Title of the research project: Comprehensive risk modeling and trajectory prediction of Diabetic Retinopathy using big data

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Name, affiliation, and contact information for the supervisor and co-supervisor

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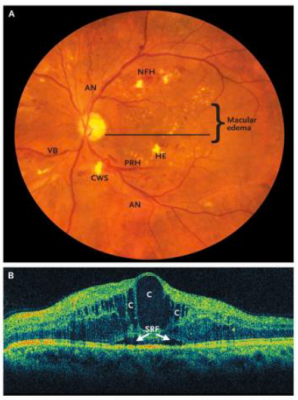

Dot-like hemorrhages, newly formed blood vessels to replace damaged ones, and eventually, fluid leaking out of blood vessels to create edema within the retina are the hallmarks of DR[6].

Abstract

Diabetic retinopathy (DR) is a microvascular complication of diabetes and a leading cause of new cases of blindness in the world. The pathogenesis of DR is multifactorial and complex. Major risk factors include the duration of diabetes, poor glycemic control, hypertension, and cholesterol. However, the known modifiable risk factors (blood sugar, cholesterol, and blood pressure) only account for ~10% of the DR risk, and the mechanisms behind how hypertension and obesity exacerbate DR are still unclear. The associations with ethnic and genetic disposition, socioeconomic status, conditions such as sleep apnea and non-alcoholic fatty liver disease, diet and nutrition are sparse and controversial, making it difficult to optimize systemic risk factors. The proposed study aims to mine the rich data in UK Biobank and the Canadian Longitudinal Studay of Aging database for a comprehensive set of studies on DR risk factors and disease trajectory.

Interdisciplinary/applied experience

Our collaborator Dr. M. Faisal Beg is an expert in medical image analysis and has developed novel algorithms for segmentation, registration and morphometric analysis of brain MR and FDG-PET images, cancer CT images, and 3D retina OCT, OCT angiography and adaptive optics OCT images. Dr. Beg has been approved for accessing UK Biobank's retinal images and participant data. His research group have successfully downloaded all the 3D OCT volumes and fundus photographs, approximately 175K files for each modality, amounting to ~700GB of fundus photos and ~2TB of compressed OCT volumes. Our Compute Canada allocation of 300 TB disc-space and 150 core-years of computational resources enable us to conduct this ambitious big data epidemiological research project. The OCT volumes were extracted by our custom OCT Surfer software and converted to NifTi format, and the images from participants who have diabetes (~2000 subjects) and DR (~1000 subjects) have been identified. The 3D OCT volumes were then corrected for the volume tilt, and the thickness of the total retina, neuronal and vascular layers, and photoreceptor layers were computed using 3D closest-distance method. His team has developed numerous retinal processing and analysis methods: 3D graphcut-based retinal layer segmentation, optic nerve head morphometric analysis, functional-shape method for pixel-wise comparison of retinal layers, and deep-learning segmentation of retinal layers and fluid structures, and optic nerve head structures. The postdoctoral fellow (PDF) will work closely with Dr. Beg on the related clinical problems and the data preprocessing and analysis. The PDF also needs to give an oral presentation to our collaborators at least once a month to keep them updated about the research progress and to seek their feedbacks.

Teaching/training/education

The postdoctoral fellow (PDF) will be provided rich opportunities to gain important teaching and mentoring skills. The PDF will teach a three-credit one-semester course in each year of the program. The PDF will also be encouraged to participate in a CANSSI sponsored summer training program. The PDF will also be invited to mentor teams of undergraduate or graduate students in project-based studies, e.g., SSC case study competition or SFU the data science Hackathon. The PDF is also involved to supervise graduate students with Dr. Cao and Dr. Nathoo.

A list of qualifications of suitable candidates

Qualifications include a strong training in statistical methods and their application. Applicants are expected to have a strong communication and mentoring skills. Applicants must have completed all PhD requirements prior to starting work.