EYENURI

By Azadeh & Buse

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Understanding Diabetic Retinopathy

Problem

Diabetic retinopathy (DR)

- Microvascular disorder that causes vision loss
- Long term effect of diabetes mellitus
- Very common for Type I diabetic patients
- Has 5 severity levels

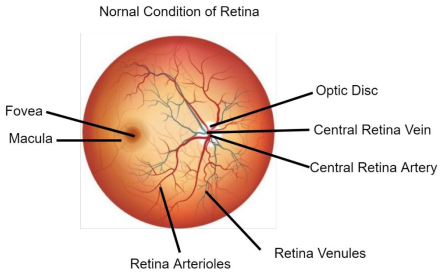
Painpoints

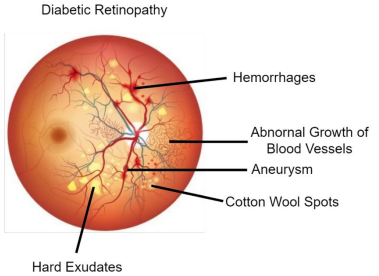
- Regular check-ups are required
- OCT is practical but appointments with a specialist is necessary
- Treatments have many side effects and expensive

Solution

An app that uses an image of your fundus to detect if your eye is healthy or not

- Time and cost efficient
- Patient friendly = Self-diagnosis
- Allows early diagnosis
- Extra source for the ophthalmologists





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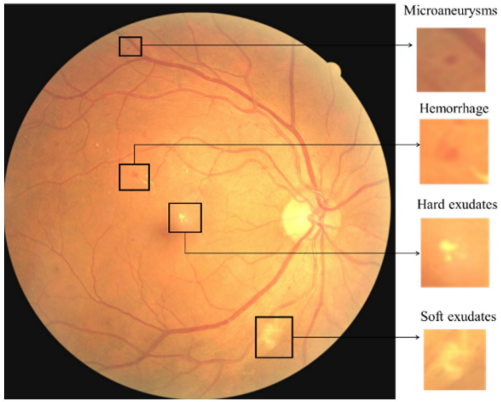
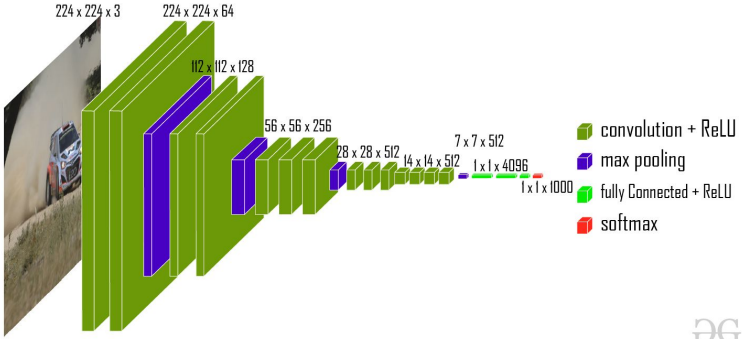
Method: Fundus Photography and Deep Learning





1. **Fundus image** preprocessing, where the data is obtained from **Kaggle**
2. Training and testing 4 different pre-trained **CNN models** and determine the best approach
   a. ResNet50
   b. Efficient Net
   c. Inception V3
   d. VGG16
3. TensorFlow model → Core ML model
4. Integrate the model to the **IOS app**

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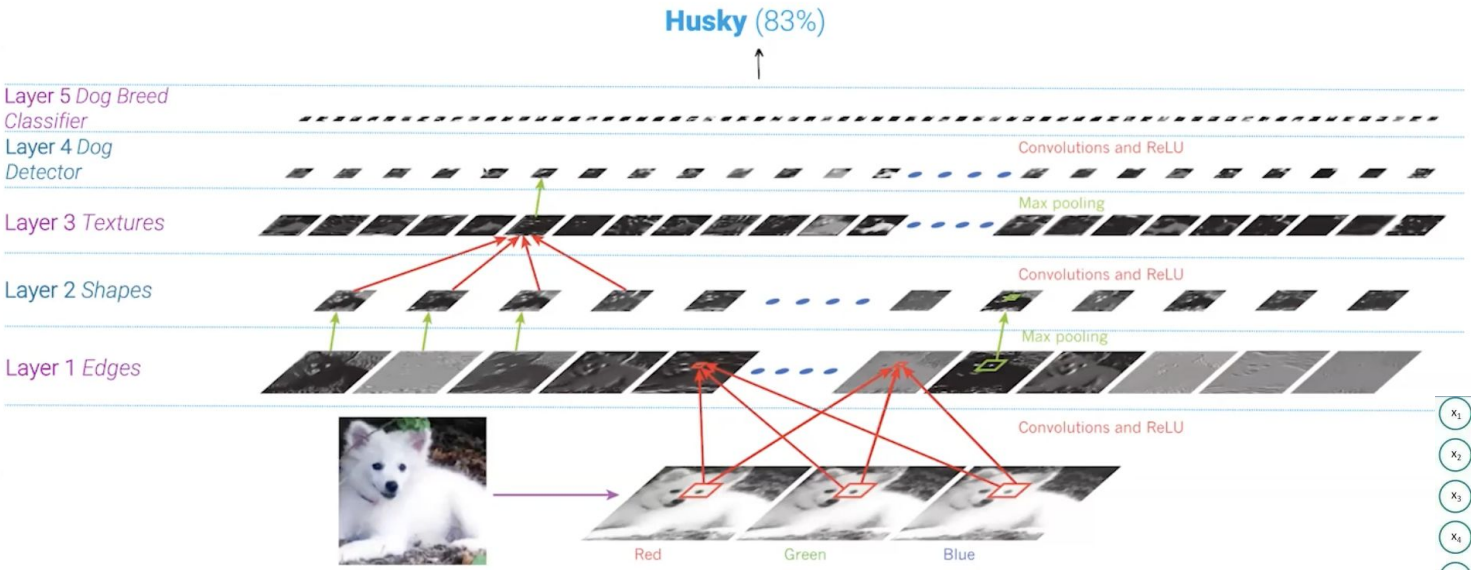
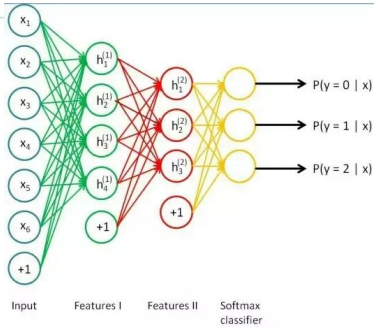
Convolutional Neural Network (CNN)



LeCun, Y., Bengio, Y. & Hinton, G. Deep learning. *Nature (2015)*



Stacked Autoencoders for the P300 Component Detection, Front. Neurosci., 2017

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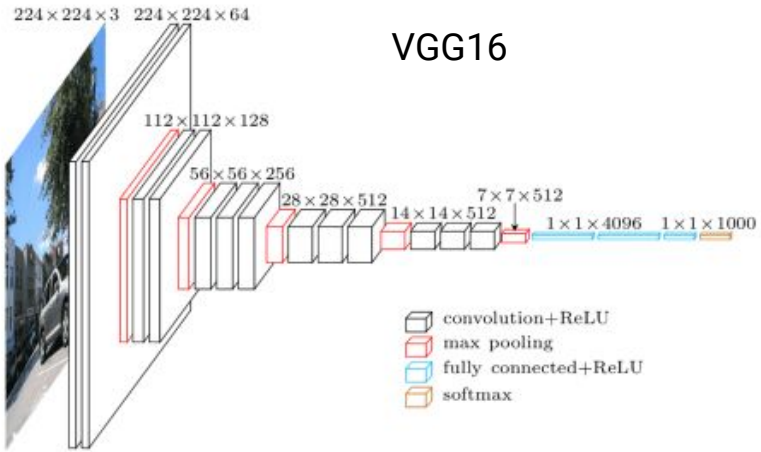
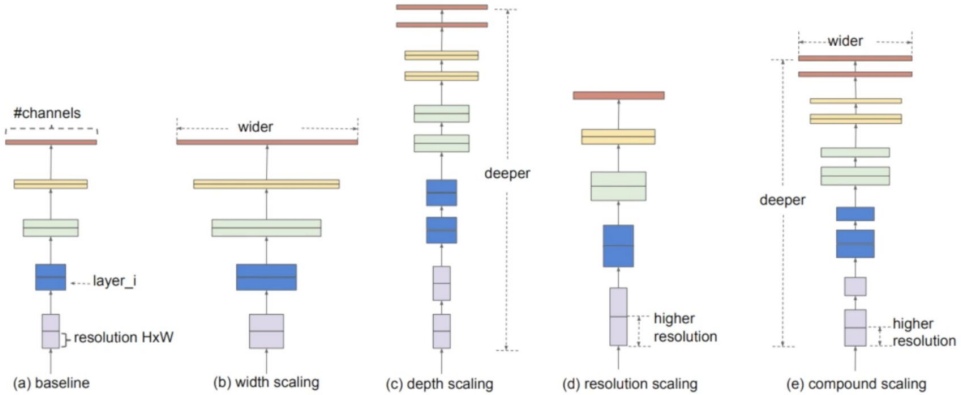
CNN Architectures

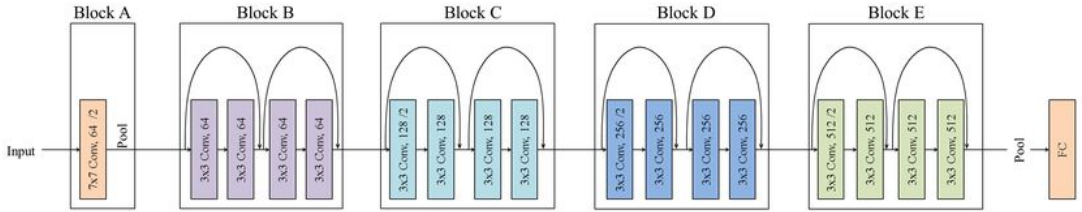
VGG16



EfficientNet



ResNet



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Platforms and Languages Used

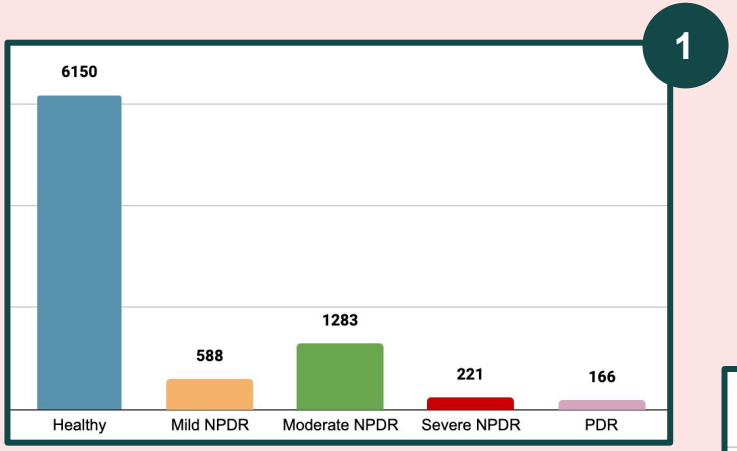
- Kaggle: For data and computing (GPU advantage)
- Visual Studio Code: IDE for Python
- XCode: IDE for Swift

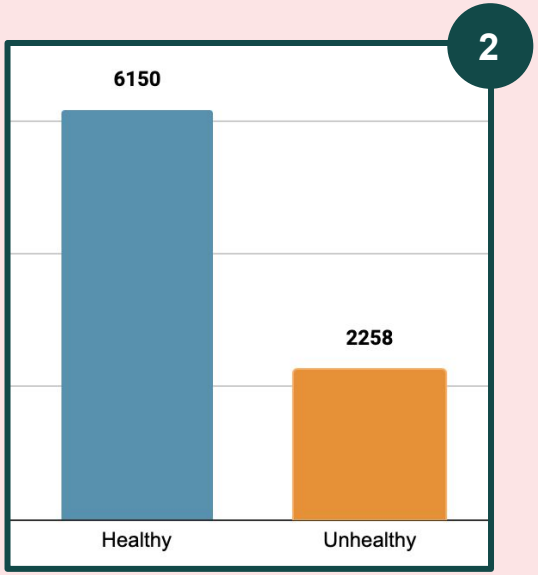
Used Libraries in Python

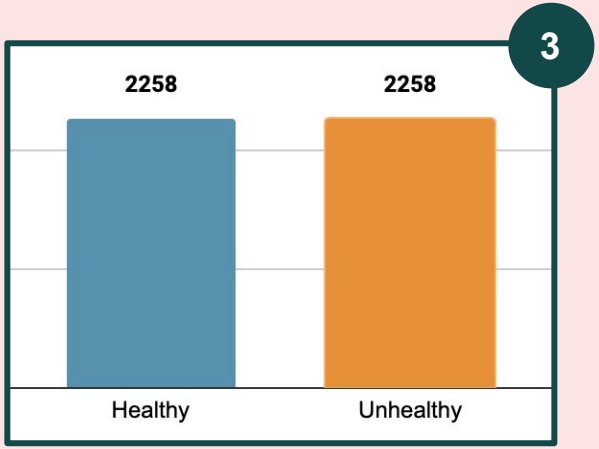
```
import [library name]
from [library name] import [function name]
```

- **tensorflow:** An end-to-end platform used for ML, e.g. data preprocessing, transforming, loading, validating
- **keras:** A part of TensorFlow. Most common deep learning framework. Improves the process of user actions
- **shutil:** High-level handling of files and directory, such as file copying or removing
- **pandas:** High-level data analysis, easy and flexible, can be used on labeled data sets
- **numpy:** Mainly for array computing, mathematical functions
- **matplotlib.pyplot:** Visualisations, and pyplot functions are for altering figures
- **seaborn:** Based on matplotlib, and used for creating statistical graphics
- **cv2 (OpenCV-Python):** Reading an image from a specific file
- **imutils:** Image processing, e.g. rotation, resizing
- **coremltools:** Converts trained ML models to Core ML format to integrate the model to the app

Data Selection







Data Preprocessing

Sorting images to right files

Selecting and processing a fraction of the Kaggle data

Checking the distribution of healthy and 4 different stages of unhealthy images

Categorization

Classification of data based on the distribution:

- **Class 0 = Healthy**
- **Class 1= Unhealthy**

Balancing no. of samples in each class for a better model

Separating no. of samples for training, validating and testing stages.

- **Training: 3162**
- **Validating: 678**
- **Testing: 676**

Image preparation

- Cropping
- Threshold
- Erode
- Dilate
- Contour
- Resize
- Specific preprocessing for model

Image conversion for the model

Every model has its own image processing method.

So all the images must be converted to a specific format for each individual model.

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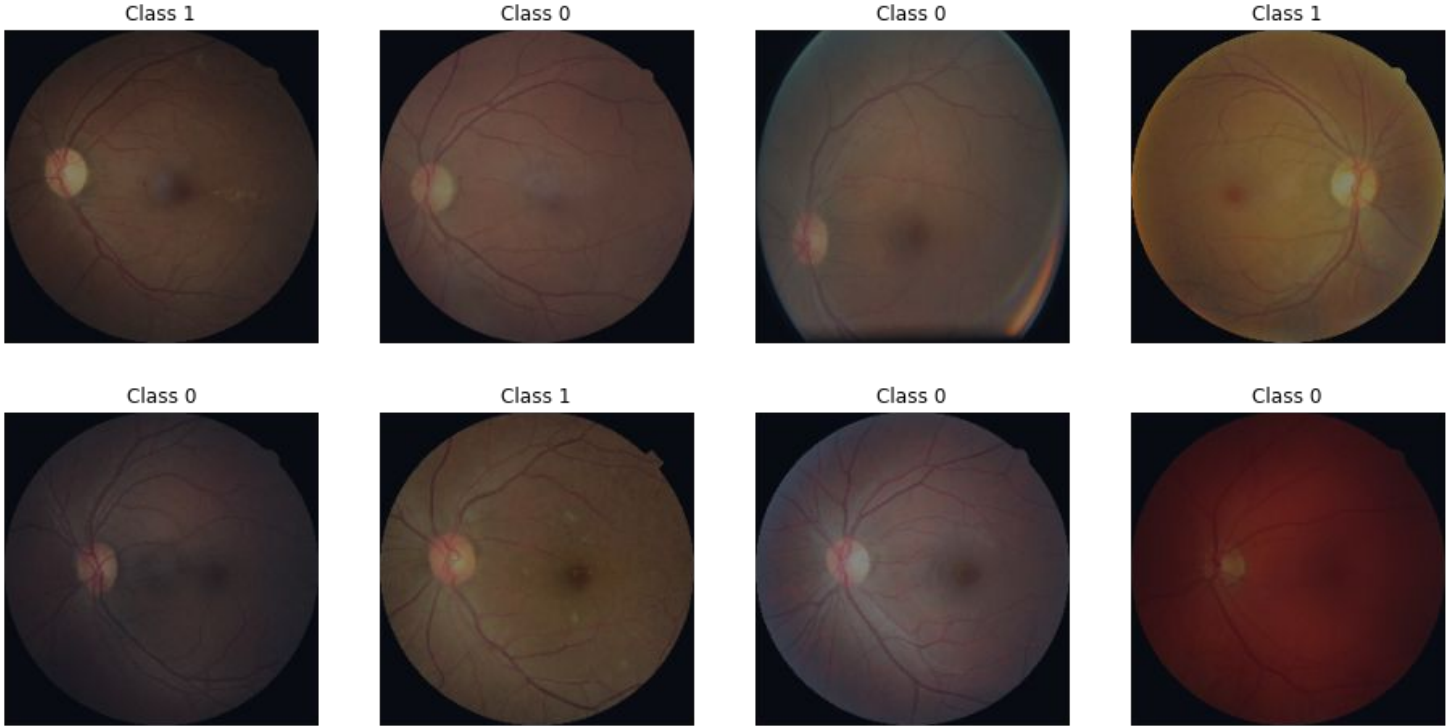
Data Preprocessing



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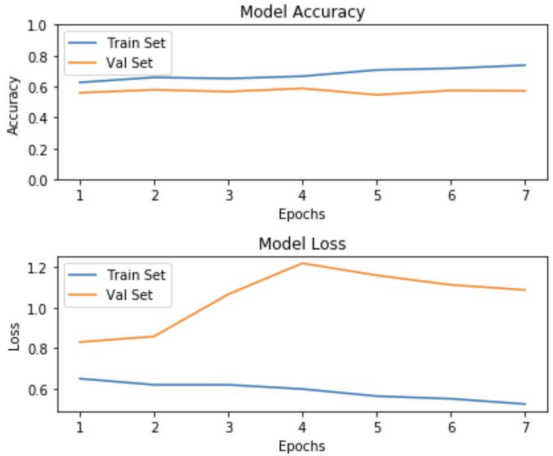
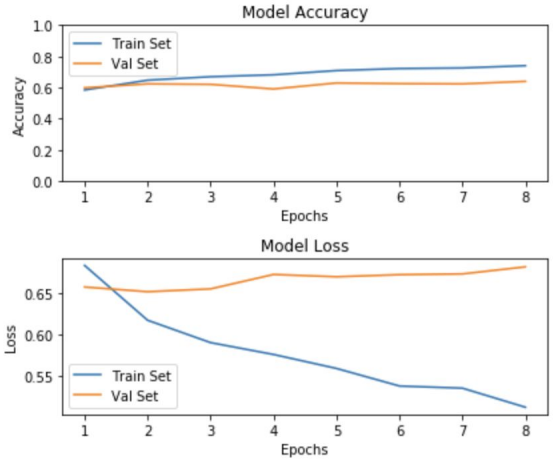
Evaluation of the Model

Training and Validation

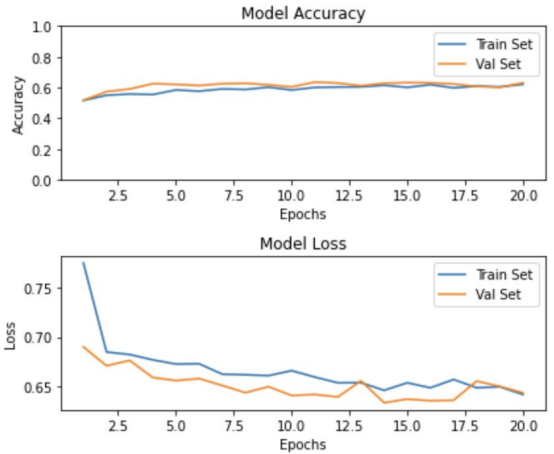
ResNet50



VGG16



EfficientNet



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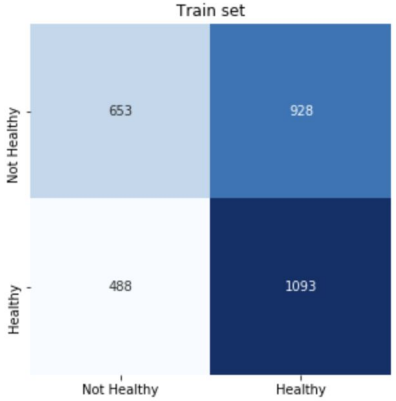
Evaluation of the Model

Train Set and Validation Set

ResNet50



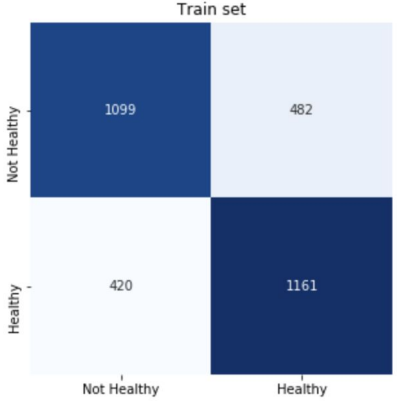
Accuracy: 0.55%

	precision	recall	f1-score	support
0.0	0.57	0.41	0.48	1581
1.0	0.54	0.69	0.61	1581
avg / total	0.56	0.55	0.54	3162

Accuracy: 0.57%

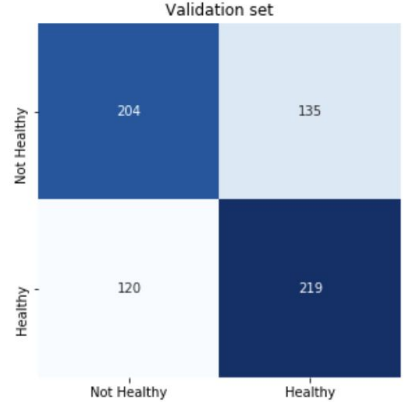
	precision	recall	f1-score	support
0.0	0.60	0.44	0.51	339
1.0	0.56	0.71	0.62	339
avg / total	0.58	0.57	0.56	678

VGG16



Accuracy: 0.71%

	precision	recall	f1-score	support
0.0	0.72	0.70	0.71	1581
1.0	0.71	0.73	0.72	1581
avg / total	0.72	0.71	0.71	3162



Accuracy: 0.62%

	precision	recall	f1-score	support
0.0	0.63	0.60	0.62	339
1.0	0.62	0.65	0.63	339
avg / total	0.62	0.62	0.62	678

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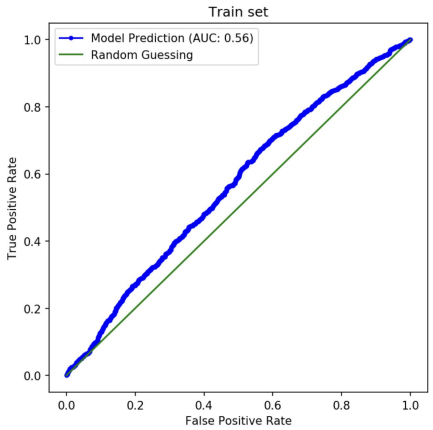
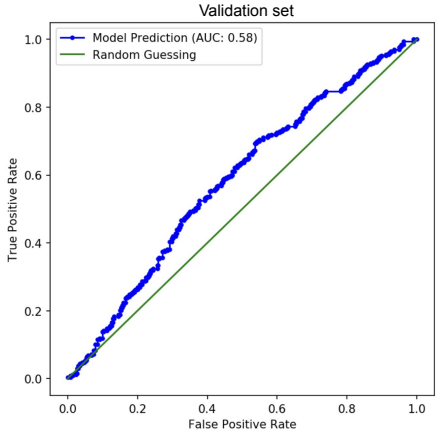
Evaluation of the Model

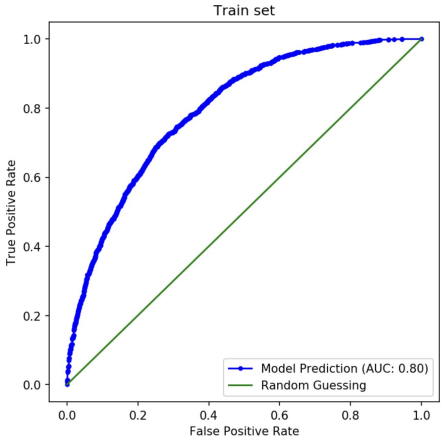
Train Set and Validation Set

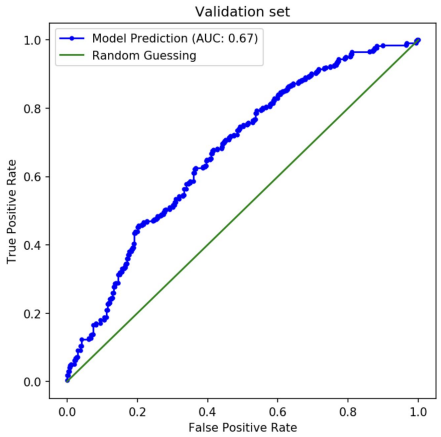
ResNet50





VGG16





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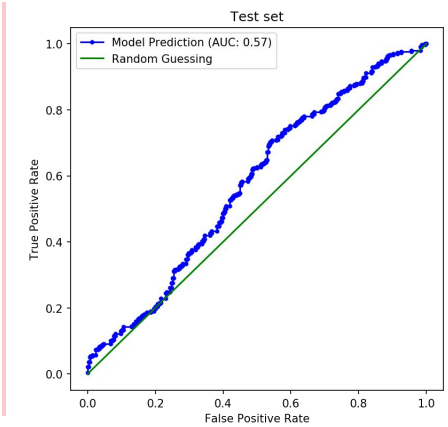
Evaluation of the Model

Test Set

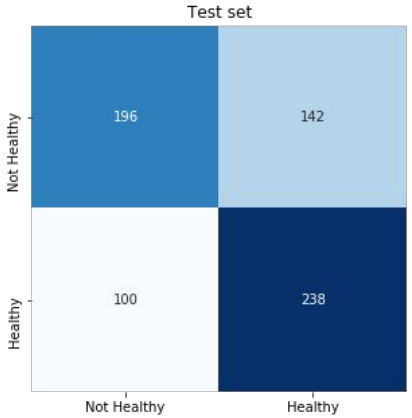
ResNet50

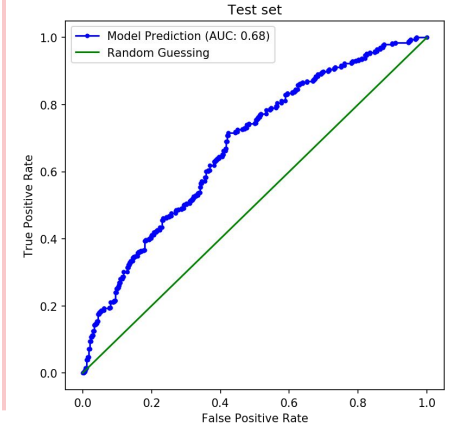


Accuracy on Test Data: 0.51%

	precision	recall	f1-score	support
0.0	0.51	0.75	0.61	338
1.0	0.52	0.28	0.36	338
avg / total	0.52	0.51	0.48	676

VGG16



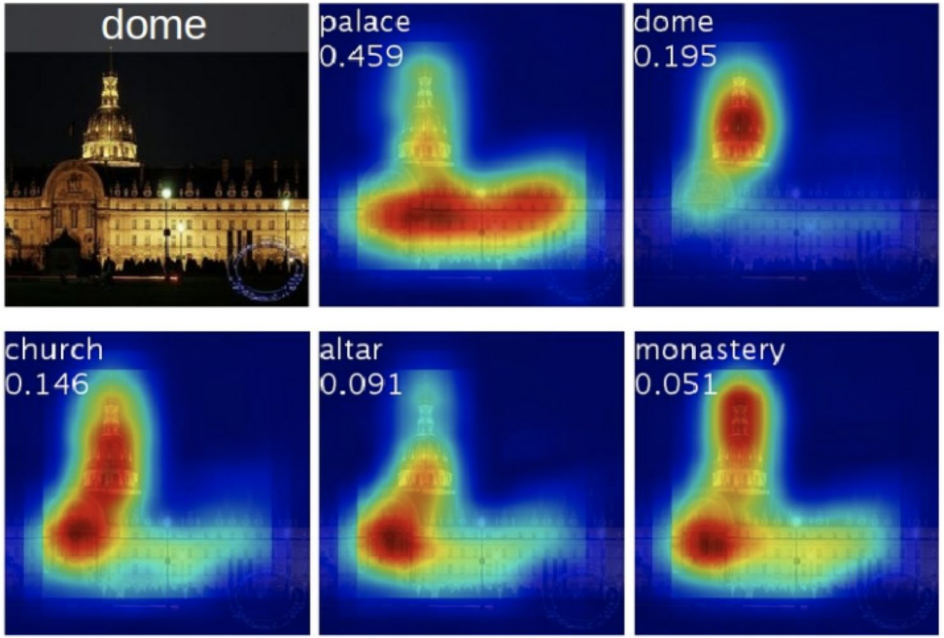


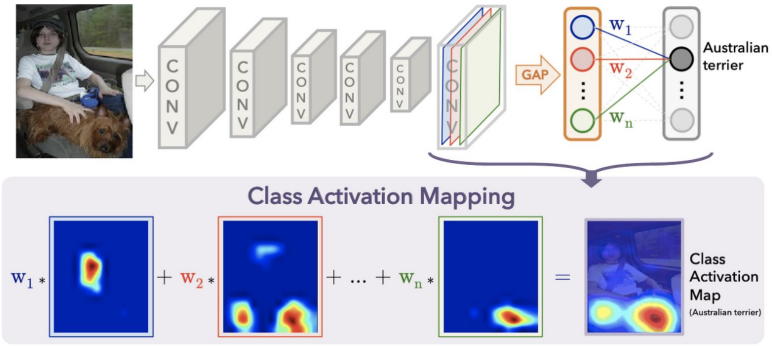
Accuracy on Test Data: 0.64%

	precision	recall	f1-score	support
0.0	0.66	0.58	0.62	338
1.0	0.63	0.70	0.66	338
avg / total	0.64	0.64	0.64	676

Explanation of the Model

Attention Maps: A way of improving the performance of the model by extracting the relevant feature of the input





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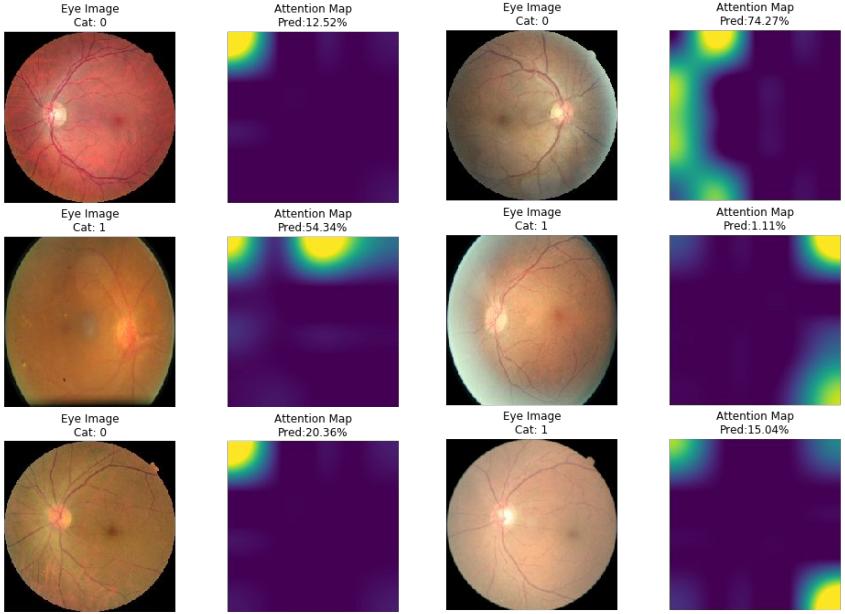
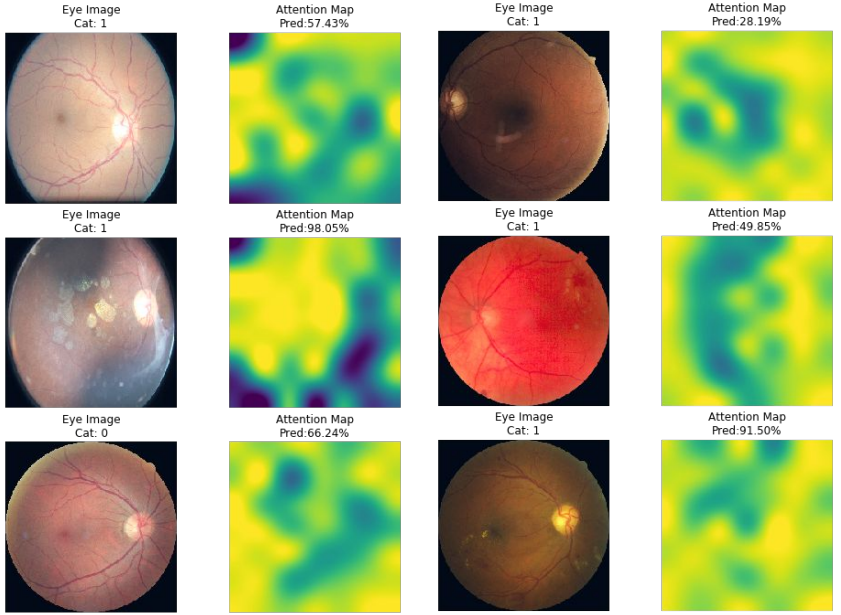
Explanation of the Model

Attention Maps

ResNet50



VGG16



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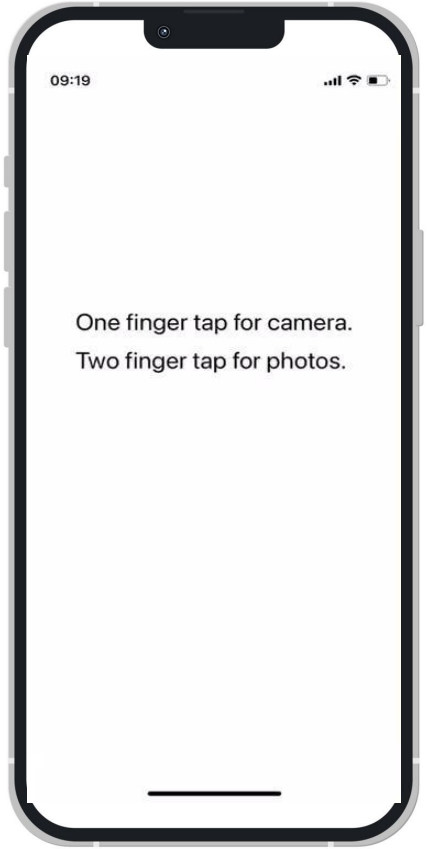
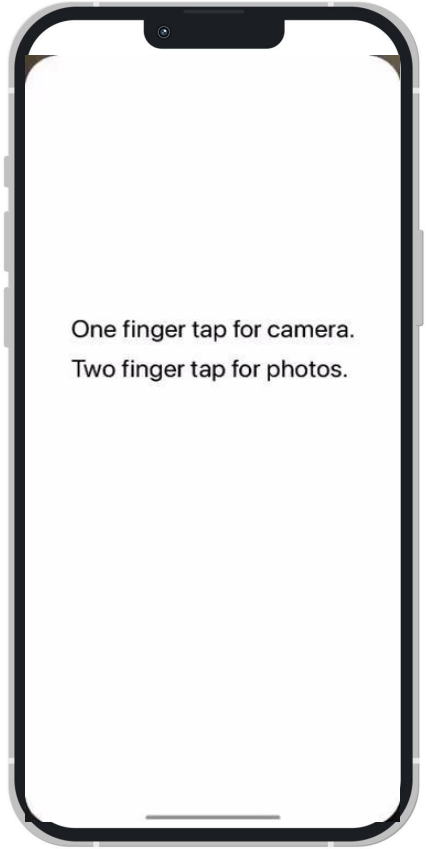
Prototype: EYENUR The App





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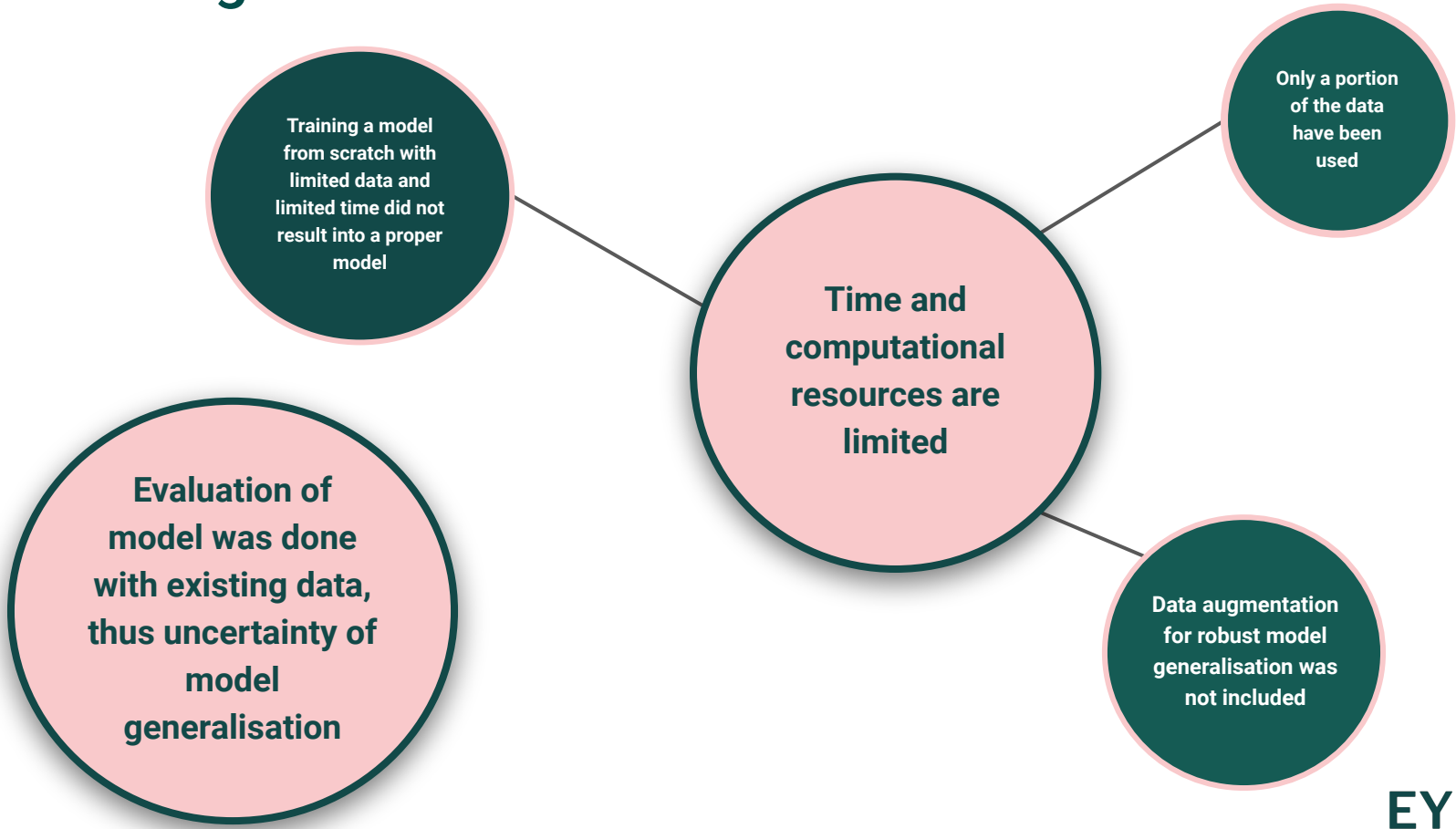
Challenges



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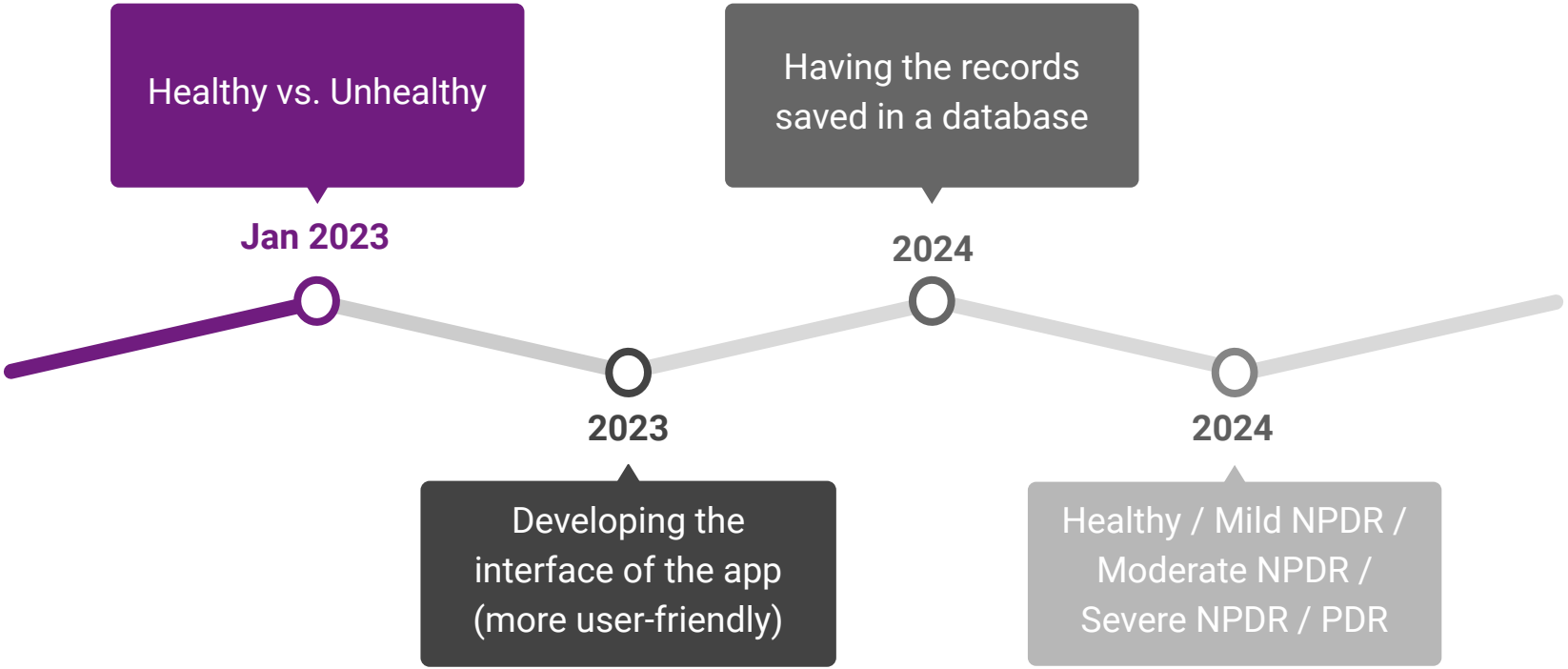
Next Steps



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Thank You!