Feature Selection and Classification Algorithms for Retinal Microaneurysm Detection

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Diabetic retinopathy (DR) is a disorder of the retina, caused by diabetes mellitus (usually simply referred to as diabetes). Color fundus images are the main resources used by ophtamologists for screening purposes. Red lesions, such as microaneurysms (MAs) and haemorrhages are one of the first signs of DR, thus their reliable detection is essential in a computer aided screening system. Literature on automatic MA detection is extensive, the first proposed method was published in 1984 [1]. In [2] Niemeijer et al. compares the results of state of the art MA detectors in an online challenge that focuses on the automated detection of retinal disease. Currently available methods divide the problem of MA detection into two consequent stages. In the first stage, MA candidates - regions of the image, that probably correspond to MAs - are extracted using some specific image segmentation method. In the second stage (detection), first, each candidate is mapped into an n-dimensional feature space, resulting in a set of feature vectors. Elements of the feature vectors attempt to describe specific attributes of the candidates, that may help to separate true MAs from false candidates. Next, supervised machine learning (classification) methods are used to separate the feature vector set, denoting the candidates corresponding to vectors as true and false. Manually marked images are used to obtain the training vectors for the classification methods. At the present time, several publicly available databases exist for training and testing MA detection algorithms [3].

In this paper, we examine the problem of optimal feature subset selection, and survey the usage of classification algorithms, as described in many proposed MA detection methods. So far, more than 50 features have been proposed for binary classifiers in MA detectors. Some features are rather simple and extensively used, such as the circularity or mean intensity value of the candidate region, and some others are strongly connected to a specific candidate extraction method. To find the optimal feature subset for a classifier, testing of all possible feature subsets is required. If large number of features are available, this approach is impractical. As a matter of fact, it is technically impossible in this specific case. Two typical categories of feature selection are subset selection and feature ranking. In the case of subset selection, a search algorithm is used to scan through the space of possible subsets, and the current subset is iteratively modified based on some scoring metric. Then, the new subset is evaluated as a group, and on the basis of the new subset's suitability, the algorithm decides on terminating or continuing the search. Such search approaches are simulated annealing and genetic algorithms. Feature ranking is based on ranking each feature individually by a metric, and eliminating the ones that do not achieve a sufficient score. Popular scoring metrics are e.g. correlation, entropy, mutual information, or Kullback-Leibler divergence (information gain). The optimal feature subset depends not only on the used classifiers, but also on the candidate extraction method, i.e. different feature set is optimal for every candidate extractor, classifier pair. Classification methods used for the final decision in MA detectors include e.g., nearest neighbour algorithms, artificial neural networks, support vector machines, and kernel density estimators.

As a result, a new feature set is proposed, with better performance in the previously mentioned classifier methods for two publicly available datasets from [3]. The quantitative comparison of the performance of the binary classifiers is performed in terms of ROC and FROC curves [4].

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