# Blindness Detection Using Deep Learning

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# Diabetic Retinopathy (DR)

- DR is a condition that causes damage to blood vessels in the retina
- Some of the risk factors are:
  - Type 1 or type 2 diabetes
  - Poor control of blood sugar
  - High blood pressure
  - High cholesterol
  - Pregnancy
  - Tobacco use
- It can lead to blurry or complete loss of vision
- The Eye Diseases Prevalence Research Group determined that in the US, the crude prevalence rate of retinopathy in adults with diabetes is 40.3%; sight-threatening retinopathy occurred at a rate of 8.2% [(1)].

# Diabetes Retinopathy

- Symptoms include:
  - Spots or dark strings floating in your vision (floaters)
  - Blurred vision
  - Fluctuating vision
  - Impaired color vision
  - Dark or empty areas in your vision
  - Vision loss
- A comprehensive dilated eye examination is conducted to diagnose DR and its progression.
- The pupils are dilated and fundus images are taken to assess blood vessels, optic nerves and retina

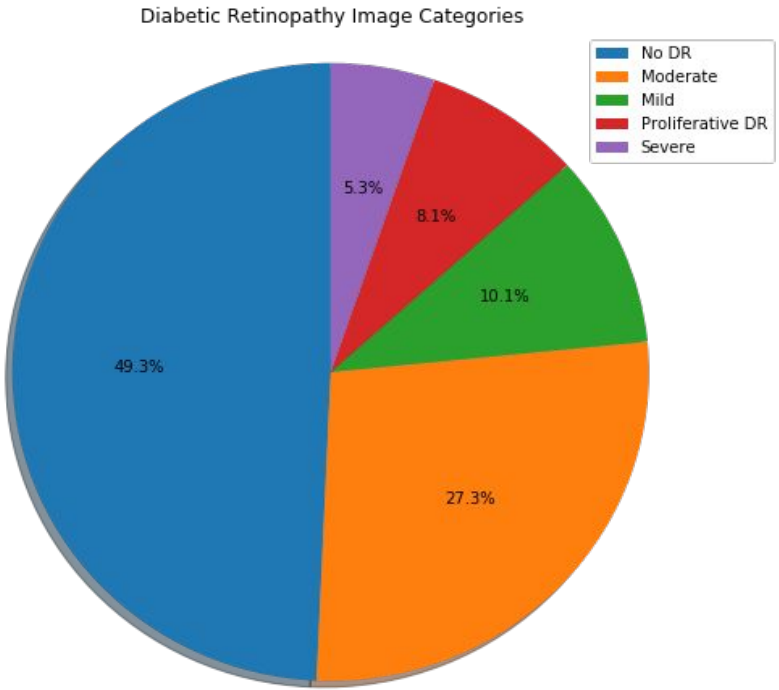
# Objective

The goal of the project is to develop a deep learning model that can effectively identify the severity of diabetic retinopathy from fundus images and classify it into the following categories:

0 - No Diabetic Retinopathy (DR)
1 - Mild
2 - Moderate
3 - Severe
4 - Proliferative DR

The dataset was made available via Kaggle competition, hosted by Aravind Eye Hospital and APTOS (https://www.kaggle.com/c/aptos2019-blindness-detection/overview )

# Dataset




| | |
|---|---|
| Total number of images | 3622 |
| No DR | 1805 |
| Mild | 370 |
| Moderate | 999 |
| Severe | 193 |
| Proliferative DR | 295 |

# Healthy vs DR Eye

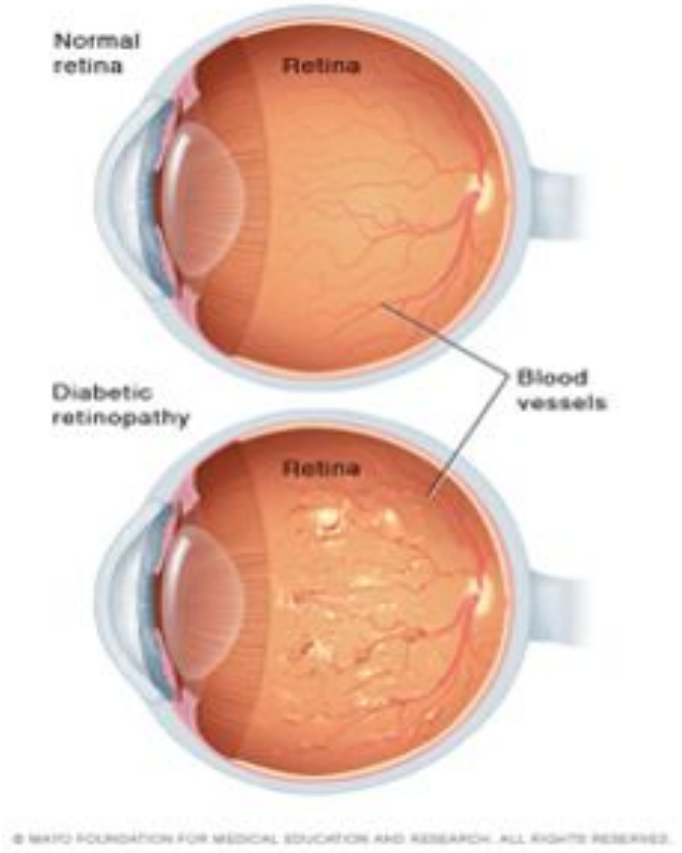
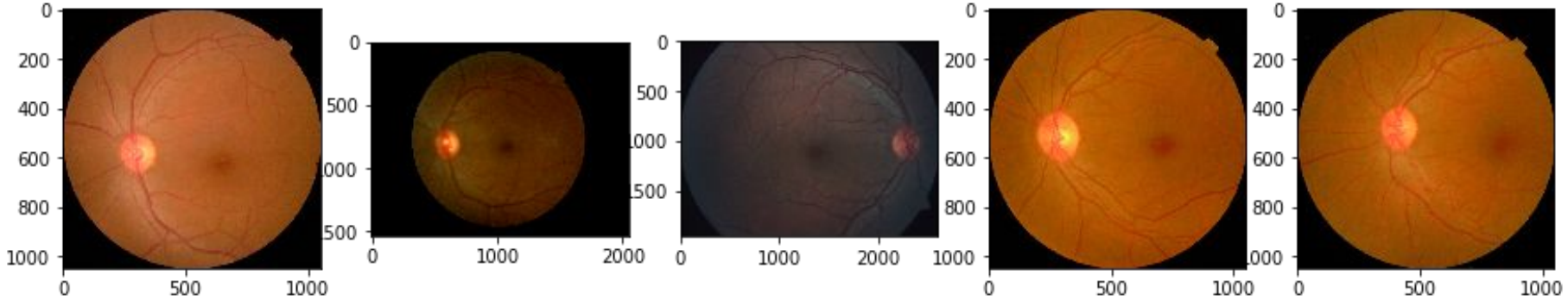


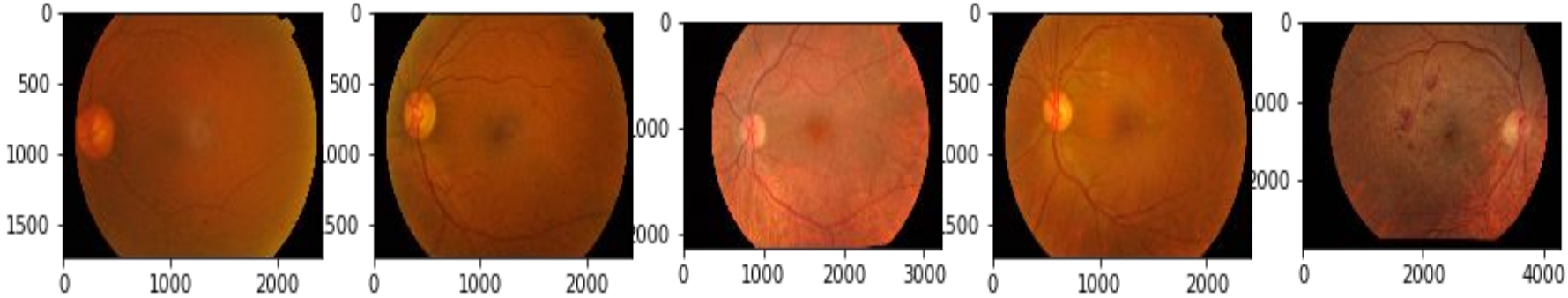



Image Courtesy: Mayo Clinic [2]

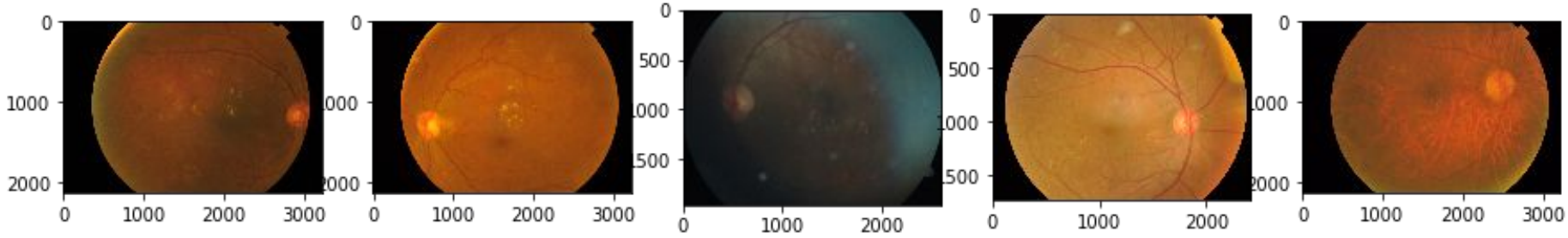
**No DR**



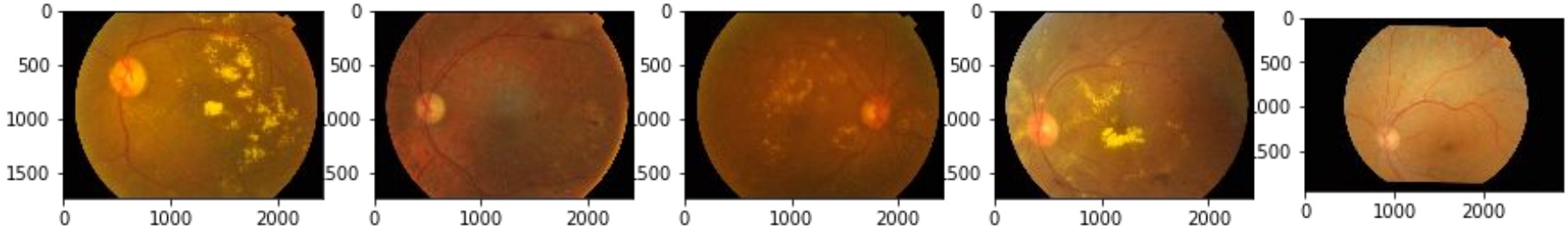
**Mild**



**Moderate**



**Severe**



**Proliferative DR**

# Deep Learning Models

1. Convolutional Neural Network from scratch

Transfer Learning using:

2. ResNet-50
3. VGG-19

# Model 1: CNN Architecture

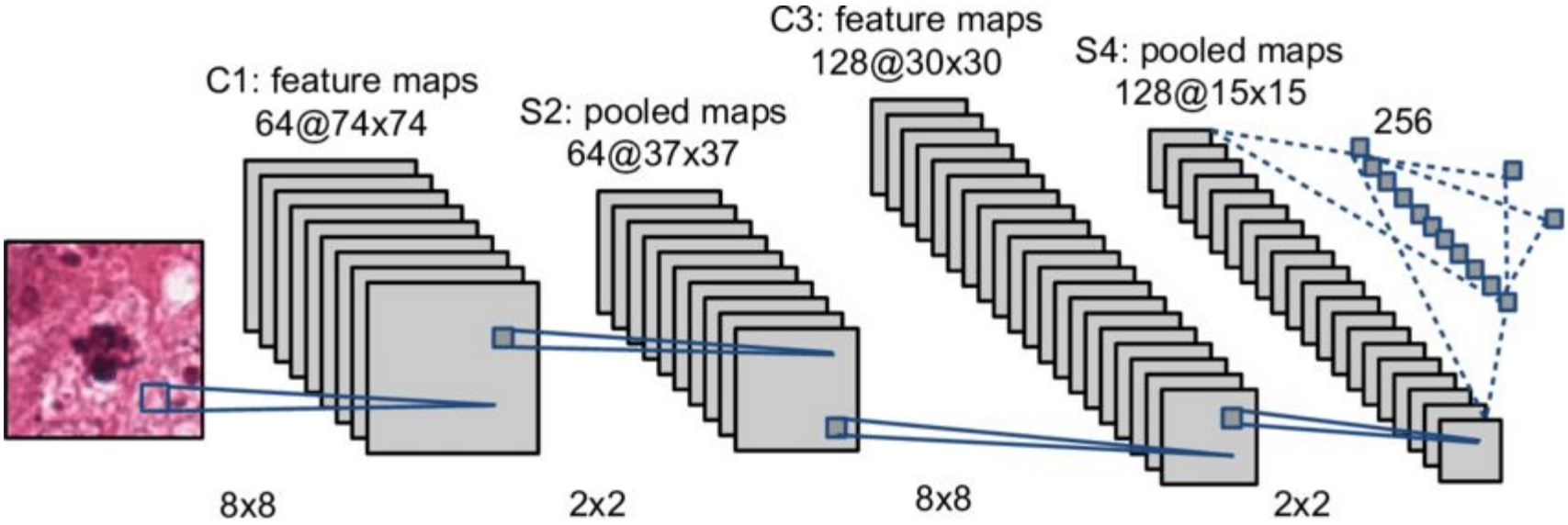
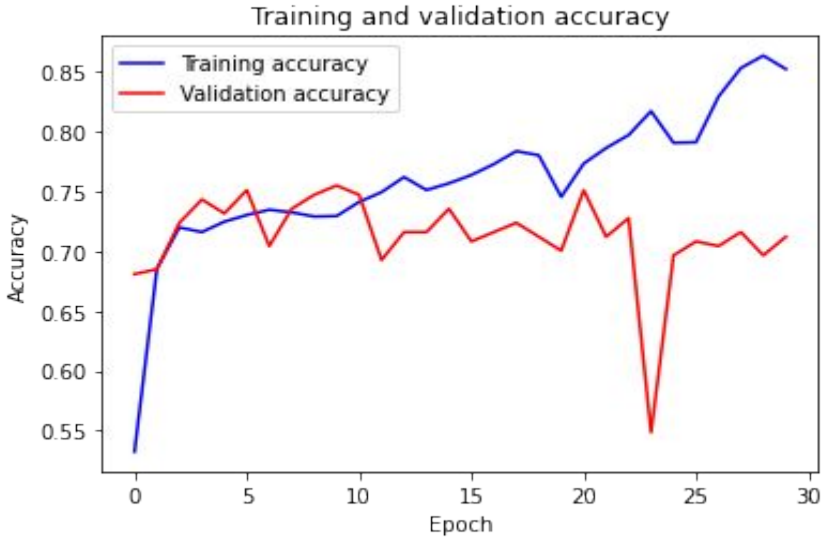
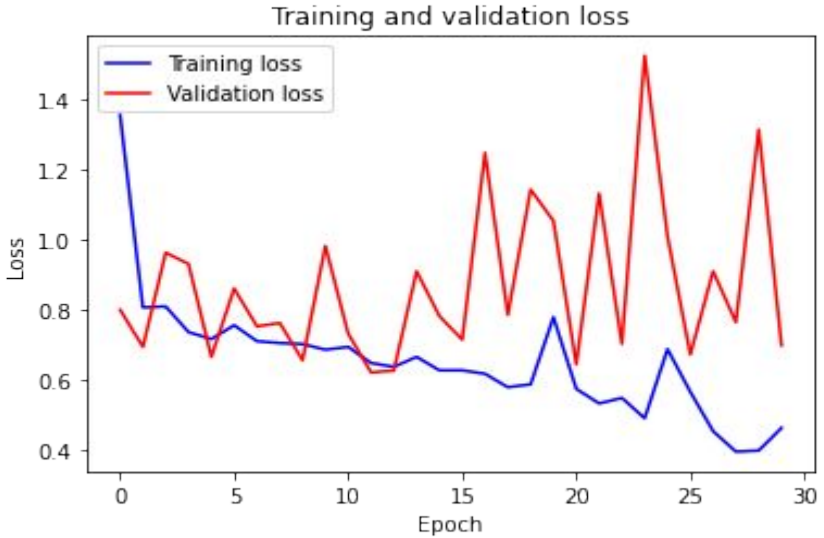



Image Courtesy: Wang et.al[3]

# Model 1: CNN Learning Curves




The model consisted of 3 convolution layers and pooling layers, followed by 3 dense and 2 dropout layers for regularization.

# Model 2: ResNet-50 Architecture

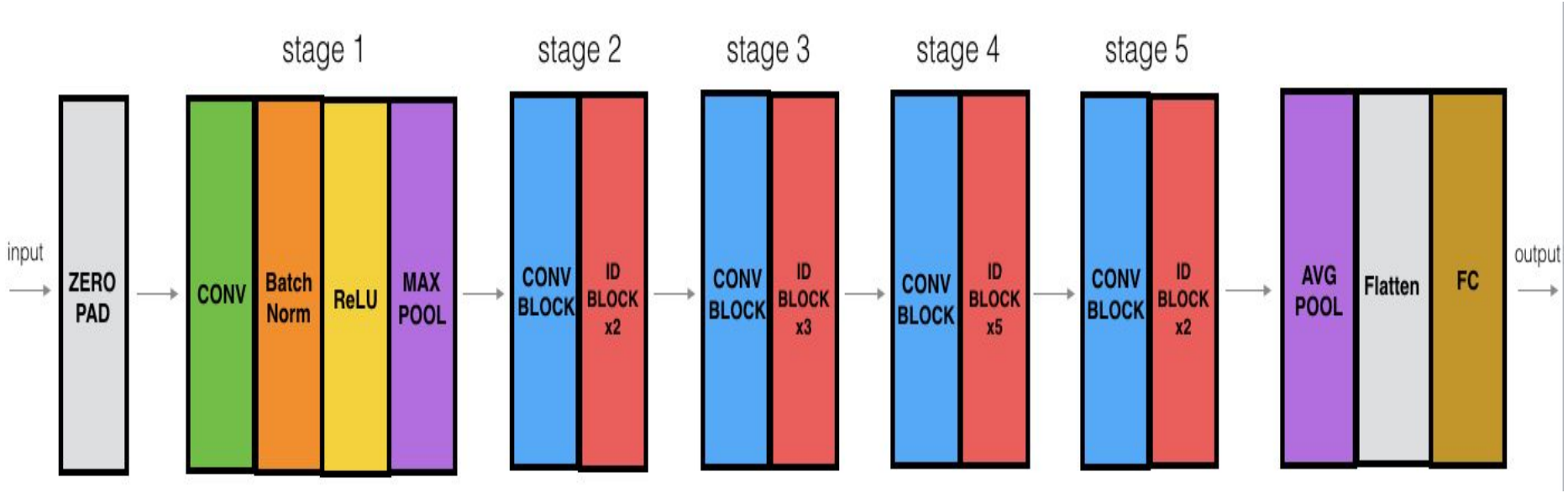
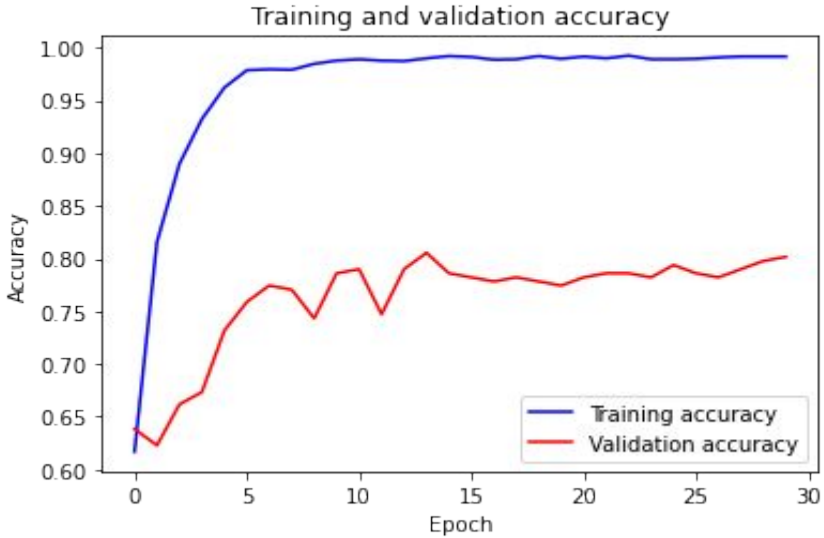
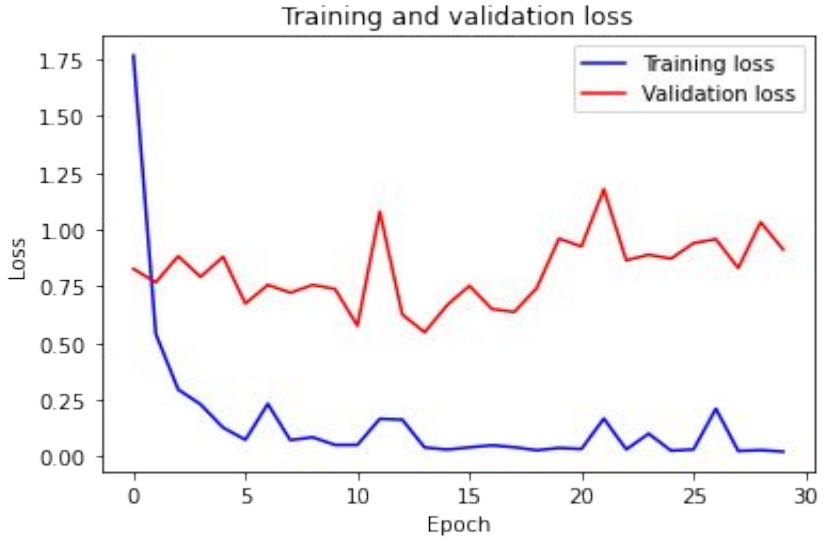



Image Courtesy: Priya Diwedi [4]

# Model 2: ResNet-50 Learning Curves



# Model 3: VGG-19 Architecture

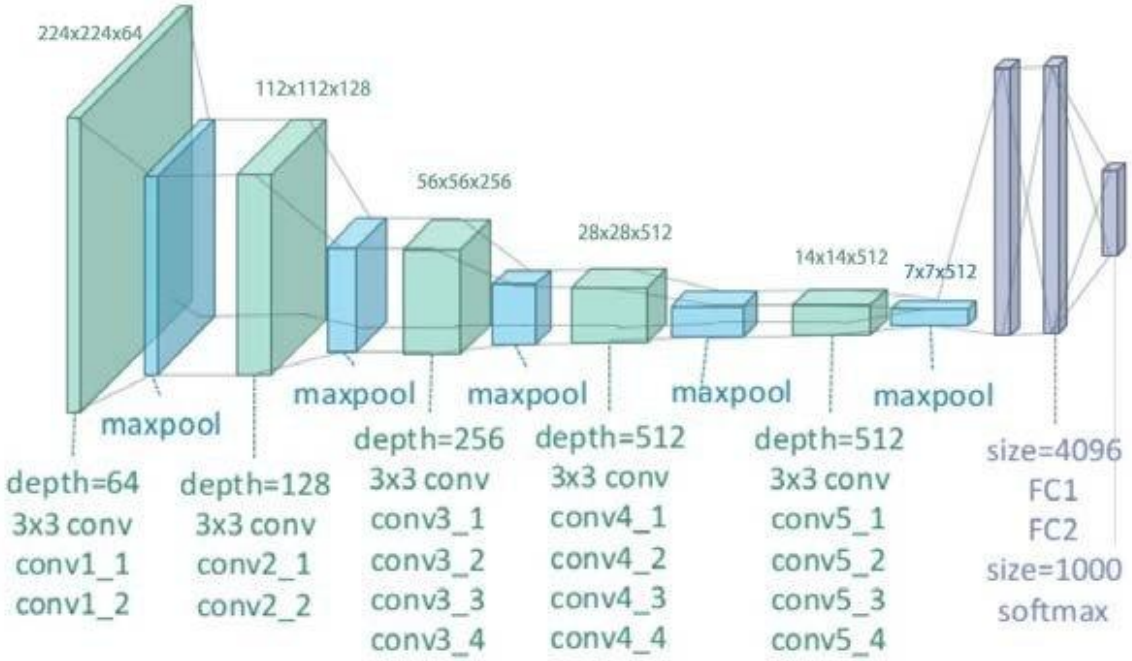
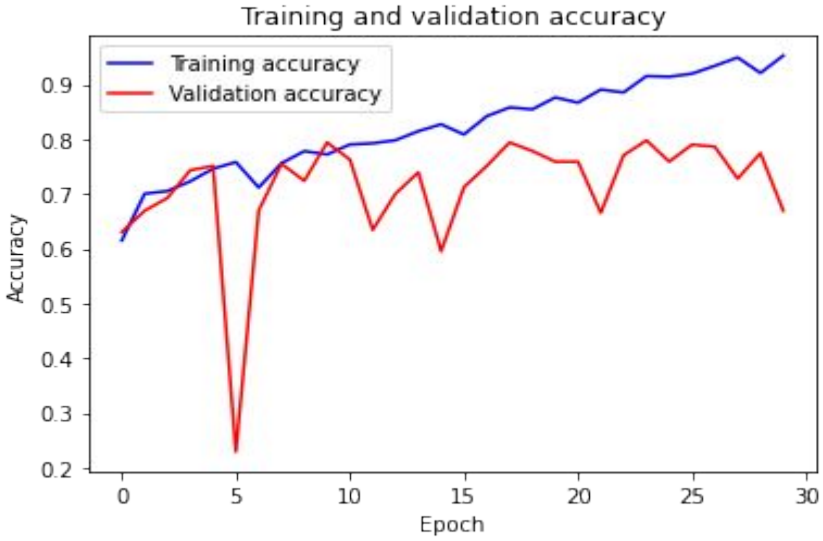
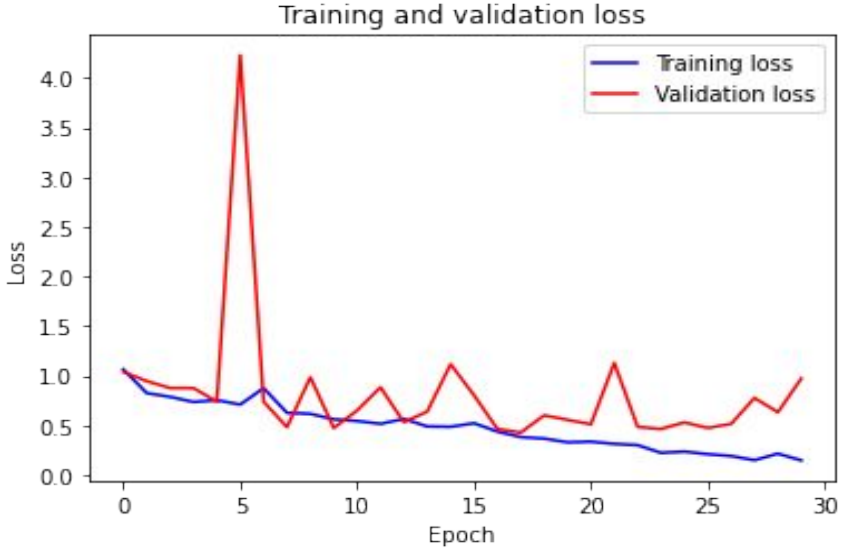



Image Courtesy: Zheng et.al [5]

# Model 3: VGG-19 Learning Curves



# Model Evaluation

| Model | Accuracy | Loss | Precision (weighted avg) | Recall (weighted avg) |
|---|---|---|---|---|
| CNN | 0.70 | 1.08 | 0.66 | 0.70 |
| Resnet50 | 0.72 | 2.03 | 0.66 | 0.72 |
| VGG-19 | 0.62 | 1.55 | 0.71 | 0.62 |

ResNet50 performs the best on the test dataset. It gives an accuracy of 72%. This is followed by the CNN model at 70% and VGG-19 at 62% accuracy. In all three models, the precision was highest in the No DR class. It could be because there were more images in that category. For future work, utilizing advanced preprocessing techniques, such as image augmentation, can help enhance the performance of these model.

# Conclusion

- Diabetic Retinopathy detection is not an easy process.
- It requires trained personnel and regular screening.
- Availability of trained professionals and screening equipment are a serious concern. However, it is very encouraging to see the potential of deep learning models to achieve some automation in the detection process. Collaboration of clinicians and deep learning experts would be crucial to take this project to the next level and help elevate the standard of care for patients.

# References


1. Diabetes Canada Clinical Practice Guidelines Expert Committee. Diabetes Canada 2018 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. Can J Diabetes. 2018;42(Suppl 1):S1-S325. (http://guidelines.diabetes.ca/cpg/chapter30#sec1)
2. Diabetic Retinopathy, Mayo Clinic, 2018 (https://www.mayoclinic.org/diseases-conditions/diabetic-retinopathy/symptoms-causes/syc-20371611#dialogId8139015)
3. Wang, Haibo & Cruz-Roa, Angel & Basavanhally, Ajay & Gilmore, Hannah & Shih, Natalie & Feldman, Mike & Tomaszewski, John & González, Fabio & Madabhushi, Anant. (2014). Mitosis detection in breast cancer pathology images by combining handcrafted and convolutional neural network features. Journal of Medical Imaging. 1. 1-8. 10.1117/1.JMI.1.3.034003.
4. Understanding and coding a ResNet in Keras, Priya Diwedi, Towards Data Science
5. Zheng, Yufeng & Yang, Clifford & Merkulov, Aleksey. (2018). Breast cancer screening using convolutional neural network and follow-up digital mammography. 4. 10.1117/12.2304564.)