Fast Detection of Tan Spot and Powdery Mildew on Wheat using Deep Learning

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Several diseases affect the potential for wheat production, usually related to leaf disease area what limit the whole plant development. Our work makes use of deep learning procedures to train a neural network to predict the occurrence of leaf diseases in the field with a fast and good accuracy. Digital images of tan spot and powdery mildew symptomatic and non-symptomatic wheat leaves were collected at Embrapa Wheat using a standard RBG digital camera. All processing and classification are done using a workstation with GPU support, TensorFlow, and Python. For the neural network architecture, we choose a convolutional neural network (CNN), but this procedure is time and computational consuming what could restrict the use of this novel technologies in areas other than applied computation. To cut off this, we adopt the transfer learning (TL) methodology which utilizes a pre-trained neural network, and allows the detachment of outer the classification layer and uses the remains structure to retraining and get new weights for the new image set and classes of interest. We use the output from [1] as a pre-trained neural network. During the training were used 25,884 arranged into four categories: healthy, dry, tan spot and powdery mildew. We could share our positive experience in using the transfer learning for an entirely new set of images and obtain a good overall accuracy. The validation set presents a total of 4.4% of misclassification. The most common error occurs between tan spot and powdery mildew with an index of 1.4% and 1.3%, respectively. In conclusion, the use of transfer learning for deep neural network cut down the overall time, effort and resources necessary to utilize this cutting-edge technology from artificial intelligence applied to fast non-invasive diagnosis of wheat leaf diseases with an overall accuracy of 95.6%.

References:
[1] C. Szegedy et. al., *Neural Networks*, v. 61, p. 85 – 117, (2015).