**Automated diagnosis of fundus camera images for diabetic retinopathy for treatment referral**

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**Design**

Through utilising convolutional neural networks and high end GPU computing we aim to use deep learning to classify fundus images for diabetic retinopathy.

**Purpose**

We aim to produce an automated framework to provide instant referral recommendations for diabetic retinopathy (DR) from colour fundus images of the retina taken during diabetic screening.

**Methods**

We develop a convolutional neural network approach to analyse retinal fundus images and provide a DR referral recommendation. We train our network to learn over 400 thousand independent parameters to characterise the features of fundus images most related to DR classification and therefore the question of referral. We use a single image from each eye in 70 thousand fundus images of a single eye with the corresponding DR diagnosis from expert graders. Through augmenting the data we use the images multiple times to maximise the use of the data to the machine learning process. Having seen a vast amount of images of retinopathy, along with their labels, the neural network learns the features which relate to the referral of the disease.

**Results**

We test our method on 10 thousand fundus images, including images of poor quality and containing artefacts. Our deep learning algorithms show impressive ability to learn appropriate features, allowing it to distinguish between patients needing referral. We obtain sensitivity and specificity of over 0.85 and accuracy of 0.91 on previously unseen test data. We obtain an Area Under the Curve (AUC) score of 0.94. The mean computation time for providing a recommendation was 0.0028 second.

**Conclusions**

The computation time and accuracy we have achieved make our approach suitable for filtering the screening process and providing an immediate preliminary diagnosis at point-of-care. As well as facilitating considerable acceleration in grading decisions and reducing grader workloads, this has the potential to cut down costly unnecessary referrals.