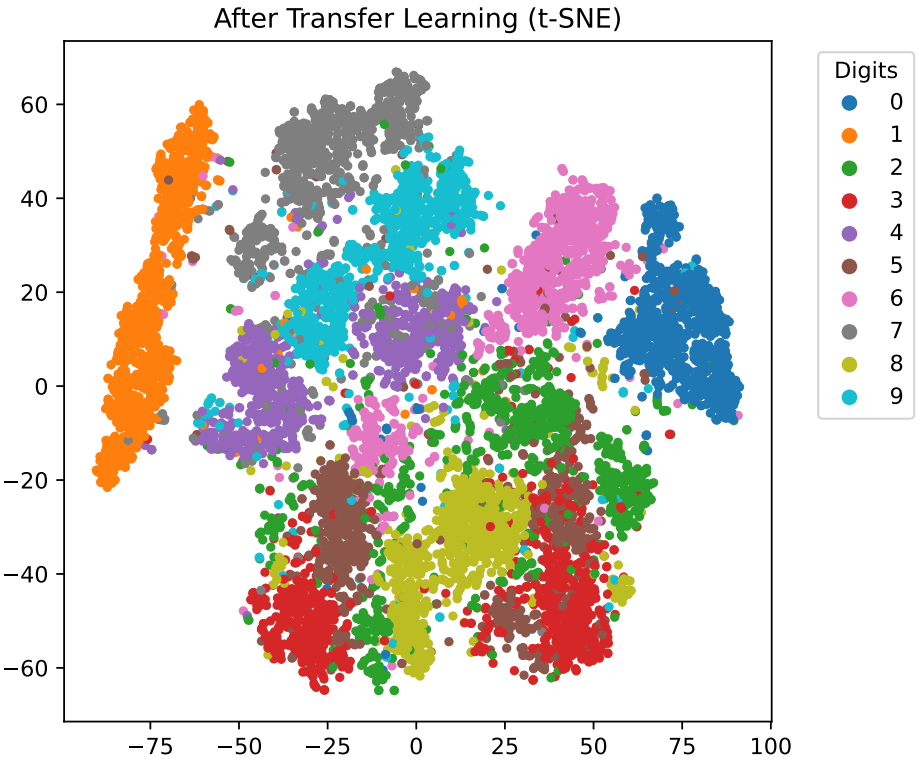

Figure 5: Feature space visualization after transfer learning using t-SNE

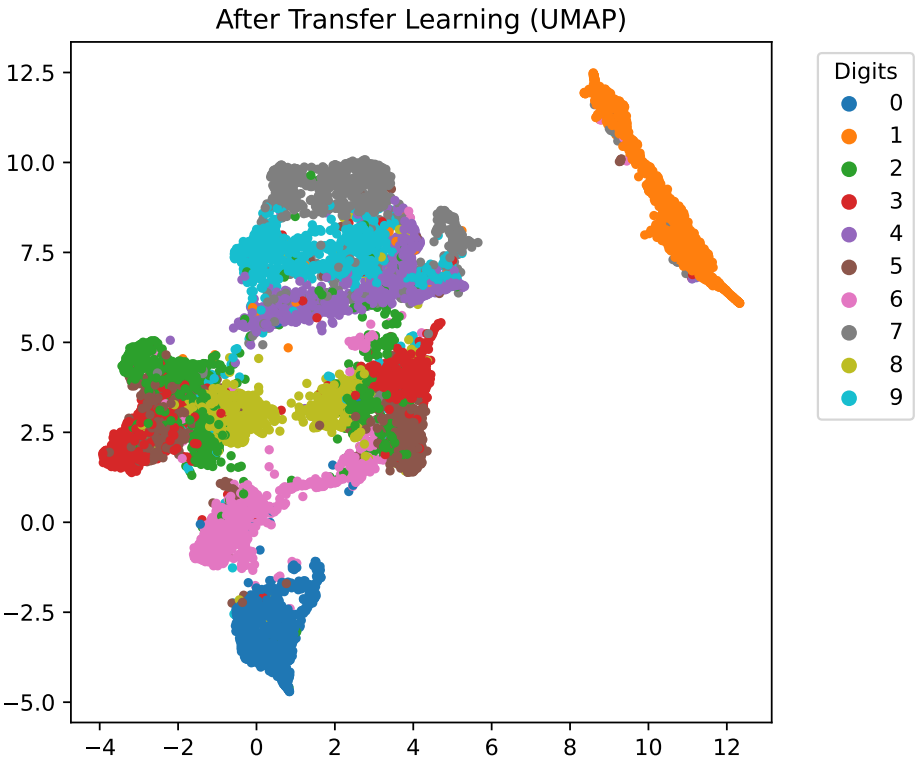

Figure 6: Feature space visualization after transfer learning using UMAP