

Adaptive Thresholding of CNN Features for Maize Leaf Disease Classification and Severity Estimation

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Abstract

Convolutional neural networks (CNNs) are the gold standard in the machine learning (ML) community. As a result, most of the recent studies have relied on CNNs, which have achieved higher accuracies compared with traditional machine learning approaches. From prior research, we learned that multi-class image classification models can solve leaf disease identification problems, and multi-label image classification models can solve leaf disease quantification problems (severity analysis). Historically, maize leaf disease severity analysis or quantification has always relied on domain knowledge—that is, experts evaluate the images and train the CNN models based on their knowledge. Here, we propose a unique system that achieves the same objective while excluding input from specialists. This avoids bias and does not rely on a “human in the loop model” for disease quantification. The advantages of the proposed system are many. Notably, the conventional system of maize leaf disease quantification is labor intensive, time-consuming and prone to errors since it lacks standardized diagnosis guidelines. In this work, we present an approach to quantify maize leaf disease based on adaptive thresholding. The experimental work of our study is in three parts. First, we train a wide variety of well-known deep learning models for maize leaf disease classification, then we compare the performance of the deep learning models and finally extract the class activation heatmaps from the prediction layers of the CNN models. Second, we develop an adaptive thresholding technique that automatically extracts the regions of interest from the class activation maps without any prior knowledge. Lastly, we use these regions of interest to estimate image leaf disease severity. Experimental results show that transfer learning approaches can classify maize leaf diseases with up to 99% accuracy. With a high quantification accuracy, our proposed adaptive thresholding method for CNN class activation maps can be a valuable contribution to quantifying maize leaf diseases without relying on domain knowledge.