Transfer Learning for Image Classification

Name: Soumalya Mondal
Roll No: M24DE2031

Contents

1 Introduction

The primary goal of this project is to compare the performance of models trained from scratch versus a model trained using transfer learning. By evaluating the accuracy of three models (A1, A2, and A3), we aim to demonstrate the effectiveness of transfer learning in improving classification accuracy, particularly when working with limited data or complex datasets. This study highlights the benefits of leveraging pretrained models to enhance the performance of image classification tasks when faced with resource constraints.

2 Dataset Visualization

In this project, we utilize two datasets:

2.1 Task 1 Dataset

- Contains more training samples compared to Task 2.

- **Class names**: {'n01532829', 'n01558993', 'n01704323', 'n01749939', 'n01770081', 'n01843383', 'n01855672', 'n01910747', 'n01930112', 'n01981276'}
- **Class to index mapping**: {'n01532829': 0, 'n01558993': 1, 'n01704323': 2, 'n01749939': 3, 'n01770081': 4, 'n01843383': 5, 'n01855672': 6, 'n01910747': 7, 'n01930112': 8, 'n01981276': 9}

Figure 1: Sample images from Task 1 dataset

2.2 Task 2 Dataset

- Smaller dataset with fewer classes compared to Task 1.
- **Class names**: {'n02074367', 'n02089867', 'n02091244', 'n02091831', 'n02099601'}
- **Class to index mapping**: {'n02074367': 0, 'n02089867': 1, 'n02091244': 2, 'n02091831': 3, 'n02099601': 4}

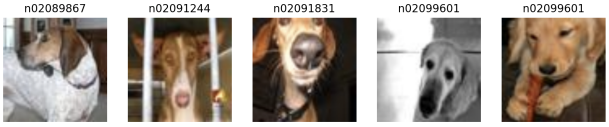

Figure 2: Sample images from Task 1 dataset

3 Accuracy Comparison (A1, A2, A3)

Comparison of A1, A2, and A3 Accuracy:

Model	Task	Accuracy
A1 (model1)	Task 1	55.40%
A2 (model2)	Task 2 without Transfer Learning	39.40%
A3 (model3)	Task 2 with Transfer Learning from Task 1	48.20%

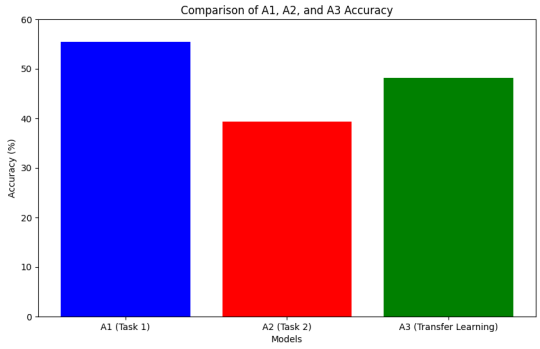

Figure 3: Sample images from Task 1 dataset

4 Observations

- **A1 (Task 1 Accuracy)**: Achieved 55.40% accuracy when trained from scratch on Task 1. This performance is indicative of the model's standard training procedure without transfer learning.
- **A2 (Task 2 Accuracy from Scratch)**: 'Model2' trained from scratch on Task 2 achieved 39.40% accuracy, indicating challenges likely due to dataset complexity, different class distributions, or limited training data.
- **A3 (Task 2 Accuracy with Transfer Learning)**: 'Model3', using transfer learning, achieved 48.20% accuracy on Task 2, demonstrating the benefit of leveraging pretrained weights from Task 1 for improved performance.

5 Explanation of the Differences Between A2 and A3 Accuracy

- **Initialization of Weights**:
  - **A2 (model2 trained from scratch)**: Starts with random weights and learns features from scratch.
  - **A3 (model3 with transfer learning)**: Utilizes pretrained weights from Task 1, which already capture useful general features, leading to faster and better convergence.
- **Feature Reusability**:
  - **Low-Level Features**: General features like edges and textures, learned in earlier layers, are reused effectively in model3.

  - **High-Level Adaptation**: Model3 adapts high-level features to Task 2 through transfer learning, enhancing performance.

- **Regularization Effect**: Transfer learning acts as regularization by providing better initial weights, reducing overfitting and improving performance with limited training data.

- **Faster Convergence**: Models with pretrained weights, like model3, converge faster, achieving higher accuracy in fewer epochs compared to randomly initialized models like model2.

- **Dataset Differences**: The shared characteristics between the classes in Task 1 and Task 2 enhance transfer learning effectiveness, as observed in model3.

6 Conclusion

- **Transfer Learning Boosts Accuracy**: The 8.8% accuracy improvement from model2 to model3 illustrates the advantages of using pretrained models, especially for similar tasks or when training data is limited.

- **Better Initialization**: Both models have the same architecture, but model3's pretrained initialization from Task 1 leads to better performance on Task 2, showcasing the power of transfer learning in real-world applications.