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Automated Classification of Diabetic Retinopathy Severity: A Deep Learning Approach

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Background: Diabetic retinopathy (DR) is a damage to the retina caused by complications of diabetes and is the fastest growing cause of blindness. It is a major concern for the Qatari population, affecting about 40% of diabetic patients in Qatar. Automated DR classification techniques with high accuracy have a strong potential to help doctors in early diagnosis of DR and quickly routing patients who need medical interventions to a specialist. Most of the previous work utilized traditional machine learning techniques for the task of DR severity classification. Such techniques are based on "feature-engineering", which involves computing explicit features designed by domain experts, resulting in models capable of detecting specific regions of DR damage or predicting the classification of DR severity. Recently, deep learning has emerged as an efficient technique that avoids such engineering. It shifts the burden of feature engineering to the design of general-purpose learning system which allows an algorithm to learn by itself the most important predictive features from the raw images, given a large dataset of labeled examples. Objectives: In this work, we studied deep learning techniques described in recent literature and combined it with our own ideas to develop a deep convolutional neural networks (ConvNets) architecture for the task of diagnosing diabetic retinopathy and classifying its severity from retina images. In addition, we explored the impact of the following parameters on the performance of the model: 1) number of fully connected layers, 2) number of units within each fully connected layer, and 3) batch size (number of training examples which will be forward/backward propagated through the network in one pass). Methodology: We trained the ConvNets model on the publicly available retina images dataset from the Kaggle competition for diabetic

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retinopathy detection. The dataset included labels with information about the presence of DR in each of the images, rated by a clinician on a scale from 0 to 4 (0: No DR, 1: Mild, 2: Moderate, 3: Severe, 4: Proliferative DR). The model was implemented using Theano, Lasagne, and cuDNN libraries and trained on two Amazon EC2 p2.xlarge instances (NVIDIA GPU K40). We used the same evaluation metric of the Kaggle competition, which is the Cohen's quadratic weighted Kappa function. In our case, Kappa is described as being an agreement between two raters: the agreement between the scores assigned by human rater (labels) and the predicted scores. Results: On the dataset of 30,262 training images and 4864 testing images, the model achieved a Kappa of 0.72. Our experimental results demonstrated that the number as well as the size of the fully connected layers does not have a significant impact on the model's performance. Moreover, it indicated that increasing the batch size does not necessarily speed up the convergence of the gradient computations. Conclusion: We have shown that convolutional neural networks have the potential to be trained to identify the features of Diabetic Retinopathy in retina images. Given the many recent advances in deep learning, we hope our work will open the door for many new examples demonstrating the power of deep learning to help solving important problems in medical imaging and healthcare. Keywords: deep learning, machine learning, diabetes, diabetic retinopathy, medical imaging.