Deep Learning for Automated Detection of Diabetic Retinopathy in Fundus Images

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0.1 Problem Statement

Diabetic Retinopathy (DR) is a leading cause of vision loss globally, particularly among individuals with diabetes. Early detection is crucial for effective treatment and prevention of blindness. Traditional DR diagnosis requires specialized ophthalmologists, making early screening inaccessible in many regions. Automated DR detection using deep learning offers a scalable solution to identify and classify retinal abnormalities with high accuracy. This project aims to develop a convolutional neural network (CNN)-based model for DR detection from fundus images, improving diagnostic efficiency and accessibility.

0.2 Data

The project will use the **APTOS 2019 Blindness Detection** dataset from Kaggle. This dataset contains retinal fundus images labeled with different DR severity levels (No DR, Mild, Moderate, Severe, and Proliferative DR). Challenges include class imbalance, image quality variations, and the need for robust preprocessing techniques such as contrast enhancement and noise reduction.

0.3 Methods

The proposed approach includes:

- **Preprocessing:** Image resizing, normalization, and data augmentation (rotation, flipping, zooming) to improve model generalization.
- **Model Selection:** Transfer learning with pre-trained CNN architectures (ResNet-50, EfficientNet, or MobileNet) fine-tuned on DR images.
- **Training Process:**
  - Loss function: Cross-entropy loss
  - Optimizer: Adam with learning rate scheduling
  - Regularization: Dropout and data augmentation to reduce overfitting

  - Early stopping to prevent unnecessary computations

- **Hyperparameter Tuning:** Grid search or Bayesian optimization to improve model performance.

0.4 Evaluation

To ensure a robust evaluation, the model will be tested using:

- **Quantitative Metrics:**
  - Accuracy, Precision, Recall, F1-score, AUC-ROC to measure classification effectiveness.
  - Confusion matrix for understanding class-wise performance.
- **Qualitative Analysis:**
  - Grad-CAM (Gradient-weighted Class Activation Mapping) to highlight regions in the fundus images that influence model predictions.
  - Comparison with actual ophthalmologist diagnoses.
- **Baseline Comparison:** The model's performance will be benchmarked against existing models trained on similar datasets

0.5 Conclusion

This project will provide hands-on experience in medical image analysis and deep learning while addressing a critical healthcare issue. The automated DR detection system can contribute to early diagnosis, improving treatment outcomes and accessibility to retinal disease screening.

References