**Diabetes Detection through Retinopathy**

**Introduction**

Diabetes detection through retinopathy is a crucial step in preventing vision loss caused by diabetic retinopathy. Diabetic retinopathy is a complication of diabetes that affects the eyes due to damage in the blood vessels of the retina. If untreated, it can lead to vision impairment and blindness.

This project aims to classify retinal fundus images into different stages of diabetic retinopathy using a deep learning-based approach combining Convolutional Neural Networks (CNNs) and Vision Transformers (ViTs).

**Dataset**

The dataset consists of labeled retinal fundus images categorized into five stages of diabetic retinopathy:

1. **No DR (0)** - No signs of diabetic retinopathy.
2. **Mild (1)** - Small hemorrhages and microaneurysms.
3. **Moderate (2)** - Increased number of microaneurysms and hemorrhages.
4. **Severe (3)** - Significant hemorrhages and possible venous beading.
5. **Proliferative DR (4)** - Advanced stage with abnormal blood vessel growth.

These images are preprocessed and used to train a hybrid deep-learning model for classification.

**Model Architecture**

The model used in this project is a **Hybrid EfficientNet-ViT model**, which combines the strengths of CNNs and Transformers:

* **EfficientNet-B0** extracts spatial features from retinal images.
* **Vision Transformer (ViT)** captures long-range dependencies and texture variations.
* Fully connected layers perform final classification.

**Training and Optimization**

* **Preprocessing**: Images are resized to 224x224, normalized, and augmented using random transformations.
* **Loss Function**: Cross-entropy loss is used for multi-class classification.
* **Optimizer**: AdamW optimizer with a learning rate of 1e-4.
* **Hardware**: The model is trained using GPU acceleration for efficient computation.

**Evaluation Metrics**

The model is evaluated using standard classification metrics:

* **Accuracy**: Measures the proportion of correctly classified images.
* **F1 Score**: Balances precision and recall for imbalanced data.
* **Precision & Recall**: Provide insights into model performance for each class.

**Prediction**

After training, the model can classify a given retinal fundus image into one of the five diabetic retinopathy stages. A function is implemented to take an image path as input and output the predicted stage (0-4).

**Conclusion**

This deep learning-based approach provides an automated and efficient way to detect diabetic retinopathy stages from retinal images. It can assist ophthalmologists in early diagnosis and treatment planning, ultimately helping prevent vision loss in diabetic patients.