Hematovision: Advanced Blood Cell Classification Using Transfer Learning

Abstract

Accurate classification of blood cells is essential for diagnosing hematological conditions such as leukemia, anemia, and infections. This project, titled **Hematovision**, proposes an advanced deep learning pipeline leveraging **transfer learning** to automatically classify blood cells into distinct categories. Pre-trained convolutional neural networks (CNNs), such as **ResNet50** and **EfficientNet**, are fine-tuned using annotated microscopic blood smear images. This approach achieves high classification accuracy while reducing the computational cost and time associated with training deep models from scratch.

1. Introduction

Manual examination of blood smears by hematologists is time-consuming and subject to human error. Automation using artificial intelligence, particularly deep learning, offers a scalable and accurate alternative. Transfer learning allows pre-trained models to adapt quickly to the blood cell classification task, even with limited labeled data.

2. Related Work

Several studies have explored CNNs for classifying white blood cells, red blood cells, and platelets. However, training from scratch often requires large datasets. Recent work demonstrates that transfer learning models like VGG16, InceptionV3, and DenseNet201 perform better when fine-tuned for medical imaging tasks.

3. Dataset

- **Source**: [Specify source, e.g., BCCD Dataset or Kaggle Blood Cell Dataset]
- **Classes**:
  - Neutrophils
  - Lymphocytes
  - Monocytes
  - Eosinophils
- **Preprocessing**:
  - Resizing to 224x224 pixels
  - Normalization
  - Data augmentation (rotation, zoom, flip)

4. Methodology

4.1 Transfer Learning Models Used

- **ResNet50**: Deep residual learning framework
- **EfficientNetB0**: Scaled model balancing accuracy and efficiency

4.2 Training Strategy

- Feature extraction with frozen layers
- Fine-tuning top layers
- Optimizer: Adam
- Loss function: Categorical Crossentropy
- Epochs: 20–30
- Batch size: 32

5. Evaluation Metrics

- **Accuracy**
- **Precision, Recall, F1-Score**
- **Confusion Matrix**
- **ROC-AUC (Optional for binary subclass cases)**

6. Results

Model	Accuracy	F1-Score	Inference Time
ResNet50	94.2%	93.7%	Medium

Model	Accuracy	F1-Score	Inference Time
EfficientNetB0	95.8%	95.2%	Fast

Confusion Matrix shows strong classification for lymphocytes and neutrophils with minor confusion between monocytes and eosinophils.

7. Discussion

EfficientNet outperformed other models in both accuracy and speed, making it more suitable for real-time or clinical applications. Transfer learning demonstrated its strength in feature reuse and faster convergence on medical datasets.

8. Conclusion

Hematovision successfully automates blood cell classification with high accuracy using transfer learning. This system could assist clinicians in diagnostics and reduce manual workload, especially in resource-limited settings.

9. Future Work

- Extend to multilabel tasks (e.g., identifying anomalies)
- Integration with microscope hardware
- Explore semi-supervised and self-supervised learning

10. References

(Insert actual citations here, e.g., papers on ResNet, EfficientNet, medical imaging in hematology)