Retinal Imaging

Medical Image Classification

Data Science In Health

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https://scitechdaily.com/unlocking-the-future-of-health-predicting-disease-with-retinal-imaging-and-genetics/

Agenda

- Introduction
- Data
- Preprocessing
- Model Architecture
- Model Performance
- Related Work
- Discussion
- Code Walk Through

https://scitechdaily.com/unlocking-the-future-of-health-predicting-disease-with-retinal-imaging-and-genetics/

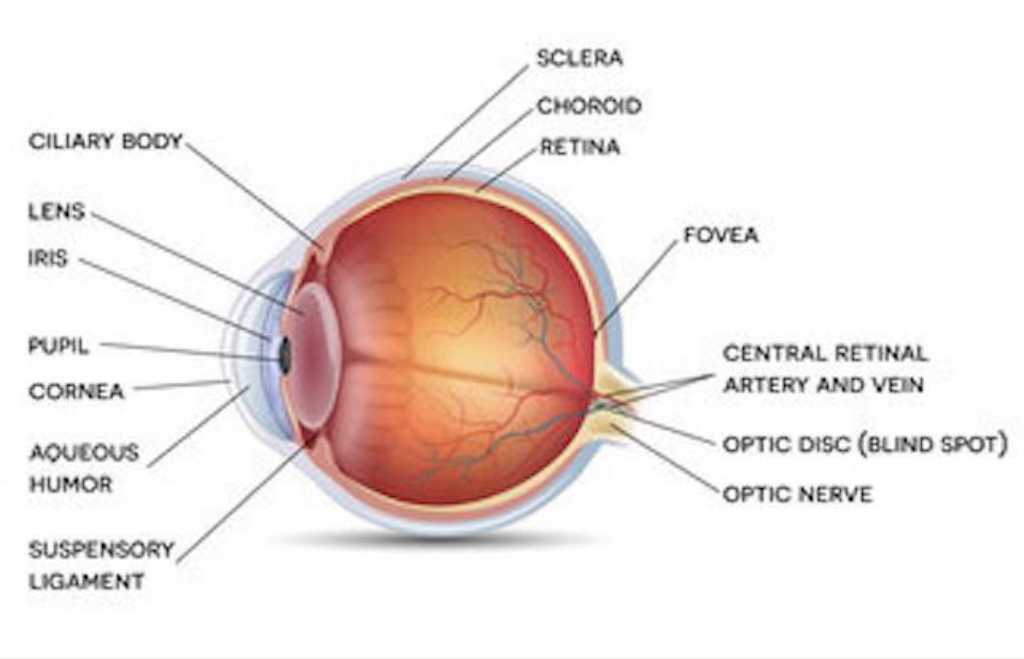
Introduction

Funduscopy

https://www.allaboutvision.com/eye-exam/faq/what-is-ophthalmoscopy/

Introduction

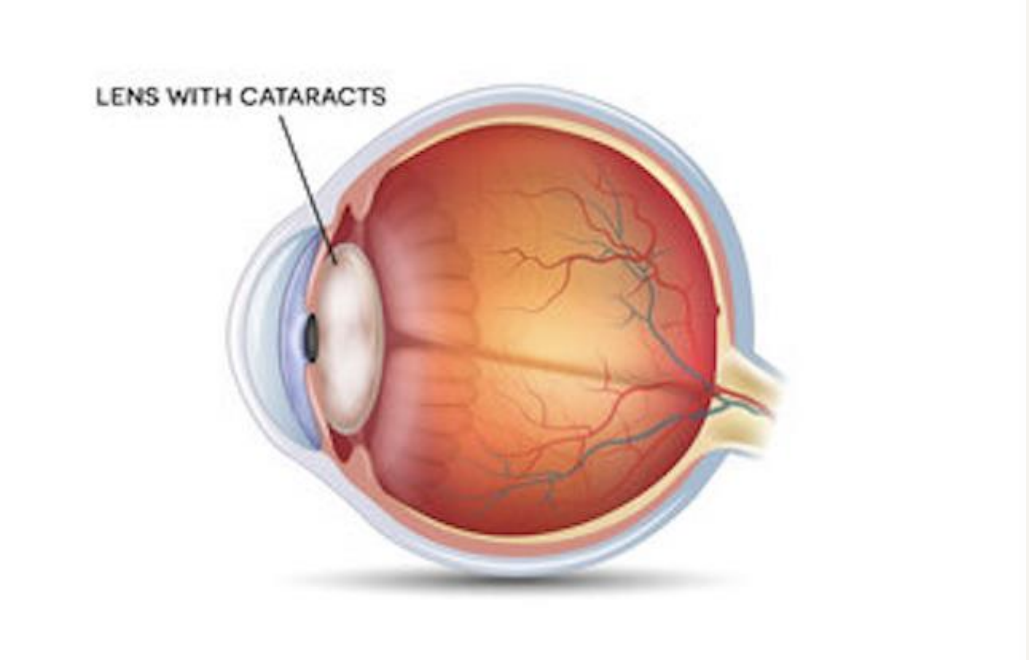
Normal Eye



https://atlanticeyeinstitute.com/diabetic-eye-issues-5-ways-diabetes-impacts-vision/

Introduction

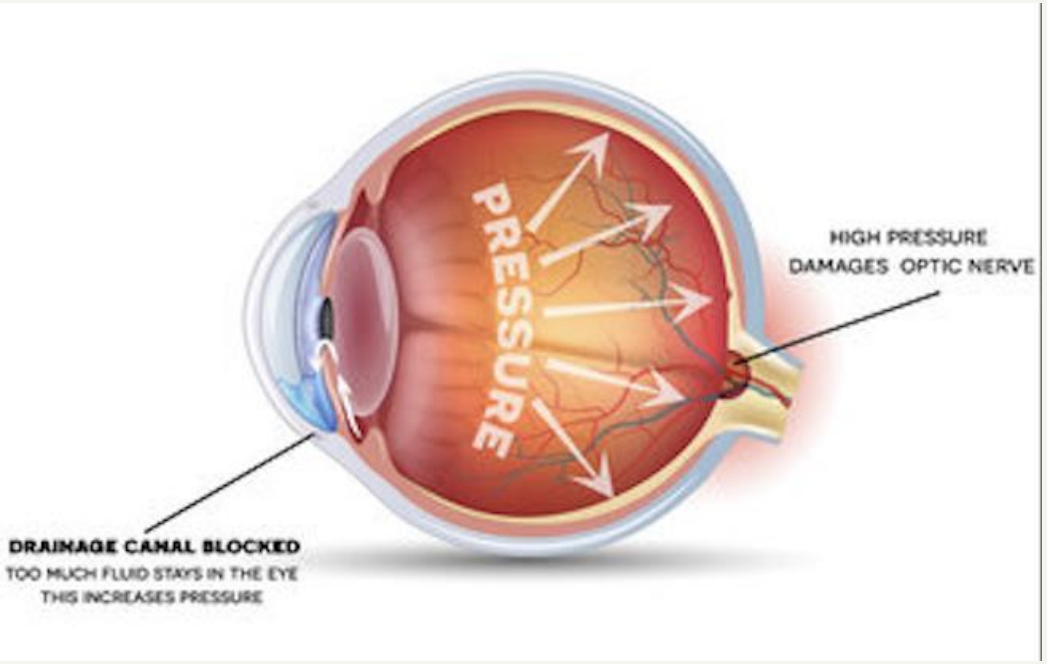
Cataract



https://atlanticeyeinstitute.com/diabetic-eye-issues-5-ways-diabetes-impacts-vision/

Introduction

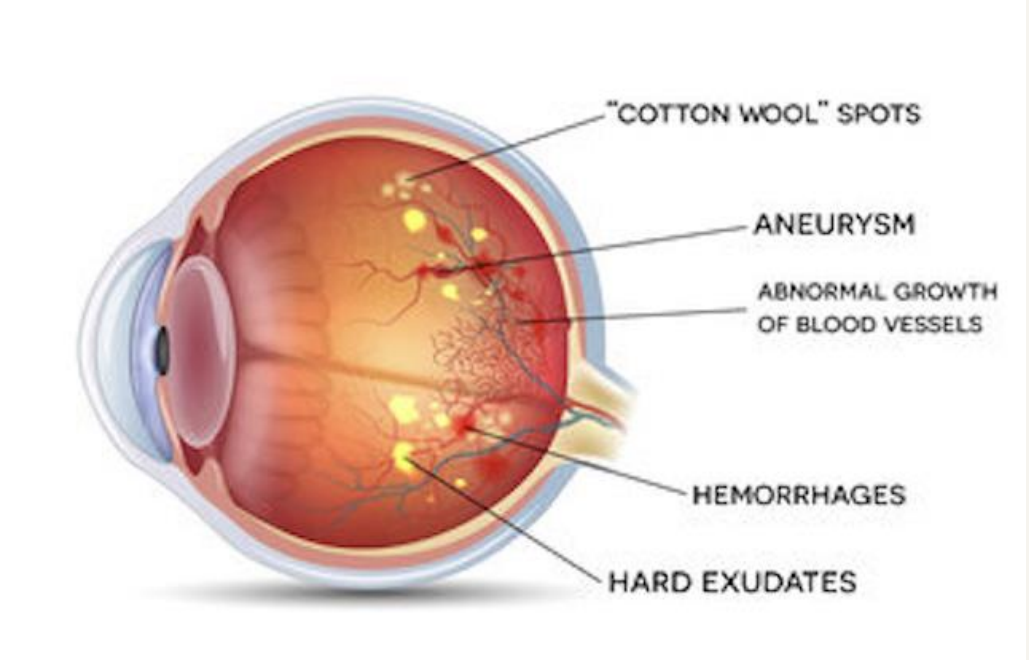
Glaucoma



https://atlanticeyeinstitute.com/diabetic-eye-issues-5-ways-diabetes-impacts-vision/

Introduction

Diabetic Retinopathy



https://atlanticeyeinstitute.com/diabetic-eye-issues-5-ways-diabetes-impacts-vision/

Data

→ *from Kaggle*
(Medical Scan Classification Dataset LINK)

Normal: 1074 Files

Cataract: 1038 Files

Glaucoma: 1007 Files

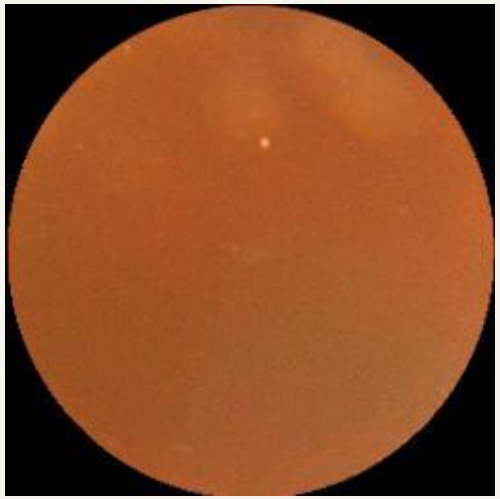
Diabetic Retinopathy: 1098 Files

→ Almost balanced Distribution of the data

Preprocessing

- Manual visual inspection of the images in each class

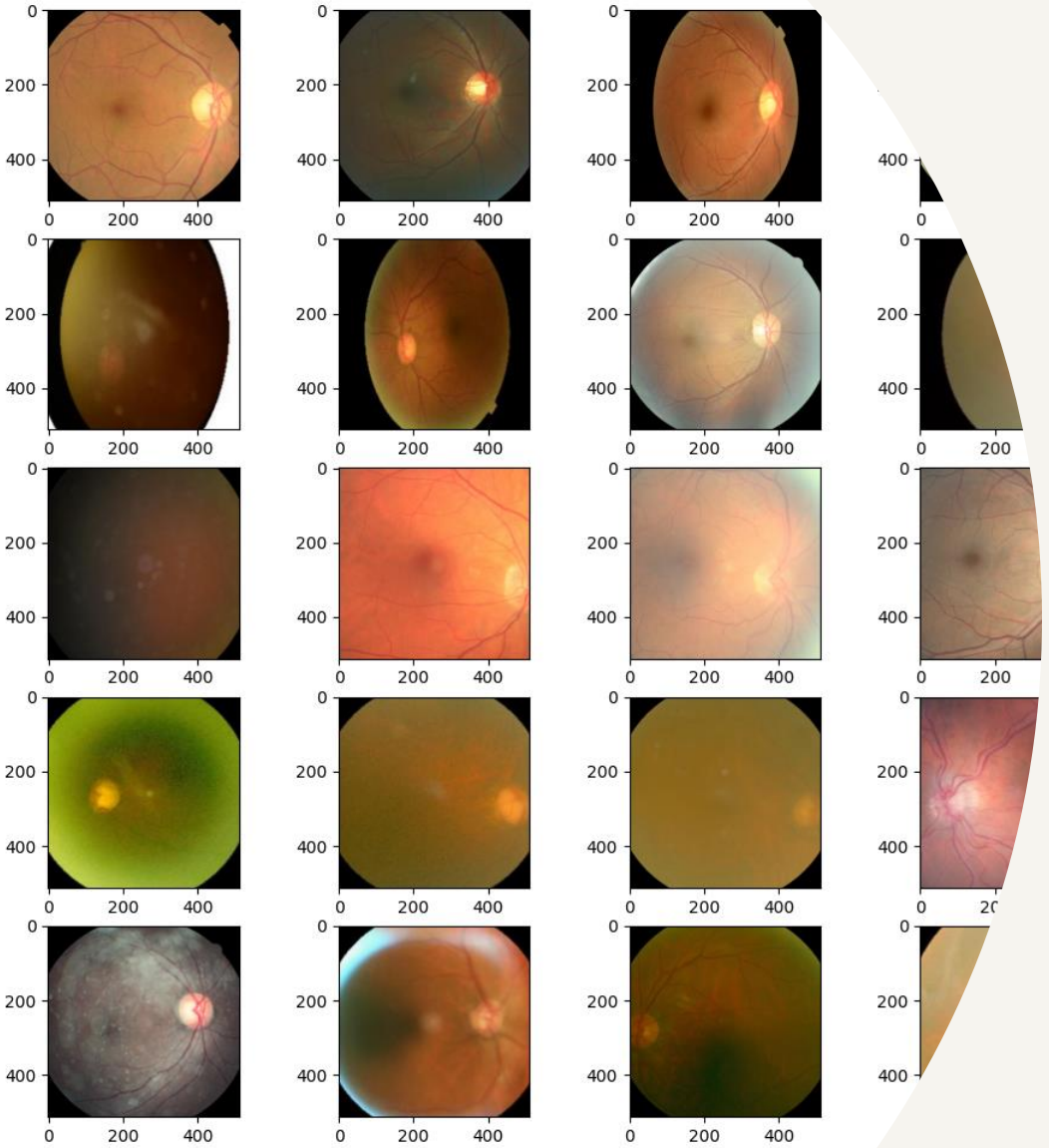
Normal Eye



Cataract

Glaucoma

Diabetic Retinopathy

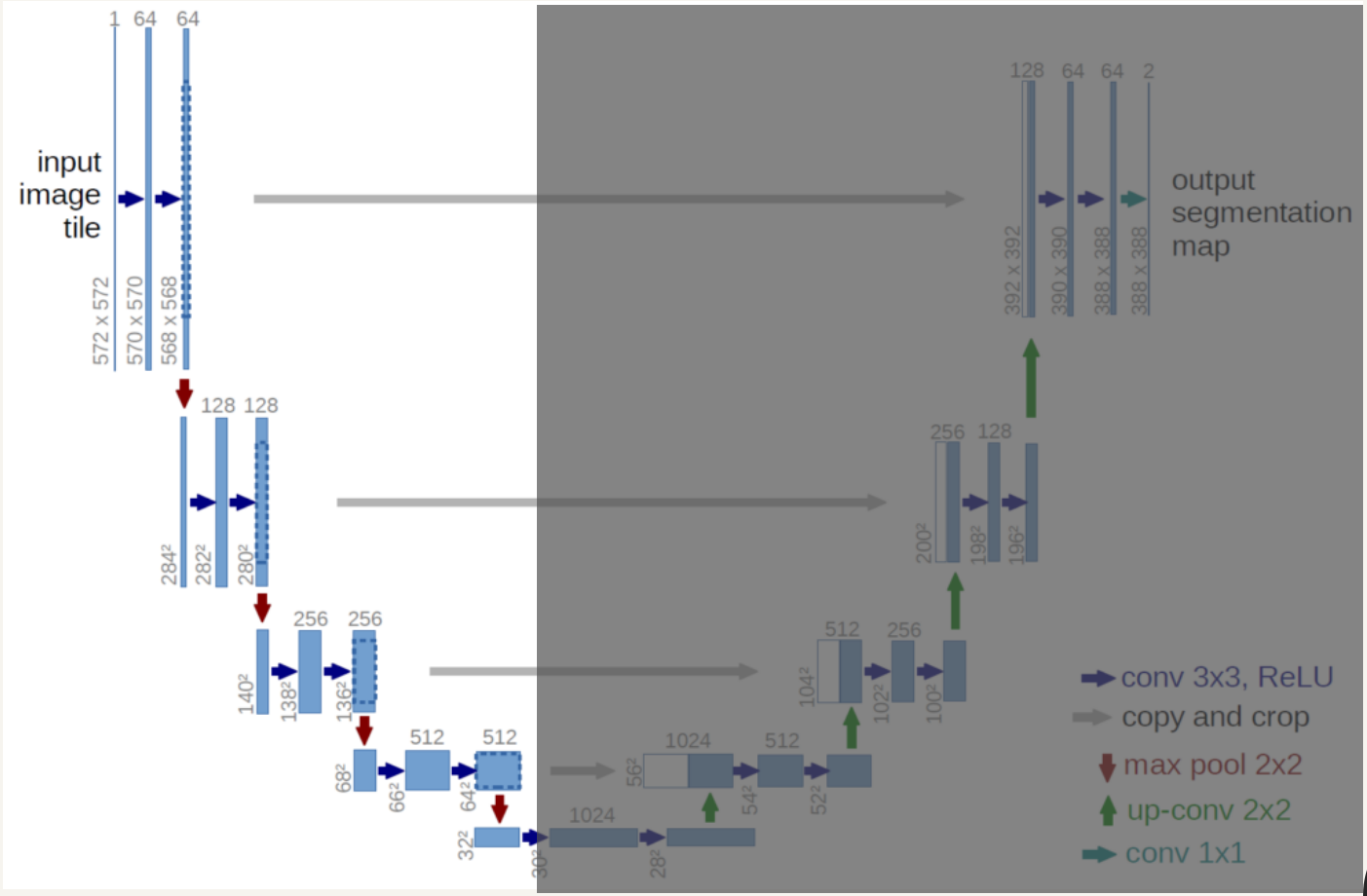


Preprocessing

- **Resizing** to 600 x 600 pixels
- **Center Crop** to 512 x 512 pixels
- **Data Splitting**
  - 80% (3374 images) training
  - 20% (843 images) validation

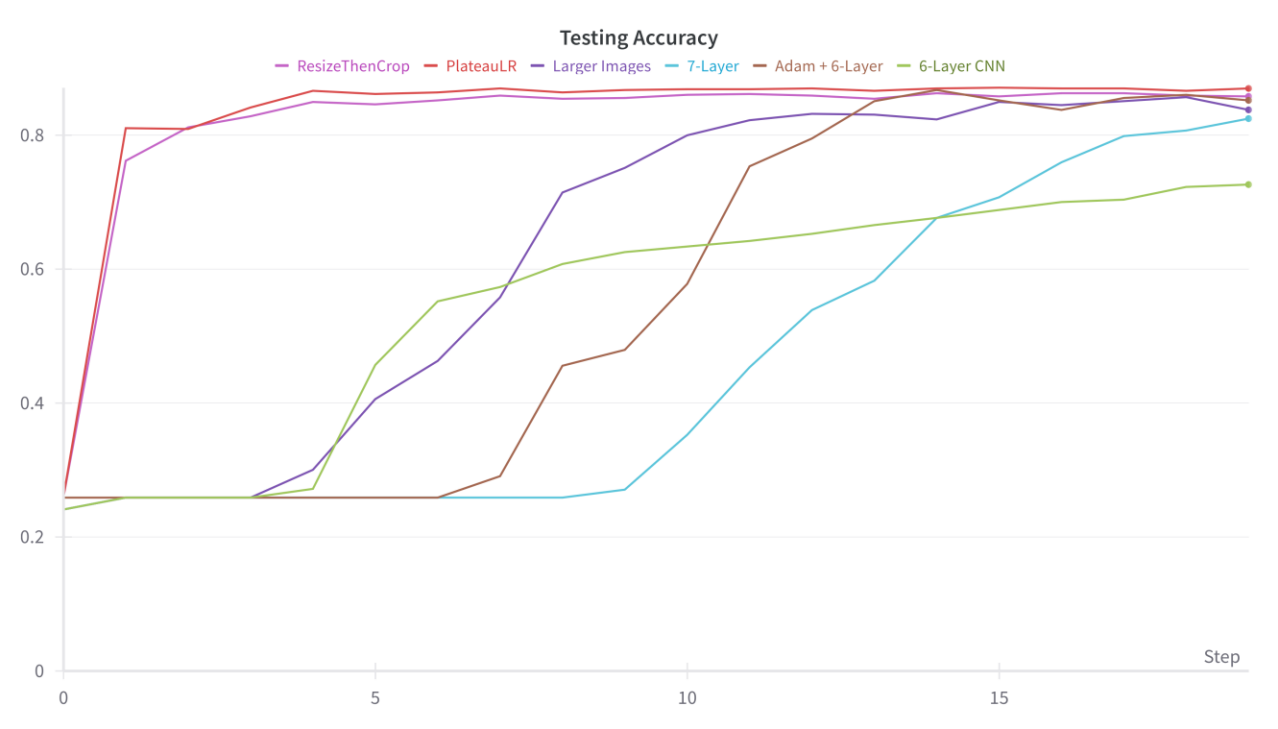
Model – Architecture

- Adaption of the encoder part of the **U-Net architecture** with minor changes, such as **padding** and **2 additional layers**
- (see *U-Net: Convolutional Networks for Biomedical Image Segmentation*)



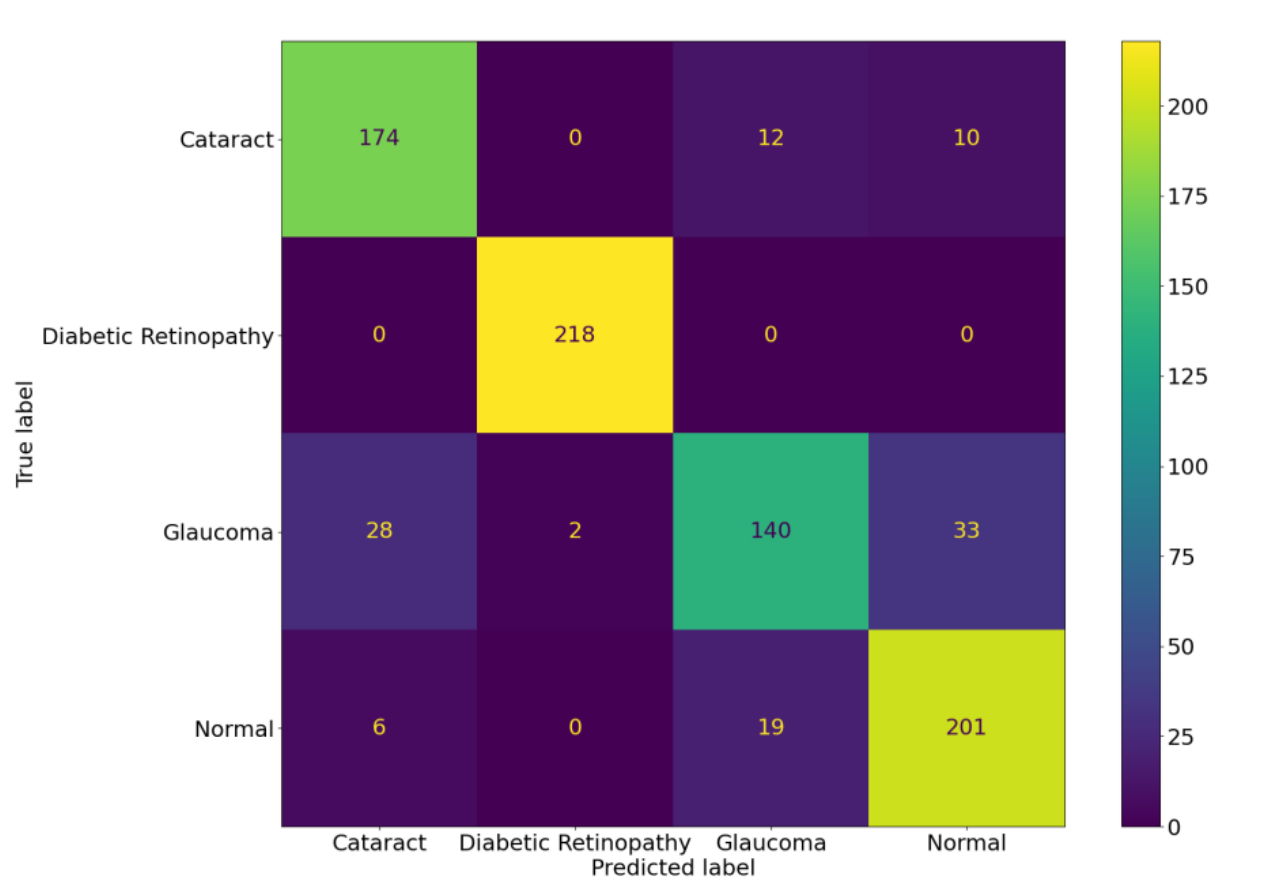
U-Net: Convolutional Networks for Biomedical Image Segmentation (https://arxiv.org/pdf/1505.04597)

Model - Performance



- Final balanced accuracy: ~87%
- The F1-Score matches accuracy
- Learning Rate scheduling plays a big role!

Model - Performance



Class wise accuracy

- **Normal Eye:** 91.9%
- **Glaucoma:** 88.8%
- **Cataract:** 93.1%
- **Diabetic Retinopathy:** 96.4%

Related Work

Multi Class

→ ours: 86.9%

Study	Approach	Accuracy
Khan et al. (2019) An Automatic Ocular Disease Detection Scheme from Enhanced Fundus Images Based on Ensembling Deep CNN Networks LINK	CNN	86 %
Glaret et al. (2022) Optimized convolution neural network based multiple eye disease detection LINK	CNN	98.3 %
Gour et al. (2021) Multi-class multi-label ophthalmological disease detection using transfer learning based convolutional neural network LINK	CNN	89.06%

Related Work

Glaucoma

→ ours: 88.8%

Study	Approach	Accuracy
Raghavendra et al. (2018) Deep convolution neural network for accurate diagnosis of glaucoma using digital fundus images LINK	CNN	98.13 %
Dias-Pinto et al. (2019) CNNs for automatic glaucoma assessment using fundus images: an extensive validation LINK	CNN (with different ImageNet-trained models)	96.05%
Shoba et al. (2020) Detection of glaucoma disease in fundus images based on morphological operation and finite element method LINK	SVM	94.86%
Septiarini et al. (2018) Automatic Glaucoma Detection Method Applying a Statistical Approach to Fundus Images LINK	KNN	95.24%

Related Work

Cataract

→ ours: 93.1%

Study	Approach	Accuracy
Zhang et al. (2017) Automatic cataract detection and grading using Deep Convolutional Neural Network LINK	CNN	93.52 %
Ran et al. (2018) Cataract Detection and Grading Based on Combination of Deep Convolutional Neural Network and Random Forests LINK	CNN with Random Forest	90.69 %
Zhou et al. (2020) Automatic Cataract Classification Using Deep Neural Network With Discrete State Transition LINK	Deep NN	94.00%

Related Work

Diabetic Retinopathy

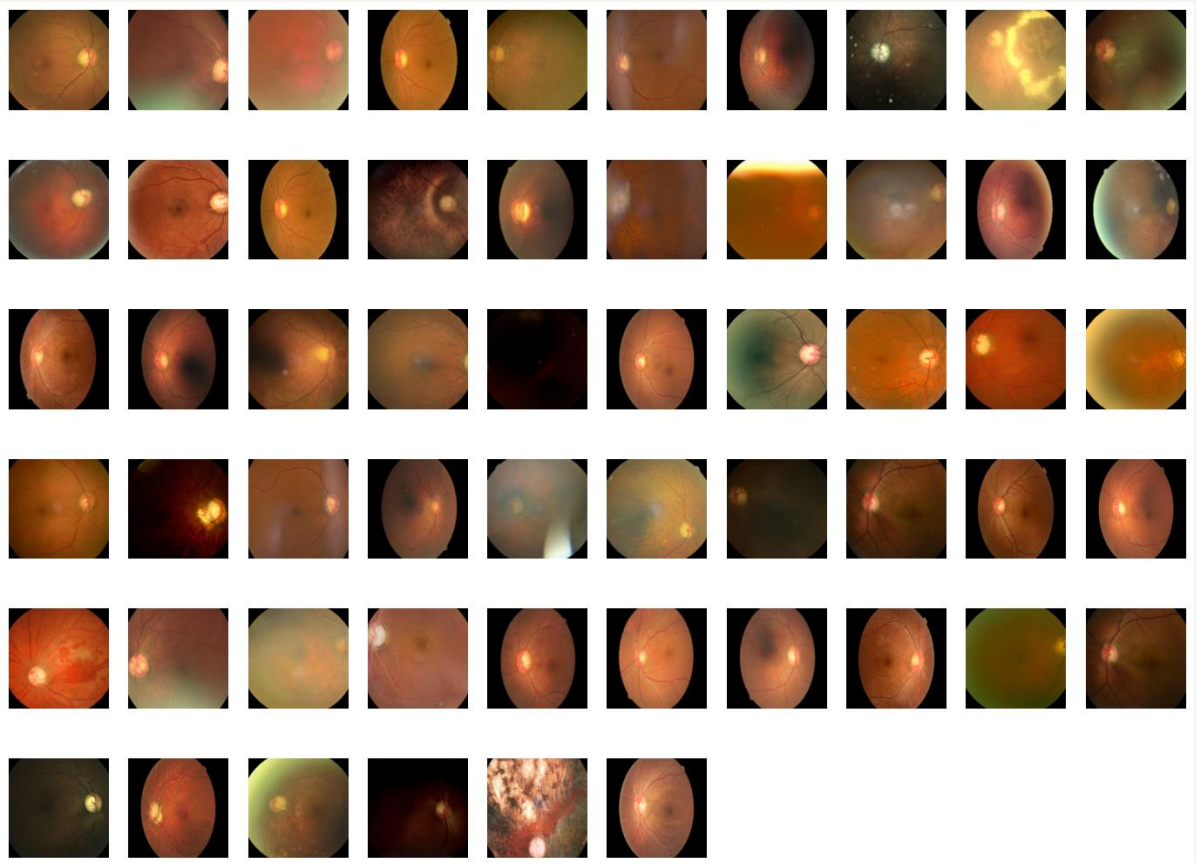
→ ours: 96.4%

Study	Approach	Accuracy
Mohsin Butt et al. (2019) Multi-channel Convolutions Neural Network Based Diabetic Retinopathy Detection from Fundus Images LINK	CNN	97.08 %
Li et al. (2019) Computer-Assisted Diagnosis for Diabetic Retinopathy Based on Fundus Images Using Deep Convolutional Neural Network LINK	CNN	91.05%
Saleh et al. (2018) Learning ensemble classifiers for diabetic retinopathy assessment LINK	Ensemble Classifiers	72.84%

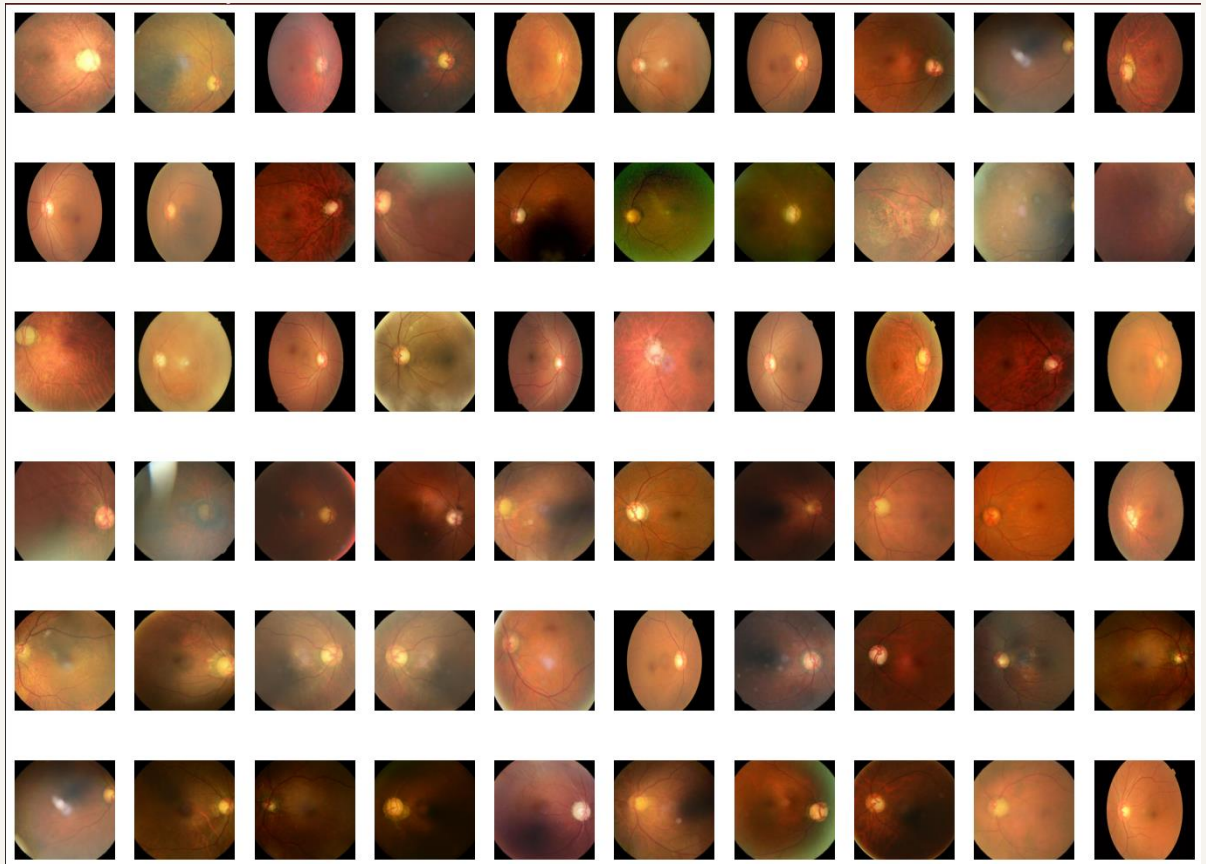
Glaucoma?

- *Our model performs ~10% below State-of-the-art when it comes to Glaucoma predictions. Why?*

Incorrect Predictions



Correct Predictions



Glaucoma?

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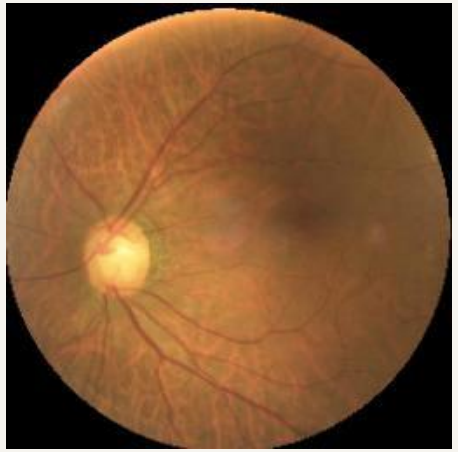
Discussion & Future Steps

The images are not uniform (within and across classes). It could be very beneficial if we could transform them in the same format. The center crop helps, but not for all variations, such as images with different aspect ratios



Discussion & Future Steps

- *We will test whether down-sampling solves the issue with the poor performance regarding Glaucoma*
- *Do a 5-fold cross-validation on the dataset*

```
        super().__init__()
        self.classifier = Sequential(
            double_convolution_layer(3, 16),
            MaxPool2d(4),
            double_convolution_layer(16, 32),
            MaxPool2d(4),
            double_convolution_layer(32, 64),
            MaxPool2d(2),
            double_convolution_layer(64, 128),
            MaxPool2d(2),
            double_convolution_layer(128, 256),
            MaxPool2d(2),
            double_convolution_layer(256, 512),
```

Code Walk-Through

Question