DR Problem Statement (Hypothesis Formation)

What is the an optimal deep learning algorithm to detect the level of retinopathy in a diabetic retinal screen so that the grade can be artificially diagnosed with at least 80% of accuracy by using only a retinography image TIFF file?

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1 Context

Diabetes has reached impressive numbers by 2017, having almost 425 million people facing the disease and estimating almost 629 million by 2045. According The American Society of Retina Specialists, half of the patients with diabetes suffer from retinopathy and is the number one cause of irreversible blindness in working-age people. However, there is substantial scientific evidence that early detection and timely treatment can prevent vision loss.

In recent years, there have been programs based on the analysis of fundus photographs by specially trained ophthalmologists (mostly remote graders). However, although great eyes are behind the analysis, the **diagnostic accuracy achieved may not be optimal, and scaling and sustaining such programs has been found to be challenging**. Additionally, the costs of those type of services could be quite high even for developed countries. Therefore, to develop technology for making proper diagnosis based on computer vision is an actual trend of paramount importance.

Deep learning, a machine learning (ML) technique, has shown promising diagnostic performance in several applications, such as in image recognition and computer vision tasks. These technologies have been widely adopted in many domains including healthcare and medicine. For medical imaging analysis in general, it has achieved robust results in various medical specialties such as radiology; for ophthalmology in particular, deep learning (DL) continues the tradition of **autonomous and assisted analysis of retinal photographs**. Such **artificial intelligence (AI) systems** have been demonstrated to lower cost, improve diagnostic accuracy, and increase patient access to Diabetic Retinopathy screening. Recent works on DL in ophthalmology showcase its potential to at least partially replace human graders, while providing a similar level of accuracy. Nonetheless, being more adopted as a medical-aid systems than a replacement itself.

2 Criteria for success

- Develop a deep learning algorithm capable **of detecting retinopathy grade** in patients' retinography images with at least 80% of accuracy
- Being able to train the model using **standard computer resources** and enabling scaling for a cloud environment
- Create a data **pipeline transferable to a production environment** for a successful model deployment
- Develop a deep learning algorithm capable of **detecting risk of macular edema** in patients' retinography images with at least 80% of accuracy

3 Scope of solution space

The analysis and modeling will be made using **10 zip files containing 100 retinography images each** in .tiff file format These images were provided by the Messindor Database Project (Methods to evaluate Segmentation and Indexing Techniques in the Field of Retinal Ophthalmology within the Scope od diabetic Retinopathy).

It is planned to load and read the images from those files and use the labels to classify the images by using a machine learning algorithm (deep learning) transferable to software APIs or other platforms for use in the field of ophthalmology or for research and statistical analysis purposes.

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4 Constraints within solution space

- Not enough hardware resources for image reading and processing due to the volume of images
- Image file formats that could differ from the dataset and a medical workstation
- Class imbalances considering the number of patients with DR
- Data overfitting
- Interpretability of the Deep Learning model that could halt its clinical use

5 Stakeholders to provide key insight

Diabetic Retinopathy / Ophthalmology Institutes or Universities – with specializations in computer vision for medical applications

Microscope or Ophthalmology Companies – Carl Zeiss, Johnson and Johnson Vision Care, Canon, Abbott Medical Optics, etc.

Springboard Mentor – Yadunath Gupta

6 Key data sources

1200 eye fundus color numerical images of the posterior pole of the Messidor database were acquired by 3 ophthalmologic departments using a color video 3CCD camera mounted on a Topcon TRC NW6 non-mydriatic retinography with a 45-degree field of view. Images were captured using 8 bits per color plane at 1440*960, 2240*1488 or 2304*1536 pixels.

800 images were acquired with pupil dilation (one drop of Tropicamide at 0.5%) and 400 without dilation.

The 1200 images are packaged in 3 sets, one per ophthalmologic department. Each set is divided into 4 zipped subsets containing each 100 images in TIFF format and an Excel file with medical diagnoses for each image.

Reference:

Decencière et al.. Feedback on a publicly distributed database: the Messidor database.
Image Analysis & Stereology, v. 33, n. 3, p. 231-234, aug. 2014. ISSN 1854-5165.