## Milestone 1

Retain this document throughout the development of the project. This form should be submitted as needed for instructor feedback. Make sure all instructions/prompts following each subtopic are removed before submission.

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| **General Information** |

Project name: Ocular Disease Detection

Author: David Bui

Project organization: 3rd World Volunteers

Project manager: David Bui

Date project proposal form is submitted: 01/21/2022

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| **Project Overview and Project Objectives** |

**State the Problem**

There are approximately 2.2 billion people with visual impairments, and of those impairments 1 billion are preventable. The majority of these preventable cases reside in 3rd world countries that have limited medical staff and resources. In fact the largest cause of preventable blindness is cataract disease which can be treated through surgery if detected early enough by a trained eye care professional; however, only 10% of all cataracts are detected at an advanced stage due to lack of access to vision screenings or health awareness campaigns (Vision 2020 Global Report).

**Background**

A Convolutional Neural Network could be trained to for ocular disease recognition using fundus images from the ODIR-1 database developed by EyePACS, University Of Illinois Hospital Urbana-Champaign. The purpose of this project was not merely to train a model but rather one designed specifically around detecting Ocular Disease through fundus Images. Fundus images capture the inside of the human eye, and these images come in pairs for both left and right eye.

#### Project Objectives

The primary objective of this task was to classify diseases on retinal fundus image pairs into one of eight possible classes: DR (diabetic retinopathy), RVO (retinal vein occlusion), STTA (soft drusen, macular degeneration type), CME (macular edema), HRD (hypertensive retinopathy) ARMD(age related macular degeneration), and BRVO (branching retinal vein occlusion). To accomplish this, we first converted the original color retinal image data sets provided by EyePACS into grayscale versions for analysis

**Challenges**

There are several challenges that this project faces, the first being that the images seem to hold an inconsistency within their diagnosis and need to be properly vetted before being processed into the data pipeline. The second issue is that the images many times hold multiple diagnoses which can really make noise for the diagnosis. Finally, since the images do not always follow the same standards dimensional sizes and it would benefit from proper preprocessing. In order to resolve each of these issues I implemented several algorithms and methods such as:

- Normalization techniques to ensure correct input values were fed into the algorithm. This included standardizing pixel ranges between 0 and 1.

- Data augmentation techniques like random cropping, rotation, flipping and translation in order to increase the number of training examples available without compromising accuracy.

- Training a new model with every change made in preprocessing techniques so that results weren't skewed

#### Benefits and Opportunities

This assignment helped me realize how difficult and complicated computer vision applications can truly become. While my initial thought process about solving this problem involved just feeding raw images into the CNN, I quickly realized there was much more than simply what you see in front of your eyes! There were many factors that needed to be considered when attempting to build a functioning model. These include preprocessing steps, normalizations, data augmentations, hyper parameter tuning, and evaluating the performance of models based on various test scenarios.

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| **Project Scope** |

The scope of this project focused purely on the detection aspect of Ocular Disease and did not take into account its classification ability nor attempt any means to detect the specific stages of ocular disease progression. For future work I will implement more features into the deep learning network such as other layers besides convolutions, pooling, batch normalization etc... along with incorporating multi-class prediction capabilities.

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| ID | Task | Status | Planned Completion | Resource |
| 1 | Outline Goals | Complete | - | - |
| 2 | Research variables | Complete | - | - |
| 3 | Data collection | Complete | - | - |
| 4 | Data analysis | Ongoing | 1/24 | - |
| 5 | Multiple Model applications | Ongoing | 1/25 |  |
| 6 | Cross-comparison of models and validation | Ongoing | 1/30 |  |
| 7 | Select Optimized model and setup trial case | Ongoing | 2/14 |  |
| 8 | Review trial results | Ongoing | 2/24 |  |
| 9 | Final Presentation | Ongoing | 3/1 |  |

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| **Project Completion** |

1. Describe what measures will be used to calculate project success.
2. Use the template to list the project completion criteria.

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| Project Completion Criteria |
| 1 – Cleaning the data and setting up Pipeline |
| 2 - A convolutional neural network is shown to be stable with continuous updating imaging data. |
| 3 – An evaluation of the effects of implementation of these models |

Use the template to list the project assumptions and constraints, if applicable. An assumption is an educated guess that a likely condition or circumstance is presumed to be true. A constraint is a limiting condition or circumstance that defines the project boundaries. Assumptions allow the project to succeed. Constraints restrict or limit the project execution.

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|  | Assumptions | and Constraints |  |  |  |
| ID | Description | Comments | Type | Status | Date  Entered |
| 1 | VGG16 Classification assumptions | Assumptions are created through data analysis and the statistical power of the validity of the findings. | Assumption |  |  |
| 2 | Convolutional Neural Network Assumptions | A CNN assumes that all inputs are image base data, and that a differentiable function is able to find unique identifiers within layer transformations. | Assumption |  |  |
| 4 | Network capabilities for 30 fps cameras and data warehousing | For this project to function there needs to be an underlining network of remote access to cameras. | Assumption |  |  |
| 5 | Image data updating | The model requires resizing of the images and cropping of black space. | Constraint |  |  |

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| **Project Controls** |

1. Use the template to define the risk(s), and list the steps to prevent or minimize the chances of the risk(s) occurring. The contingency plan describes alternative solutions to reduce the impact of the risk(s). An example of a contingency plan is to provide the customer a temporary web server if there are delays in delivery/completion.

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|  |  | Risk Management | |  |
| **Event Risk** | **Risk Probability**  **(high, medium, low)** | **Risk Impact** | **Risk Mitigation** | **Contingency Plan** |
| What is the risk? | What is the probability? | What is the impact if the risk occurs? | What can be done to minimize the risk? | What can be done to minimize the impact of the risk? |
| Model size is too large to export to | Medium | Extraction of cameras | Open communication and a sharing of results | Taking proper legal procedures |
| Model performs subpar to expectations | Medium | Replacement of model | Validate the model | Implement backup model for comparison. |
| Project Implementation | Low | Waste of monetary resources | Salvage project into a new direction | Utilize data collected for new project |

1. All projects have either anticipated and planned or unexpected changes. Describe any issues in management or management changes due to the anticipated and planned or unexpected changes. Use the template to list anticipated and planned or unexpected changes.

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|  | | Change Control Log | | | |  |  |  |  |
| **ID** | Change Description | Priority | Originator | Date Entered | Date Assigned | Evaluator | Status | Date of Decision | Included in Rev. |
| 1 | Changed Project to Ocular Disease Detection | 1 |  |  |  |  |  |  |  |
| 2 | Salvaged CNN model | 2 |  |  |  |  |  |  |  |

1. Use the template to describe how the end user is involved in the software development, if applicable. Include relevant information about meetings, reviews, presentations, etc.

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|  |  | Roles and Responsibilities | |
| Name | Team | Project Role | Responsibility |
| David Bui | Me | Author | All of it |

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| **Project Schedule** |

This was older schedule from my previous milestone, but I lost the dating. But this illustrates the planning if moved towards 1/21/2023

A picture containing chart

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| **Overall Instructor Feedback/Comments** |

**Integrated Instructor Feedback into Project Documentation**

☐ Yes ☐ No

**Project Approval**

☐ Instructor <Insert Name and Title>

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| **Requirements Analysis** |

I had to create some custom code in order to solve the following required components:

- Normalize all images to a fixed size of (250x250)

- Perform data augmentation techniques including cropping, rotating, flipping, translating and adding noise to the images

- Build a new model for every time there's a significant change in preprocessing technique

- Write functions to extract certain feature maps from different layers and visualize them after training is complete

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| **Use Cases** |

* Imaging data is transferred into a trained CNN
* The CNN compresses the image to outline unique features.
* Characterization is statistically selected from features using the ODIR dataset
* Binary pixels are grouped together as a variable
* Each variable is uniquely identified, and attributes recorded into current dataset
* Abnormalities are classified and a diagnosis is sent out with pertinent information for the user.

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| **System Design With Literature Review** |

Diagram

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| **Technical Requirements** |

Provide a listing of the technical requirements for the system.

- The goal of this assignment was to create a system that could identify different ocular disease conditions from fundus images given in pairs for either eye

- Since the original images came in color they required converting them into black/white format

- Due to inconsistent image resolution throughout the database certain preprocessing steps needed to be performed to fix dimensions and scale down pictures appropriately before passing it off to the neural net

- Images often contained duplicates with varying degrees of quality making it hard for the network to recognize patterns between similar looking diseases

- A major challenge arose when trying to incorporate multi-class predictions in order to predict additional conditions alongside main ones present in the image

- Another issue was that sometimes no condition would exist in an image pair altogether resulting in empty output spaces

- Due to class imbalance problems occurring during the course of training a balanced data split needs to be achieved

- The final concern that needed addressing was overfitting - a common occurrence where small variations of the training set resulted in poor performance overall

- During testing phase our team found that having too few labeled samples led to low precision numbers across almost every single category causing false negatives

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| **Data Science Model** |

Provide a top-down design of the system with a diagram similar to a flowchart.

**Convolutional Neural Network and Classification method**

Diagram, engineering drawing

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| **Security** |

Provide a security matrix and a statement of security issues that the system must address. If there are no security issues for the system, state why.

Calendar

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