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Exploring the potential of machine learning for leaf angle distribution estimation from leveled digital photography

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Leaf angle distribution (LAD) is an important plant structural trait that determines radiation interception, biomass production, rainfall interception, and evapotranspiration. Assessment of LAD is a challenging task and a significant source of uncertainty in ecological models. So far, the information on leaf inclination angle distributions of different plant species is scarce in literature and databases (e.g. TRY). Approximate quantification of LAD is often made by means of modeling.

The aim of this study is to find a user-friendly and accessible method to estimate leaf angle distribution type. We used Google's TensorFlow convolutional neural network (CNN) to test for the first time the possibility of using machine learning for automatically classifying LAD types from leveled digital photographs. We used different combinations of five LAD distribution types (planophile, erectophile, spherical, plagiophile and uniform). The highest training accuracy of 95% and validation accuracy of 91% were achieved by using the two most distinct leaf angle distribution types – planophile and erectophile. As expected, the accuracy subsequently decreased with the addition of other leaf angle distribution types (spherical, plagiophile, uniform). However, our results indicate that the involvement of machine learning may indeed hold the potential to remove the current bottleneck in retrieving the information on leaf angle distribution and its better quantification in ecosystem modeling.