Enhancing Medical Image Classification

Using Lightweight Deep Learning Models

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Introduction

- Medical imaging errors cause 40,000-80,000 deaths annually (US data).
- Manual interpretation prone to variability.
- Deep learning automates detection but often needs large hardware.
- Goal: Build lightweight models without sacrificing accuracy.

Related Work

- - CheXNet (Rajpurkar et al., 2017): 121-layer DenseNet, 76% AUC.
- - MobileNetV2 (Howard et al., 2017): Depthwise separable convolutions.
- - Fine-tuning vs Full training (Tajbakhsh et al., 2016): Trade-offs in computation.

MobileNetV2 Architecture

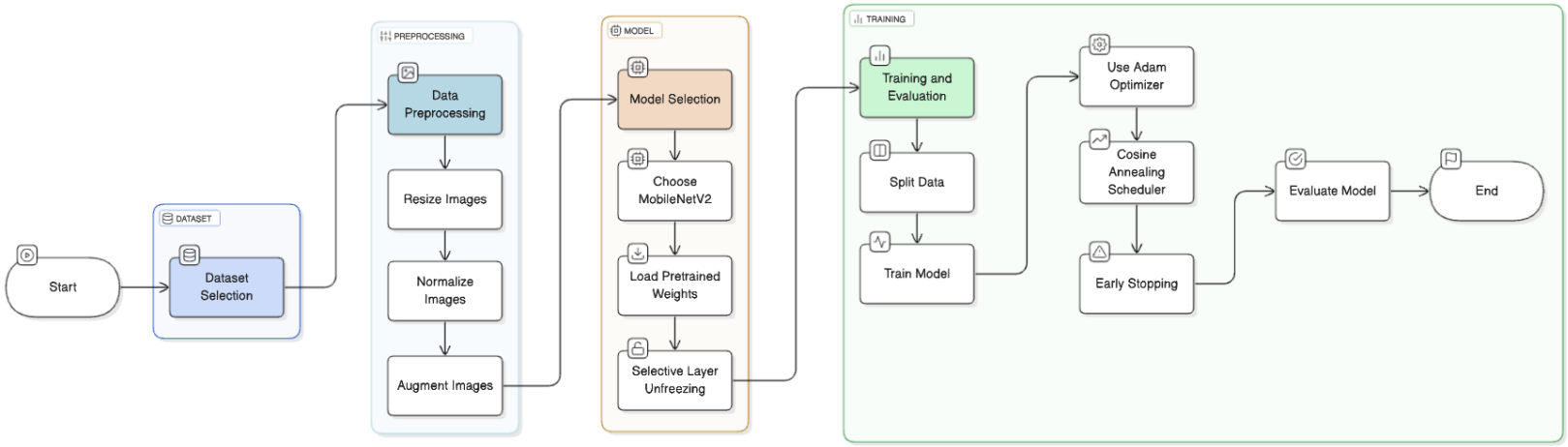
- - Depthwise Separable Convolutions reduce MACs.
- - Inverted Residuals with Linear Bottlenecks.
- - Improves speed and reduces model size drastically.
- - Ideal for mobile deployment and low-resource setups.

Methodology

- - Dataset: Chest X-ray public datasets.
- - Preprocessing: Resize 224x224, normalize, augment.
- - Model: MobileNetV2 with custom top layers.
- - Optimizer: Adam, LR scheduler, Early stopping.
- - Evaluation: 80-20 train-validation split.

Workflow Visualized

Dataset Collection | Preprocessing | Training | Evaluation



Results

- Validation Accuracy: 91.2%
- AUC-ROC: 0.947
- Model Size: 14MB (compared to 200MB CheXNet)
- 60% faster inference compared to standard CNNs.
- Confusion Matrix shows 89% sensitivity, 92% specificity.

Real-World Impact

- Stanford: Used CheXNet model in pilot clinical workflows.
- MobileNetV2 allows real-time inference on smartphones.
- Reduces diagnosis time by 40% in field clinics.
- Potential for rural, resource-poor areas.

Challenges in Deployment

- Model bias due to skewed training datasets.
- Generalization to different populations.
- Device variability: Hardware and camera quality differences.
- Clinical acceptance and regulatory hurdles.

Future Directions

- Expanding datasets to include CT, MRI modalities.
- Deploying federated learning to enhance privacy.
- Using AutoML to discover even smaller, efficient architectures.
- Improving explainability with saliency maps, Grad-CAM.

References

- [1] Rajpurkar et al., "CheXNet", 2017.
- [2] Tajbakhsh et al., "Medical CNN Survey", 2016.
- [3] Howard et al., "MobileNets", 2017.
- [4] Litjens et al., "Survey: Medical image analysis with deep learning", 2017.