CODING CATEGORY

Theme: Global Health

Team Name: CSPDarknet53

Team-members:

Sujash Barman (barmansujash4@gmail.com)

Anshuman Tekriwal (tekriwalanshuman@gmail.com)

Project Name: EYE.AI

The Problem

With ageing populations, health systems worldwide are struggling to provide adequate eye care at the population level, giving rise to projections of increasing levels of visual impairment and blindness from major eye diseases in the near future. The substantial burden of visual impairment has overwhelmed global efforts to expand the physical capacity (eye clinics and hospitals and related facilities) and expert availability of eye care providers (eg, ophthalmologists, optometrists). While this is not an uncommon occurrence in rural areas where it is common to have one eye clinic tending to hundreds of kilometres of area, this trend has been observed even in developed nations.

Of the major eye diseases, diabetic retinopathy, corneal ulcers, glaucoma, and cataract make up for almost 90% of global causes of blindness of which a major chunk (namely, 85%) is avoidable with action taken in due time.

A study in England reported that a delay in care of 22 weeks resulted in harms such as permanent visual acuity deterioration and visual field loss in some patients that could have been avoided with earlier intervention, even once the patient was through with all tests.

This reflects the urgent public health need for completely novel solutions to improve the accessibility and availability of eye care services at primary, secondary, and tertiary level for the larger population.

The Idea & The Solution

One of the pivotal reasons that led to us developing an application around Global Health was deep concern about little development around clinical accommodations in the less economically developed parts of India. On further research, we discovered how people from even the most developed areas all around the world suffer from health care neglect and we set out on creating an **innovative solution** to help identify and recommend treatment for **potential life-threatening vision disorders**.

Our project leverages a deep-learning algorithm which can detect cataracts, glaucoma as well as uveitis with a photo of your eyes that can be clicked using just your smartphone camera.

Deep Learning is a technique which has burst onto the scene and is being developed with unprecedented potential with the trebling of data available to analysts. Solving problems in the health industry with deep learning is becoming more and more relevant with the great advances in deep learning works.

Not only that, our project can **detect diabetic retinopathy** as well as it's severity on retina images with the use of fundus photography - an easily available tool in local clinics **as well as corneal ulcer recognition** and classifying it into grades with the help of staining and fluorescein - a widely used diagnostic agent in ophthalmology.

Our program can also local doctors in rural areas of India by giving them the tools needed to check if patients have eye blindness/diseases that are hard to determine through the lack of facilities and equipment that is stationed in their hospitals.

The application will have an intuitive Graphical User Interface which will let the user upload an image of the patient's eye which is suspected of having said disease. The

image is then uploaded to the ML algorithm which outputs the probability of the eye having disease/blindness as well as a recommended prescription to treat the eye.

There have been researchers in Tohoku University Japan, who have designed deep learning models that analyse ophthalmic images to determine if the eyes have diseases/blindness. However, their program requires a lot of processing power and isn't compatible on mobile devices. Our solution on the other hand, does all of the processing on the web and since we are using Windows Presentation Foundation as the GUI, it can be exported to mobile devices, making our solution much more accessible to the general public.

Target Users

The main target groups that we want to reach out to are local physicians and people residing in impoverished regions all around the world who don't have the necessary tools and facilities to carry out proper eye testing to determine if the eyes of the patients are at risk to be the visually impaired.

Another major demographic which has revealed itself on digging deeper are people living in developed cities and countries, with low-tier health insurance who are unable to find appointments to consult with doctors on how to go about treatment or are unable to pay for simple testing procedures.

Most of our target audience will be devoid of any form of a medical degree or understanding and as proved many times, the internet has the tendency to 'over-diagnose' mild symptoms. Dealing with these complicated disorders and diseases are their primary 'pain-point' for them because of the pin-point accuracy and precision (usually available only through consultation with a practising specialist) required to diagnose the patient. Through our endeavours, we aim to give useful and practical advice which the doctors can use while checking if patients have eye blindness or diseases.

The only requirement that would be asked of our audience is to have access to the internet in order to access our application and a camera as basic as that of a smartphone (a 2MP camera would do) with which the user is able to accurately photograph their eye. For more advanced diagnoses such as diabetic retinopathy, only a retina image through fundus photography is enough while corneal ulcers require the typical fluorescein stained images for detection to occur.

Current Status

The application is ***through the brainstorming phase*** and after thorough research, we have ensured nothing similar to this currently exists in the market and that the idea has potential to make real impact and ***'save sight'.***

What lies next is :-

- Finding Datasets Applicable To Our Use Case
- Data Cleaning

Once The 48-hour 'hack time' commences :-

- Data Analysis	Simultaneously	- Application Development
- Model Development		- Frontend Design + Coding
- Model Training		- Backend Development
- ModelOps		- API BedWork
- Model Deployment		- Model Linking Through TorchServe

Technologies Used

Anshuman will be working on the deep learning side of things while Sujash builds the application.

The Deep Learning Model

While the decision of which model to use hasn't yet been made, it has to be a Convolutional Neural Net (CNN) for each of the datasets as it has yielded, by far, the most accurate predictions of all computer algorithms. Vision-in-Transformers (ViT) comes close but ResNeXT has edged out ViTs in medical imagery.

A thorough documentation of the model and the data cleaning methods will be maintained during the 48 hour hack time...

The language used will be Python3 .

- The PyTorch framework will be used for model training
- A custom image dataset class will be built on the PyTorch 'nn' module to parse the images and apply the necessary transformations while TensorBoard will be used for model tracking.
- Flask will be used to build the API to send the predictions on receiving the image on the application.

The Application

XAML (Windows Presentation Foundation) [C#] will be used to develop the front-end of the application, this application will be a desktop application. Although, it **can be migrated to an Android or IOS mobile app.**

The framework that can be used is TorchSharp to integrate the Deep Learning portion of the Python API to the C# Desktop Application, (**this is optional and may not be required when building the application in the 48 hours**).
A prognosis plan will also be generated based on the results tabulated by the model which would help the people to avoid going through complex and expensive procedures and a recurring theme of misdiagnosis.

The Link To The Folder Where Files For The Hackathon Will Be Maintained (Currently Only The Project Plan Is Uploaded)

https://drive.google.com/drive/folders/1_WFEouhITWhw91oLcoKAL3divcBu68HG?usp=sharing

To-Do for Sujash

1. Develop the prototype design for the front-end
2. **Start developing the overall timeline of the project, use timeboxing to develop the 48 hour plan.**
3. Design a demo for new users visiting the website
4. Build the backend to connect to the API
5. Develop the long-term goals and plans.

To-Do for Anshuman

1. Data Cleaning
2. Data Analysis
3. Eye Disease Model Development
4. Model Inference And Prediction API
5. Help with the long-term goals and plans.

Ideal Outcomes

As a member of the community, that suffers from the very bitter truths that we try to cure, for us, the most optimistic outcome of this competition would be to **gain enough traction**, more than winning - to be able to reach out to people in every part of the world, who don't have an eye clinic for hundreds of miles around them, doctors tending to the less privileged, who are unable to foot the expenses for complicated and expensive tests to detect the disease - not to mention the expenditure on it's prognosis, those who do not have such tests covered by their health insurance and have to pay hefty fees on some tests that may not even yield definitive results and those who are motivated by the advancements in biotech to build the next big thing; ***it would be to have those who need it know, that there is something out there that might be able to help them, and for them to not roll the dice with fate...***

While we understand that this technology is not flawless, it has the potential to help millions who lose their eyesight - one of the most basic human needs, and if we can help even a single person out with their ailments: we will be satisfied with ourselves and what we have managed to build and we will put our best foot forward to make sure that our tech is always of the highest quality...

While this project is extremely close to our hearts (being from a place where such atrocities happen to thousands every single day), we also want to win the competition - build something meaningful and as accurate as possible, be able to tell ourselves more than the rest of the world that our theories paid off and be able to deliver to those in need :-

- The diagnosis and the prognosis completely free of cost right from one's smartphone in the matter of mere minutes: save someone from losing their eyesight not because it was incurable but because of neglect; because they were unable to pay for procedures with the utmost efficiency.

Test Success

The biggest obstacle that we, if we were to be able pursue this project, would face would be to get this technology into the hands of people who need it - maybe encouraging local clinics without machines for these procedures to test our software as well as hospitals to work with us to help us improve our model...

However, in terms of the success of the software itself working; we are confident that we can pull it off even in the limited timeframe. If we were to rate it on a scale of 1-10, we would give ourselves a *9.5*.