PLANT SEEDLING CLASSIFICATION

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Thursday, 14 February 2019

I.Definition

Project Overview

- Agriculture is vital for human survival and remains a major driver of several economies around the world; more so in underdeveloped and developing economies. Plants continue to serve as a source of food and oxygen for all life on earth.
- In continents like Africa, where agriculture is predominant, proper automation of the farming process would help optimize crop yield and ensure continuous productivity and sustainability.
- The transformation of the agricultural sector by use of smart farming methods can power economic growth in many countries. According to *[1]*, there is a strong link between increased productivity and economic prosperity.

One major reason for reduction in crop yield is weed invasion on farmlands. Weeds generally have no useful value in terms of food, nutrition or medicine yet they have accelerated growth and parasitically compete with actual crops for nutrients and space. Inefficient processes such as hand weeding has led to significant losses and increasing costs due to manual labour *[2]*.




Precision agriculture, with the goal of defining systems that support decision-making in farm management in order to optimize returns on outputs while preserving resources, and weed control systems have been developed aiming at optimizing yields and costs while minimizing environmental challenges; some robotic systems have been used to do this *[3]*. The robots and the vision machines need to be able to precisely and reliably detect a weed from the useful plants. Machine vision technologies developed for selective weeding face a challenge of reliable and accurate weed detection. It's not easy to identify the weeds due to unclear crops boundaries, with varying rocky or sandy backgrounds, and as a result, traditional classification methods are likely to fail on this task *[4]*.

In this work, I am trying to explore the performance of traditional computer vision methods on this task and show that a Deep Convolutional Neural Network (CNN) does the best job at classifying plant seedlings. In computer vision, CNNs have been known to be powerful visual models that yield hierarchies of features enabling accurate segmentation. They are also known to perform predictions relatively faster than other algorithms while maintaining competitive performance at the same time *[5]*.

DATASETS AND INPUT:

Explore plant seedling classification dataset from Kaggle at the below link provided

Dataset Link: https://www.kaggle.com/c/plant-seedlings-classification

This dataset contains 4750 images of plant species.

Dataset containing images of approximately 960 unique plants belonging to 12 species at several growth stages.

Each image has a filename that is its unique id. The goal is to create a classifier capable of determining a plant's species from a photo. Test set we need to predict the species of each image.

We performed image preprocessing on the dataset before training the models. we smoothen the image, removing high frequency content and then converting this blurred version to HSV space. We created a mask by specifying a range of possible color values of the seedlings to be captured and using a morphological erosion with an 11x11 structuring kernel, we are able to produce

foreground seedling images with the backgrounds subtracted. We then perform image normalization by subtracting the mean from each pixel, dividing by the standard deviation and then scaled the data in the range of [0,1].

PROBLEM STATEMENT:

The aim of the project is to find the CNN-driven seedling classification applications, when used in farming automation has the potential to optimize crop yield and improve productivity and efficiency when designed.

- CNNs have been widely used for diverse image classification tasks. My solution is to attempt to use keras and CNN for this problem and finally I am going to find the accuracy of the predicted model.

Metrics

- Since this is a Classification problem ,For this project I used Accuracy as a Metrics in order to calculate the performance of the model and loss metric as 'categorical_crossentropy'.
- I choose this metrics to measure the performance of the desired model and improvement of the accuracy and loss of the model changed based on the layers I consisered and also when compared to benchmark model the final has more accuracy and less loss .so these metrics says the final model I evaluated is better than the benchmark model.By this I can justify that my metrics are quite best to consider to show my model works good and also we knw that the better we get by using test and validation data says how our model work.so based on this characteristics I choose those metrics to my model.

II.Analysis

DATA EXPLORATION

- This dataset contains 4750 images of plant species.
- Dataset containing images of approximately 960 unique plants belonging to 12 species at several growth stages.

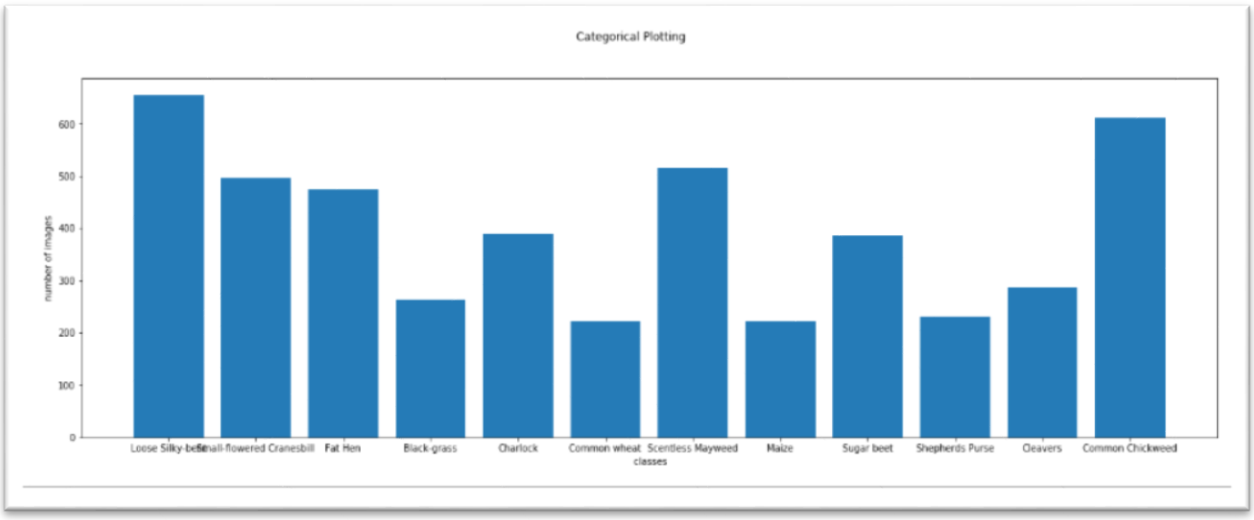
- Each image has a filename that is its unique id. The goal is to create a classifier capable of determining a plant's species from a photo. Test set we need to predict the species of each image.
- The data is primarily targeted tries to identify plant species at their early growth stage.
- Performing image segmentation at this stage is also easier because there is less over-lapping of leaves.
- We use two types of input sets; a first case where we pass in the original image pixels and a second case where we performed OpenCV preprocessing of the input image data as in the baseline.
- Although the advantage of weeding during plant seedlings early stage is to minimize the challenges that come with overlapping, it would be insightful to see how well the model identifies different classes of plants and potentially predicting the ratio of the classes present.

Exploratory Visualization

In this dataset we have 4750 images of plant species with 12 categories.

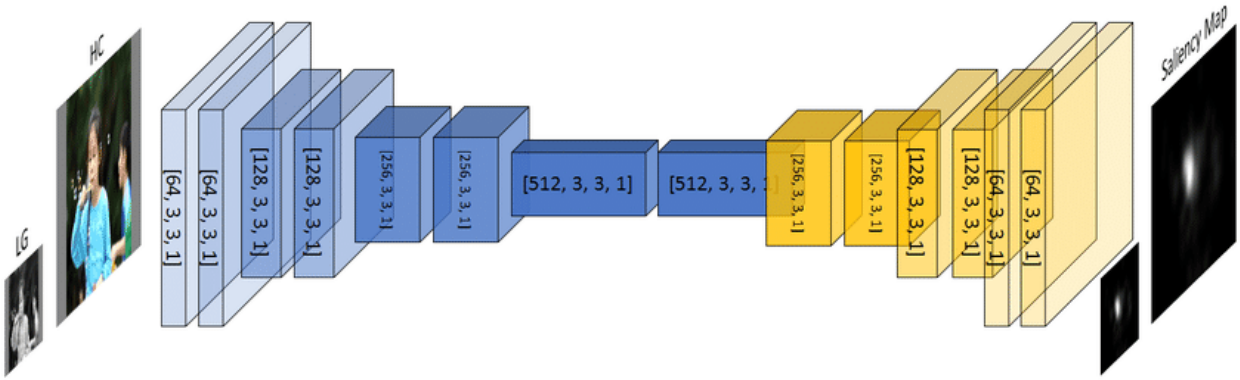
Each caetogory contains more than 150 images to train the model.

The Bar plot looks like this:



Algorithms and Techniques

In this project to solve the problem ,I used convolution network as a technique (i.e),adding convolution Layers which consists of input layer, hidden layer and output layer.I added only one Convolution Layer at first but model is notas good to perform then I increased the layers in my algorithm aand so I mentioned the input shape as (256,256,3) The Convolution Layer is represented as



- The neural network architecture has 6 convolutional layers. Each is followed with a rectified linear unit (ReLU). The first two convolutional layers have 64 filters, the next has 128 while the last one has 256. Each convolutional layer has zero padding.

- After each pair of convolutional layer, we have a max pooling layer for dimensionality reduction and a 10% dropout to prevent over-fitting. At the end of the six convolutional layers are 3 fully connected layers. The last fully connected layer has a softmax activation function which outputs probability distribution for each of the 12 classes.

- We use Adam optimizer with a batch size of 38 for each step and a loss metric of categorical entropy, to handle the imbalanced number of pixels for each class.

- Then model is predicted with better results,then data augmentation is done for reducing overfitting and to get better accuracy for the testing and validations data ,and made my to perform better.

- The over all techniques I used in this algorithm is segmentation and masking for preprocessing with helps better to evaluate the model and then I used CNN with data augmentation for better results.

Benchmark

- The Benchmark model I considered is one convolution Layer with one maxpooling layer and also 15 number of epochs which gives me testing accuracy as 40.58%.
- In order to beat the accuracy of Benchmark model ,I added three more Convolution layer and Maxpooling Layer with same number of epochs as 25.
- I increased the accuracy to 74.7% which can be considered as better model to evaluate.
- Then by using data augmentation to prevent overfiting I increased the accuracy to 82.58% successfully.

III.Methodology

Data Preprocessing

We performed image preprocessing on the dataset before training the models. First using Guassian Blur, we smoothen the image, removing high frequency content and then converting this blurred version to HSV space. We created a mask by specifying a range of possible color values of the seedlings to be captured and using a morphological erosion with an 11x11 structuring kernel, we are able to produce foreground seedling images with the Backgrounds

subtracted.

Below are images of a subset of the seedlings before and after background subtraction.

We then perform image normalization by subtracting the mean from each pixel, dividing by the standard deviation and then scaled the data in the range of [0,1].

Implementation

- We attempt to use a CNN for this problem. CNNs have been widely used for diverse image classification tasks. We use two types of input sets; a first case where we pass in the original image pixels and a second case where we performed OpenCV preprocessing of the input image data as in the baseline.

- The neural network architecture has 6 convolutional layers. Each is followed with a rectified linear unit (ReLU). The first two convolutional layers have 32 and 64 filters, the next has 128 while the last one has 256. Each convolutional layer has zero padding. After each pair of convolutional layer, we have a max pooling layer for dimensionality reduction and a 10% dropout to prevent over-fitting. At the end of the six convolutional layers are 3 fully connected layers. The last fully connected layer has a softmax activation function which outputs probability distribution for each of the 12 classes. We use Adam optimizer with a batch size of 38 for each step and a loss categorical entropy, to handle the imbalanced number of pixels for each class.

When I implemented the benchmark model I added only one convolutional layer and got the accuary of 40% only so I increased the layers for better computation and prediction by still my accuracy reached to 74% only .I am not satisfied with that then I came with data augmentation and performed data augmentation in that step and my model reached to 82% accuracy .

- compared to using just CNNs with attention its better to perform any tradition techniques

  like segmentation the data augmentation to improve the model.

Refinement

- To beat the accuracy of Benchmark model ,I added three more Convolution layer and Maxpooling Layer with same number of epochs as 25.I increased the accuracy to 74.7% when just execution by paying attention to CNN afterthen by using data augmentation to prevent overfiting I increased the accuracy to82.58% successfully with 30 epochs .So the model give better accuracy after data augmentation.

IV.Results

Model Evaluation and Validation

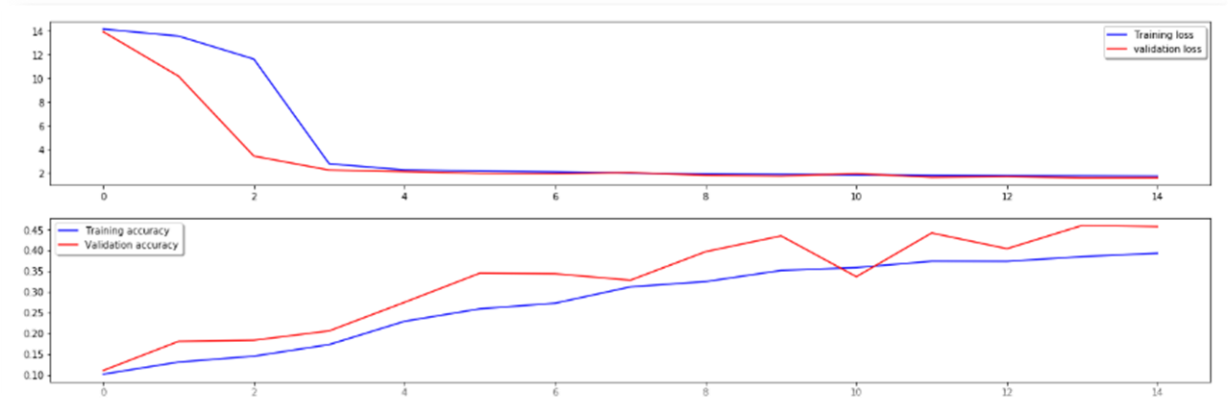
- In Final model, the accuracy of training samples have nearly 82.58% accuracy while for validation is 80 %,this is due to there are less number of validation images in given dataset .Any ways the testing accuracy is 82% which can be noted as good model for performance
- Consider the Loss for training and testing where testing images has low loss that means it is performing good predictions at testing.
- Since we got better accuracy I can say that my model generalize well to unseen data with some changes in data if we perform some preprocessing techniques before using the data then my model works good .

Justification

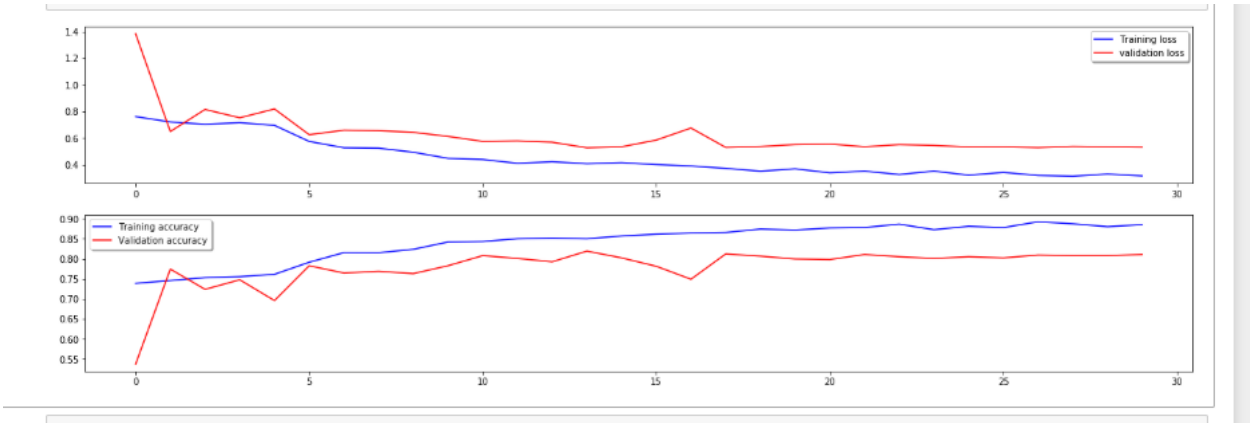
The final results occurred from the model found stronger than the benchmark model reported earlier in terms of improving the accuracy and model implementation time . An efficient deep learning model for seedlings classification can help farmers optimize crop yields and significantly reduce losses. The proposed of deep convolutional neural network method for plant seedlings classification, dataset that contains images of approximately 960 unique plants belonging to 12 species at several growth stages was used. The model can detect and differentiate a weed from other plants in the wild. A baseline version of the proposed system achieves an accuracy of approximately 83%. The proposed system can be extended to work with robotic arms for performing actual weeding operation in large farmlands.

V.Conclusion

Visualization of Benchmark model



Visualization of Final model



When we look into the visualizations of the final model and benchmark model the overfitting is reduced by using data augmentation for better results.The accuracy also increased by adding more layers to the model and that increment can be viewed in the above visuals.

An efficient deep learning model for seedlings classification can help farmers optimize crop yields and significantly reduce losses.The work can be extended to use this model in several areas like robotic arms for performing actual weeding operation in large farmlands.

Reflection

- First I have gone through some of the problems in Kaggle ,and I am interested in agriculture development and I selected the problem.
- Next I gained knowledge about the crop and seed of plant and how classification is doned in seedling.
- Afterwards I implemented the model in Kaggle in python language using keras and CNN.
- As mentioned before dataset contains train and test set of 4750 images with 12 tpyes of plant species .
- Then I started to implement my model by first preprocessing my data using segmentation and masking for reducing the overlapping.
- Then I implemented the benchmark model only by adding only one convolution layer and got the accuracy of 40%.

- Then I added more layers to perform better ,and each layer is followed with a rectified linear unit (ReLU). The first two convolutional layers have 32 and 64 filters, the next has 128 while the last one has 256.
- Each convolutional layer has zero padding. After each pair of convolutional layer, we have a max pooling layer for dimensionality reduction and a 10% dropout to prevent over-fitting. At the end of the six convolutional layers are 3 fully connected layers. The last fully connected layer has a softmax activation function which outputs probability distribution for each of the 12 classes.

- We use Adam optimizer with a batch size of 38 for each step and a loss categorical entropy, to handle the imbalanced number of pixels for each class.
- Then my model gave an accuracy of 74 % which is better than my benchmark model.
- Finaly to improve my model more i used data augmentation. I performed better with 82% accuracy by using augmentation.
- After doing all these I thought that we can use grid search for best evaluation but it takes time to search good parameters.although we can suggest the model.

Improvement

In order to improve my model performance , Transfer Learning technique can be more effective .I think GridSearch mechanism can also be applied here for improvement in case of tuning the model better. At Last adding more number of images in validation dataset can give better results for it .

REFERENCES

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[3] http://pure.au.dk/portal/files/114969776/

[4] https://www.cs.swarthmore.edu/

[5] W. Shang, S. Kihyuk, A. Diogo, and L. Honglak, Understanding and improving convolutional neural networks via concatenated rectified linear units, International Conference on Machine Learning, pp. 2217-2225. 2016.