Application of neural nets and deep learning in clinical screening systems

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Abstract

After some years ago GPU cards with high computational performance became available at a reasonable price, several methods based on deep convolutional neural networks (CNNs) have been released. As a latest example for clinical screening, Esteva et al. published the study in the journal Nature, where a GoogLeNet Inception V3 CNN architecture was trained on a dataset. The authors showed that if the training dataset was sufficiently large, a deep neural network based method was able to outperform the clinical experts regarding the classification accuracy of the dermoscopy images.

The proposed CNNs are sufficiently general to be applied to different classification problems with high accuracy. However, if we intend to improve further the classification performance, we may compose an ensemble from them. Namely, as a corresponding research direction, we investigate how an efficient ensemble of deep convolutional neural networks can be created with forcing them to adjust their parameters during backpropagation to increase the diversity in their decisions. More specifically, we join some standard, well-known neural network architectures via a fully-connected layer and introduce a new term in the loss function as a correlation penalty, when the individual neural networks decide similarly. With this approach, we implement the common guideline to increase the diversity of the members also for ensembles of CNNs. The efficiency of our method is demonstrated on a challenging medical image analysis problem to classify dermoscopy images and others from different medical fields. Besides the theoretical considerations, our experimental results also suggest that the proposed approach is a competitive one. Namely, the classification rate of the ensemble trained as described above has outperformed all the individual accuracies of the member CNNs according to the common error functions of this application domain.

Keywords: machine learning, convolutional neural network, ensemble system

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