Project Proposal: Deep Learning for Diabetic Retinopathy Detection

Problem Statement

The goal of this project is to develop and evaluate deep learning models to classify the severity of Diabetic Retinopathy using the APTOS 2019 Blindness Detection dataset. This is a five-class classification problem (ordinal) where each fundus image is labeled with a grade from 0 (no DR) to 4 (proliferative DR). Our aim is to build an accurate, interpretable, and generalizable model that could support automated eye screening workflows.

Dataset Description

We will be using the APTOS 2019 dataset, available publicly through Kaggle. It contains over 3,600 high-resolution fundus images labeled with the severity level of Diabetic Retinopathy. Images will be preprocessed to normalize brightness, resize dimensions, and enhance contrast using techniques like histogram equalization. Due to class imbalance (most samples are in class 0), resampling strategies and weighted losses will be explored.

Proposed Modeling Techniques

We plan to implement and compare multiple modeling approaches:

1. Null Model – predicts the most frequent class
2. Logistic Regression on basic image features (RGB mean, std)
3. Simple CNN trained from scratch
4. Transfer Learning using pre-trained ResNet-50 or EfficientNet

Each model will be evaluated using accuracy, Cohen's Kappa, and class-wise F1 scores.

Software and Tools

We intend to use Python as the primary programming language for all stages of the project. Development and experimentation will be conducted in Jupyter Notebooks, hosted locally or on Google Colab. For image handling and preprocessing, we will use OpenCV, Pillow, and NumPy. Modeling will be done using PyTorch or TensorFlow (Keras), enabling both custom CNNs and transfer learning with pre-trained models such as ResNet-50. Evaluation metrics and model comparison will be handled with scikit-learn, and data visualizations will be generated using Matplotlib and Seaborn.

Expected Outcomes

We aim to develop a deep learning pipeline capable of classifying Diabetic Retinopathy severity from retinal fundus images with high accuracy and clinical relevance. The project will showcase the effectiveness of convolutional neural networks (CNNs) and transfer learning for medical image analysis. Overall, the expected outcome is a robust, explainable, and generalizable model that demonstrates the potential of AI-assisted diagnostics in ophthalmology.