CSE 802 Pattern Recognition [Summer 2022]
Course Project Proposal
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Project Title: Identification of Cultivar from the Plant Image

Problem Description:
Predicting the cultivar in an image is an especially interesting problem for familiarizing the machine learning community with the TERRA-REF [1] data. Initially, the task of predicting the cultivar from an image of a plant may not seem to be the most biologically compelling question to answer -- in the context of plant breeding, the cultivar, or parental lines are typically known. However, this kind of project has a lot of application in the verification of the whole process of plantation. For example, there might be some mislabeling of the seeds in the process and thus it might add wrong conclusions in the larger experiments which are both time consuming and costly. In this project, I am going to identify the cultivar from the plant leaf image answering the question **"What cultivar is shown in that image".** I am also participating in the official Kaggle website as a competitor with this dataset.

A cultivar is a type of plant that people have bred for desired traits, which are reproduced in each new generation by a method such as grafting, tissue culture, or carefully controlled seed production. Most cultivars arise from purposeful human manipulation, but some originate from wild plants that have distinctive characteristics. [2] In this project, the data i.e., plant images are taken from above by an automatic moving machine as shown in figure 1.

Figure 1: Image Collection for Cultivar Identification

Dataset Description:

The Sorghum-100 dataset is a curated subset of the RGB imagery captured during the TERRA-REF experiments, labeled by cultivar. The dataset consists of 48,106 images and 100 different sorghum cultivars grown in June of 2017 (the images come from the middle of the growing season when the plants were quite large but not yet lodging -- or falling over).

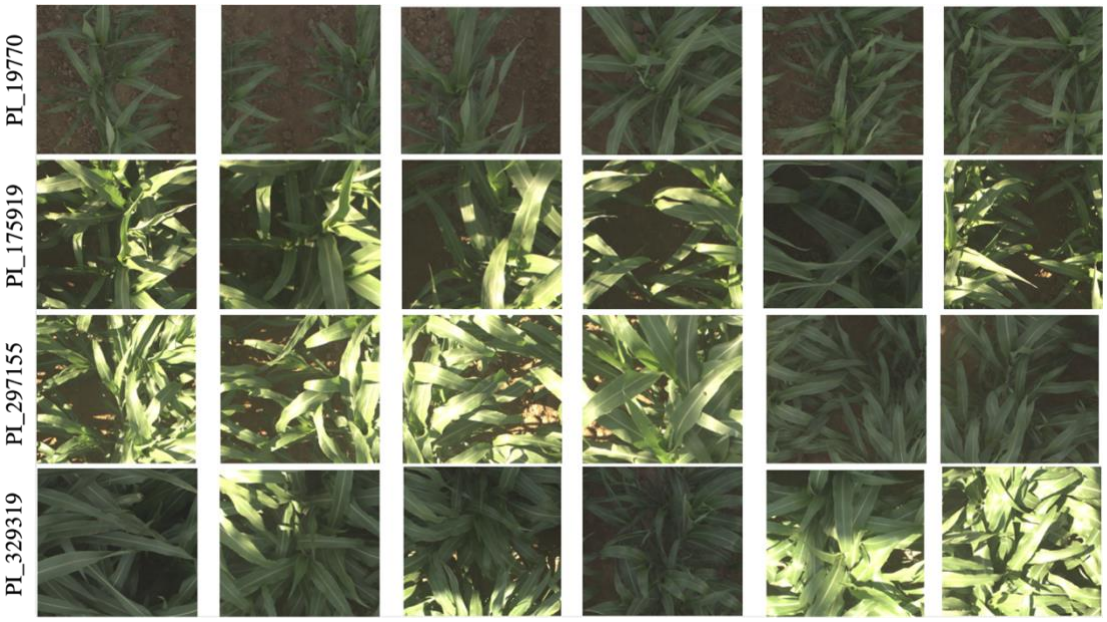

Figure 2: Sample image for each Cultivar

Each image is taken using an RGB spectral camera taken from a vertical view of the sorghum plants in the TERRA-REF field in Arizona in 2017. Figure 2 above contains some of the images form the competition website. In sample image above, images from four different cultivars are shown. Each row includes six images from different dates in June. It highlights the high inter-class visual similarity between the different classes, as well as the high variability in the imaging conditions from one day to the next, or even over the course of a day.

The dataset is divided into a training dataset and a testing dataset. Each cultivar was grown in two separate plots in the TERRA-REF field to account for extremely local field or soil conditions that might impact the growth of plants in one plot. Here in the dataset, training dataset is from one plot and test image is from the other plot so that the machine cannot memorize other features like soil patterns, dart patterns etc. that are not meaningful phenotypes.

Planned Experiments:

I am going to use off the shelf CNN models (ResNets [3] and DenseNets [4]) without any augmentations. Then I am going to add different types of augmentation on the models to generalize the model on the test data. At the end the predictions from different models will be ensembled to produce the final prediction for submission.

Project Outcome:

I am expecting several outcomes from this project. They are as follows:

- Learning how to use state of the art convolutional neural networks as pattern classifiers in real life.
- Learning how to generalize the pattern classifier models i.e., neural networks on the unseen test data using data augmentation techniques.

References:

[1] https://www.kaggle.com/competitions/sorghum-id-fgvc-9/data

[2] https://en.wikipedia.org/wiki/Cultivar

[3] He, Kaiming, Xiangyu Zhang, Shaoqing Ren, and Jian Sun. "Deep residual learning for image recognition." In *Proceedings of the IEEE conference on computer vision and pattern recognition*, pp. 770-778. 2016.

[4] Huang, Gao, Zhuang Liu, Laurens Van Der Maaten, and Kilian Q. Weinberger. "Densely connected convolutional networks." In *Proceedings of the IEEE conference on computer vision and pattern recognition*, pp. 4700-4708. 2017.