Machine Learning Engineer Nanodegree

Capstone Proposal: Plant Seedlings Classification Using Convolutional Neural Networks

Dorcas Balogun

July 24, 2018

Domain Background

Various systems have been developed for the detection of weeds over the years, but a true commercial breakthrough of these systems is still to come despite the construction of several prototypes and case studies showing promising results. Researchers in this domain have argued that the most promising approach for site-specific weed control is currently a ground-based computer vision system (Gerhards, 2010), since approaches such as remote sensing need to address a myriad of problems in order to be robust and reliable - many of which (such as solar angle and cloud cover) are beyond the control of the users (Thorp and Tian, 2004).

The computer vision system that will be used for solving the problem in this project, will be based on using convolutional neural networks in conjunction with techniques such as image augmentation and transfer learning.

Problem Statement

Classification of weeds from crop seedling is quite challenging, even with the human eye and as a result, the growth of weeds have led to the production of chemical substances which are toxic to crop plants(allelopathy), animals, or humans. The effects of weeds on plants are numerous, leading to reduced crop quality. The ability to effectively differentiate between a weed and a crop seedling, using convolutional neural network means better crop yields and better stewardship of the environment.

Datasets and Inputs

The dataset is provided by the Aarhus University Department of Engineering Signal Processing Group in collaboration with University of Southern Denmark. The images within this dataset are based on ground-based weed or specie spotting, which makes it appropriate for this project.This dataset supports and encourages the development of species recognition techniques and plant appearance analysis for the agricultural industry.

A subset of the original Plant Seedlings dataset will be used for this project. The subset contains

4,750 plant images belonging to 12 species at several growth stages. It comprises annotated RGB images with a physical resolution of roughly 10 pixels per mm.

The dataset will be divided into two categories namely; the train dataset which consist of 3,801 images and a validation dataset consisting of 949 images. The CNN model will be trained on the train dataset and tested on the validation dataset.

Solution Statement

To solve this problem, a convolutional neural network model will be developed. Different models will be generated based on series of convolutional layers, dense layers, kernel sizes, optimizers and pooling layers and the best model will be selected. Transfer learning and Image augmentation techniques will also be implemented to generate a more accurate result.

Benchmark Model

Models will be evaluated based on micro-averaged F1-score which is the performance benchmark recommended in the research paper of this dataset. The benchmark model is a CNN model consisting of three convolutional layers and two dense layers with a total of 1,945,782 trainable parameters. A reLU activation function and a kernel size of three was used. An F1 score of 0.7808 was gotten, which represents the benchmark score. This serves as a benchmark towards building a better model.

Evaluation Metrics

The convolutional neural network model generated will be evaluated on the Mean FScore, which is actually a micro-averaged F1-score. The F1 score is the harmonic mean of precision and recall.

Given positive/negative rates for each class *k*, the resulting score is computed this way:

$$Precision_{micro} = \frac{\Sigma_{k\varepsilon C} TP_k}{\Sigma_{k\varepsilon C} TP_k + FP_K}$$

$$Recall_{micro} = \frac{\Sigma_{k\varepsilon C} TP_k}{\Sigma_{k\varepsilon C} TP_k + FN_K}$$

$$MeanFScore = F1_{micro} = \frac{2Precision_{micro} Recall_{micro}}{Precision_{micro} + Recall_{micro}}$$

- True Positive (TP) is an outcome where the model correctly predicts the positive class.
- True Negative (TN) is an outcome where the model correctly predicts the negative class.

- False Positive (FP) is an outcome where the model incorrectly predicts the positive class.
- False Negative (FN) is an outcome where the model incorrectly predicts the negative class.

Project Design

First of all, the dataset will be analyzed in order to have a better understanding of the data. Some techniques will be taken to balance the data if it's not balanced.

The dataset will be divided into train and validation. Validation will be assigned 20% and 80% for the train. The dataset will go through a series of preprocessing step, to conform it to the standard that can be used as inputs to the convolutional neural networks.

A convolutional neural network model will be developed from scratch. Different models will be developed based on different augmentation techniques, convolutional layers, dense layers, kernel sizes, optimizers and pooling layers. The best model in this section will be selected.

A second model will be developed using transfer learning. Results gotten from the best model above and this current model will be compared using their Mean FScore. The model that performs better, will be selected as the final model.

References

1. Thomas Mosgaard Giselsson, Rasmus Nyholm Jørgensen , Peter Kryger Jensen, Mads Dyrmann and Henrik Skov Midtiby (2017, November 16). A Public Image Database for Benchmark of Plant Seedling Classification Algorithms.
2. https://www.kaggle.com/c/plant-seedlings-classification