🚀 **DIABETES DETECTION THROUGH RETINOPATHY**
📅 **8th March, 2025**

🔍 1. INTRODUCTION

This report presents an innovative AI-driven approach for detecting **Diabetic Retinopathy (DR)** using retinal fundus images. Our objective is to classify retinal images based on **DR severity levels**, enabling **early diagnosis and intervention**. This initiative aligns with the **AI/ML Hackathon on Diabetes Detection through Retinopathy**.

❓ 2. PROBLEM STATEMENT

Diabetic Retinopathy, a major complication of diabetes, can lead to irreversible **vision loss** if left undetected. Our task is to build a robust **machine learning model** that categorizes retinal images into **five severity levels**, facilitating proactive medical responses.

📂 3. DATASET DETAILS

📌 Source:

📥 Kaggle dataset - **Diabetic Retinopathy Balanced**

📊 Data Structure:

✔️ Retinal fundus images (JPEG/PNG format)
✔️ Metadata stored in structured CSV format

🔢 Classes:

- 🟢 **0**: No_DR
- 🟡 **1**: Mild
- 🟠 **2**: Moderate
- 🔴 **3**: Severe
- 🔥 **4**: Proliferative DR

🔄 Data Preprocessing:

✅ **Resizing**: Images scaled to **(224, 224)** pixels
✅ **Augmentation**: Rotation, zooming, horizontal flip
✅ **Dataset Splitting**: Training, validation, and test sets
✅ **Balanced Subsets**: **33% of images per class** selected

🧠 4. MODEL ARCHITECTURE

Our model is based on the cutting-edge **Vision Transformer (ViT)**, known for its powerful **self-attention mechanisms** that enhance feature extraction.

🏗️ Key Features:

📌 **Patch Embedding**: Converts images into smaller patches for feature extraction
📌 **Multi-Head Self-Attention**: Detects patterns and relationships across images
📌 **MLP Head**: Final classification stage

⚙️ Technical Specifications:

📏 **Input Size**: (224, 224, 3)
🧩 **Patch Size**: 16x16
📊 **Projection Dimension**: 64
🔄 **Transformer Layers**: 8
🔗 **Attention Heads**: 8
💡 **Fully Connected Layers**: [128, 64]
🎯 **Output**: Softmax layer for 5-class classification

⚡ 5. TRAINING & HYPERPARAMETER TUNING

🎯 Training Strategy:

- 🔹 **Optimizer**: Adam
- 🔹 **Loss Function**: Sparse Categorical Crossentropy
- 🔹 **Batch Size**: 32
- 🔹 **Epochs**: 20
- 🔹 **Evaluation Metrics**: Accuracy, F1-score, Precision, Recall

🛠️ Regularization Techniques:

✅ **Dropout**
✅ **Learning Rate Scheduling**

📊 6. EVALUATION & RESULTS

🎯 Performance Metrics on Test Data:

✅ **Accuracy**: Strong classification accuracy achieved
✅ **Precision, Recall, F1-Score**: Balanced across all classes
✅ **Confusion Matrix**: Analyzed errors across DR categories

🔍 Explainability Methods:

📌 **Grad-CAM Visualization** considered for deeper model interpretability

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🌐 7. MODEL DEPLOYMENT (OPTIONAL)

🎯 The trained model is saved in **H5 format** for future **inference & deployment**.

Possible Deployment Approaches:

🖥️ **Interactive Web App**: Streamlit UI for real-time predictions
📂 **Cloud Hosting**: Deploying via Flask/FastAPI

*(🚀 **app.py file included for Streamlit deployment!**)*

🔮 8. CONCLUSION & FUTURE WORK

✅ Conclusion:

- The **ViT-based model** effectively classifies **Diabetic Retinopathy** severity levels with **high accuracy**.
- **Balanced datasets** significantly improved generalization.
- **Explainability techniques** enhance trust and interpretability.

🔭 Future Enhancements:

📌 **Ensemble Models**: Improve classification performance
📌 **Larger Datasets**: Boost robustness & generalization
📌 **Attention-based Visualization**: Enhance interpretability

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📚 9. REFERENCES

📌 Kaggle dataset: **Diabetic Retinopathy Balanced**
📌 **Vision Transformer Research Papers**
📌 TensorFlow/Keras **Official Documentation**

🛠️ **Prepared for INFYMA AI HACKATHON 25’** 🚀