**Title:** **A novel Catract-Net-Detect deep learning model for efective cataract classifcation through data fusion of fundus images**

**Problem Statement:**

Cataracts, characterized by clouding of the lens, lead to progressive vision loss and are a leading cause of blindness globally. Despite advances in cataract surgery, early detection remains a challenge, particularly in resource-limited settings. Manual diagnosis is time-consuming, subjective, and prone to human error. While CNN-based deep learning models have shown promise in classifying ocular conditions, limitations in model generalizability, feature extraction, and handling variability in data persist. There is a critical need for robust, automated systems capable of accurate and efficient cataract detection, especially when analyzing bilateral fundus images for comprehensive diagnostic insights.

**Proposed CNN:**

The study introduces Cataract-Net-Detect, a stacking ensemble of three pre-trained CNN models:

1. DenseNet-121
2. ResNet-50
3. Inception-V3

The integrated stacking model combines features extracted by these architectures to enhance diagnostic accuracy. This hybrid ensemble approach processes bilateral fundus images, extracts discriminative features, and utilizes majority voting for multi-label classification. It outperforms traditional single-model CNN architectures in robustness, accuracy, and generalizability.

**Pre-Processing:**

The fundus images undergo extensive pre-processing to improve the model's performance:

* **Noise Reduction:** Removal of artifacts to enhance image clarity.
* **Contrast Enhancement:** Adjusting contrast to highlight features.
* **Scaling:** Normalization of image dimensions.
* **Circular Border Cropping:** Focusing on the regions of interest in the fundus images.

**Data Augmentation:**

To address over-fitting and increase the diversity of the training dataset, the following techniques were employed:

* Random-angle rotations.
* Horizontal flipping.
* Scaling.
* Resizing.

These augmentations ensured robustness in model training, improving generalization across varied datasets.

**Dataset:**

The study utilized the **ODIR-5K** dataset, which contains:

* 5,000 bilateral fundus images (left and right eyes).
* Eight ocular conditions, including normal, cataracts, glaucoma, diabetes, hypertension, AMD, myopia, and other abnormalities.
* Fundus images captured under varying conditions using cameras from Zeiss, Canon, and Kowa.

This dataset provided the variability needed to test the model's performance and generalization capabilities effectively.