Deep Learning

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**Abstract**: The goal of this project is to create a tool able to distinguish between a healthy corn leaf, and one of three possible diseases afflicting the leaf. These four classifications would be healthy, blight, common rust, and grey spot. The application for this tool would be for farmers to be able to accurately determine whether a stalk of corn would be healthy to harvest, as well as identify what disease is affecting the crop. Multiple trade studies were performed to find an ideal combination of hyperparameters to tune for an optimized model. It was found that with a mini-batch size of 64, learning rate of 0.01, 8 hidden layers, 32 perceptrons per layer, starting with a pre-trained EfficientNetV2L base, an ELU activation function, no data augmentation, and 6 epochs yielded the highest performing model. This optimized model scored a test accuracy of 89.7 with an overfit score (ABS(train accuracy – test accuracy)) of 2.1.

**Design**: Before any test was to be performed, all color images were rescaled to a size of 128x128 pixels, and each image was converted to a tensor representing its pixel values on all 3 color channels. PCA was used in an EDA to visualize how closely distributed the data is when represented by only 2 principal component axes. This revealed that two of the classes were clearly separated while the other two were more intermixed. Several linear regression models were created as a baseline using different solvers and the best performing model achieved 81% test accuracy. Next, deep learning was investigated to improve upon the shortcomings of the linear models. Three trade studies were conducted in an effort to identify the optimal hyperparameters for this application.

**Data**: 4,188 images in 3 color channels. Resolution ranging from 256x256 - 4068x3456. Data was downloaded from the following Kaggle link: <https://www.kaggle.com/datasets/smaranjitghose/corn-or-maize-leaf-disease-dataset>.

**Algorithms**: Transfer learning was employed for all test cases examined in this project. The overall network structure chosen was a deep convoluted network. This consisted of an input layer, a convolutional transfer learning base whose output is flattened, followed by N fully connected dense layers where N was varied in the trade study, followed by a final dense output layer with 4 perceptrons (1 for each class). The first trade study analyzed 16 combinations of the following parameters: mini-batch size, learning rate, # hidden layers, and # perceptrons per layer. A second trade study analyzed 15 combinations of transfer learning bases and activation functions on the least overfit model from the first trade study. Finally, a third trade study analyzed 6 combinations of with/without data augmentation at different numbers of epochs on the least overfit model from the second trade study (that scored >80% on the test data). An optimal model was found through these experiments.

**Tools**: Pandas, Keras, TensorFlow, ImageDataGenerator, Xception, InceptionResNetV2, NASNetLarge, EfficientNetV2L, VGG16, os, glob, sklearn, PIL, numpy, plotly, seaborn, Excel

**Communication**: In addition to the powerpoint presented, the Jupyter Notebooks will be posted on the following GitHub link: <https://github.com/MitchellB9/Corn-Classifier-DL>