Diabetic Retinopathy Detection using deep learning

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1. Introduction

Diabetic retinopathy is a leading cause of blindness among adults worldwide, primarily affecting individuals with diabetes. The condition occurs when high blood sugar levels damage the blood vessels in the retina, potentially leading to vision loss if left undiagnosed and untreated. This project aims to automate the detection and classification of diabetic retinopathy stages using deep learning, specifically the ResNet50 model. By training a pre-trained ResNet50 model on retina scan images, the goal is to provide a faster, more reliable tool for diagnosing DR, ultimately supporting early treatment and improving patient outcomes.

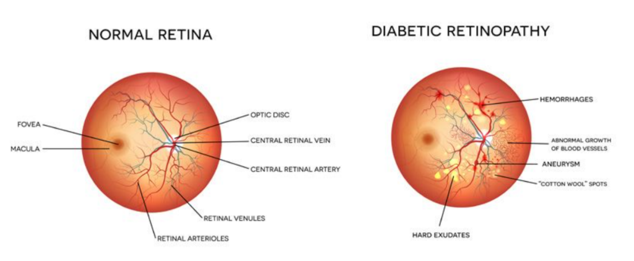

Figure 1: Normal Eye Vs Diabetic Retinopathy

2. Objectives

- Automate DR detection using deep learning techniques.
- Classify DR severity into five stages: no DR, mild, moderate, severe, and proliferative.
- Improve diagnostic accuracy and efficiency through ResNet50 model.
- Reduce dependency on manual analysis, aiding early diagnosis and treatment.

3. Methodology

- **Data Collection:** Retina scan images from the APTOS 2019 and Diabetic Retinopathy 224x224 Gaussian Filtered datasets were used, labeled by severity of DR.
- **Preprocessing:** Images were resized to 224x224 pixels, normalized, and augmented with techniques like rotation, flipping, and zooming to increase dataset diversity and prevent overfitting.
- **Model:** A pre-trained ResNet50 model was fine-tuned to classify DR into five severity stages. The model benefits from residual connections, enabling deeper learning and mitigating the vanishing gradient problem.
- **Training:** The model was trained using Cross-Entropy Loss and optimized with the Adam optimizer. The dataset was split into training, validation, and test sets to evaluate the model's performance.
- **Evaluation:** Model performance was assessed using accuracy, precision, recall, F1-score, and a confusion matrix, with a focus on minimizing misclassification across different DR stages.

4. Results

The deep learning model's performance in classifying diabetic retinopathy was evaluated using accuracy, precision, recall, and F1-score: Accuracy: 85% – the overall percentage of correctly classified retina scans. Precision: 92% – the proportion of true positive detections among all positive predictions. Recall: 94% – the proportion of true positives identified from all actual positive instances. F1-Score: 93% – the harmonic mean of precision and recall, providing a balanced measure of model performance.

ROC Curve: The ROC curve shows the model's ability to distinguish between retinopathy stages. The blue curve lies above the red dotted line (random chance), indicating the model's strong performance, with a larger AUC reflecting better accuracy.

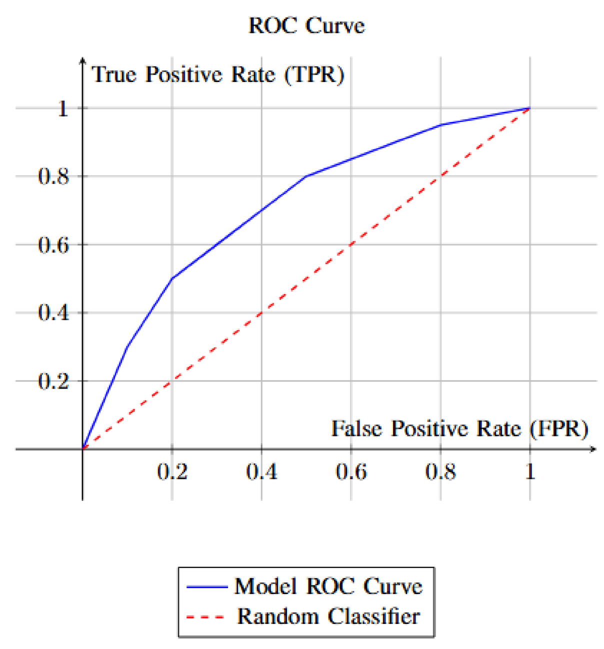

Figure 2: ROC Curve for Diabetic Retinopathy classification

5. Conclusions

In conclusion, the deep learning model based on ResNet50 demonstrated strong performance in classifying diabetic retinopathy severity stages. With high accuracy, precision, recall, and F1-score, the model proved effective in detecting and classifying diabetic retinopathy from retina scans. The ROC curve further confirmed the model's ability to distinguish between different severity levels, outperforming random guessing. This approach holds significant potential for assisting healthcare professionals in early detection, ultimately improving diagnostic accuracy and enabling timely treatment to prevent vision loss in diabetic patients.

6. Future Research

In upcoming research, we aim to further enhance the performance and applicability of the diabetic retinopathy detection model. This includes exploring the use of other advanced architectures, such as DenseNet and EfficientNet, to potentially achieve even higher accuracy and robustness. Expanding the dataset with more diverse retina scans from various populations will also be a focus, ensuring that the model can generalize well across different demographics. Additionally, efforts will be made to improve the explainability of the model, which will help in making the decision-making process more transparent for healthcare professionals. Lastly, integrating this model into real-time diagnostic tools for clinics and hospitals will be a priority, enabling quicker and more accurate diagnoses of diabetic retinopathy. These future steps will help in improving the model's utility, especially in resource-limited healthcare settings.