Development and Validation of a Deep Learning Algorithm for Detection of Diabetic Retinopathy in Retinal Fundus Photographs


Presentation by Aidan Fitzgerald
What is Diabetic Retinopathy

“Occurs in 28.5% of people with diabetes in the USA”
Retinal Fundus Photographs

• Photograph of the eye
• Used to help detect Diabetic Retinopathy
• Researchers Goal?
What is the benefit of an automated detection system

- Manual Interpretation is standard
- Increasing Efficiency
- Reproducibility
- Reducing Barriers to access
- Improving patient outcomes
Machine Learning

• Algorithm for automatic detection is needed
• Machine Learning has been used for classification tasks including diabetic retinopathy
• Previous work has focused on ‘feature engineering’
• Deep learning avoids ‘feature engineering’
Neural Networks
Convolution Neural Networks

• Good for Image Recognition
• Layers Called Convolutional Layers
• Detects Features of Images
Back-propagation

• How does the network learn?
• Compares expected output with actual output
• Makes adjustments to weights and biases
• Minimises the cost function
Data sets

- Trained on 128,175 Retinal Images
- Validated using 2 data sets
- No overlap in the sets
- Diabetic Retinopathy severity was graded into 5 categories
Development of the Algorithm

• Determines diabetic retinopathy severity using the intensities of the pixels
• Parameters are set to random values
• The severity grade is compared to actual grade
• Repeated many times on the data set
• The network was trained to make multiple binary predictions
Evaluation of Algorithm

• Network produced continuous number between 0 and 1 for referable diabetic retinopathy and other classifications
• Specificity and Sensitivity
• Two operating points for the algorithm were selected
Results

• EyePACS-1 validation data set consisted of 9963 images
• Messidor-2 validation data set consisted of 1748 images
• Mean agreement of ophthalmologists on referable diabetic retinopathy images 77.7% and 82.4%
• Mean agreement on non-referable images was 97.4% and 96.3%
• Sensitivity analysis was conducted for several subcategories
Results Cont.

- Sensitivity and specificity at high specificity point 90.3% and 98.1% for first data set
- Sensitivity and specificity at high specificity point 87.0% and 98.5% for second data set
- Sensitivity and specificity at high sensitivity point 97.5% and 93.4% for first data set
- Sensitivity and specificity at high sensitivity point 96.1% and 93.9% for second data set
Results Cont.

• Multiple other networks were trained
• Effect of data set size on performance plateaued at 60 000 images
• Increasing number of grades did not increase performance
• One grade per image on tuning set lead to 36% decrease
Discussion

• Deep neural networks can be trained using large data sets without specifying features for diabetic retinopathy
• Automated system for detection of diabetic retinopathy provides multiple advantages
• Abramof et al\textsuperscript{7} achieved a sensitivity of 96.8\% and specificity of 59.4\%
• Solanki et al\textsuperscript{8} achieved a sensitivity of 93.8\% and specificity of 72.2\%
• Philip et al\textsuperscript{9} achieved a sensitivity of 82.6\% and a specificity of 76.8\%
Discussion cont.

• High sensitivity and specificity is essential
• Researchers determined future medical using deep learning has 2 prerequisites
• There a limitations to the algorithm
• We don’t know what features the algorithm is using to detect diabetic retinopathy
• Algorithm is not a replacement for an eye examination
What’s Next....

• Further validation of the algorithm with different graders
• Further research is needed to determine possibility of applying this algorithm to a clinical setting
• Machine learning in ophthalmology[7]
References


