Paper Title: A deep learning system for detecting diabetic retinopathy across the disease spectrum. Link: https://www.nature.com/articles/s41467-021-23458-5

1 Summary

1.1 Motivation

This paper demonstrates a unique deep learning based technique for diabetic retinopathy detection which is a pressing problem nowadays in diabetis patients. Lack of human assessors means more robust deep learning method must be implemented for automatic assessment and diagnosis.

1.2 Contribution

In this paper, a deep learning system is developed named DeepDR (Deep-learning Diabetic Retinopathy), which can detect early-to-late stages of diabetic retinopathy. The system was developed using a real world DR screening consisting of 666,383 fundus images from 73,346 patients. Moreover, they have annotated retinal lesions, including microanuerysms, cotton-wool spots (CWS), hard exudates, and hemorrhages on 14901 images.

1.3 Methodology

DeepDR system consists of 3 deep learning sub networks - image quality assessment, lesion-aware sub-network and DR grading sub-network. These three sub-networks takes retinal images as input and does different tasks one-by-one. The DeepDR system was designed as a transfer learning assisted multiclass network. The sub-networks were developed based on ResNet and Mask-RCNN. Both ResNet and Mask-RCNN are divided into two parts: (1) feature extractor, which took images as input and output features, (2) task-specific header, which took the features as input and generated task-specific outputs (i.e., classification or segmentation).

1.4 Conclusion

The DeepDR system has achieved high sensitivity and specificity in DR grading. The system provided visual hints that allows us to identify the presence and location of different lesion types. Introducing the image quality sub-network and lesion-aware sub-network into DeepDR improved the diagnostic performance and more closely followed the thought process of ophthalmologists. DeepDR can run on a standard personal computer with average-performance processors. Thus, it has great potential to improve the accessibility and efficiency of DR screening.

2 Limitations

2.1 First Limitation

The single-ethnic cohort used to develop the system. Although they have used publicly available EYePACS data from the USA, but dataset from other countries should also be collected to confirm and validate the performance of DeepDR system on other ethnic groups.

2.2 Second Limitation

The lesion-aware sub-network was tested only on the local validation dataset., because of the lack of lesion annotations in external cohorts. Further external validation in multiethnic and multicenter cohorts is needed.

3 Synthesis

From the perspective of diabetes management, the screening for mild DR is of great clinical importance and may improve patients' outcomes. The identification of patients with mild DR facilitates health providers, such as family physicians, general practitioners, and endocrinologists, to participate in the patient education and management of blood glucose, lipid profiles, blood pressure, and other risk factors. There is no known cure for advanced DR, and some of the damage caused by leakage, oxygen deprivation, and blood vessel growth is permanent. But there is evidence showing that optimal glycemic and blood pressure controls are strongly correlated with the regression from mild DR to DR-free state. Screening for mild DR provides valuable information for clinical decision making.