Plant Phenotyping with Limited Annotation: Doing More with Less

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Abstract

Deep learning (DL) methods have transformed the way we now extract plant traits – both under laboratory as well as field conditions. Evidence suggests that "well-trained" DL models can significantly simplify and accelerate trait extraction as well as diversify the type of traits that one can extract. Training a DL model typically requires the availability of copious amount of annotated data. Creating a (large) annotated dataset requires effort, patience, time, and resources. This has become a major bottleneck in deploying DL tools in practice. SSL methods can use unlabeled data to produce pretrained models for subsequent fine-tuning on labeled data. They have demonstrated superior transfer learning performance on down-stream classification tasks. In this work, we investigated the application of self-supervised learning (SSL) methods for plant stress classification using few labels. Plant stress classification is fundamentally challenging problem in that (1) disease classification may depend on abnormalities in a small number of pixels, (2) high data imbalance across different classes, (3) there are far fewer unlabeled plant stress images than natural images. We compared four different types of self-supervised learning methods on two different plant stress datasets. We find that pre-training on unlabeled plant stress images significantly outperforms transfer learning methods using random initialization for plant stress classification. SSL based model initialization and data curation improves annotation efficiency for plant stress classification task.

Keywords: Deep Learning, Self-Supervised Learning, Plant Phenotyping, Plant Stress Classification