Using Deep Learning to Determine Honeysuckle Bark

Brett Huffman - CSCI 5390 - Main Project Phase IV

Abstract

The objective of this project is to build a convolutional neural network which can accurately classify based on a learned images set.

This specific project will build a model capable of spotting several species of invasive Honeysuckle in the wild. The model will try to determine which species is invasive out of the many desired forest plants in the Illinois/Missouri habitat.

1 Phase 4 Objective

There are multiple objectives for Phase 4:

- To re-watch the Chapter 8 videos;
- Implement Data Augmentation to the best performing model of Phase III, and study it's performance;
- Plot the learning curves.

The results of all these activities are discussed in this paper.

2 Overall Problem To Be Solved

The Engineering and Biology Departments at Principia College are teaming up to build an autonomous rover that will poison unwanted species of plants.

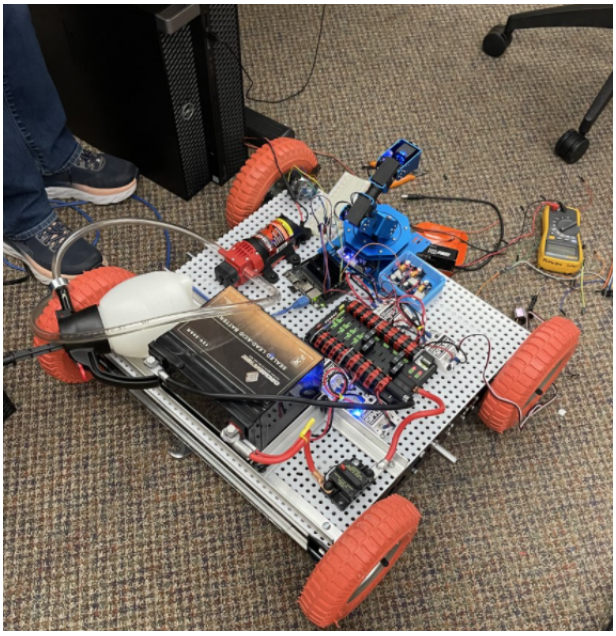

Figure 1: A view of the early rover prototype

After a year of work, they have demonstrated the ability to maneuver around a space, then when manually activated, chemically treat an unwanted plant.

The Biology department has identified a herbicide that is only poisonous to Honeysuckle – the main plant which they want to eradicate.

The problem with the herbicide is that it must be delivered into the stem. Thus, to treat a plant, the rover lowers a grinder boom which takes some of the bark off the plant. Next, a few drops of the herbicide is sprayed into the plant. Correctly applied, the plant dies within days ([Web20]).

The last big problem for the team to solve is how to autonomously determine if the plant is a target Honeysuckle.

This project is an attempt to see if the species of plant can be accurately identified from other plants in the target area.

2.1 Honeysuckle

Honeysuckle is an invasive species brought into the United States in the early 1900's as an ornamental plant. It has been used for erosion control, but quickly became invasive to many other species of native plants. It invades areas that have been disturbed such as forest fire scorched areas and flood plains. It rapidly out competes native plants for nutrients and sunshine ([Wik22]).

Further, Honeysuckle produces a thick canopy that prevents sunlight from getting to lower levels of the forest and effectively chokes off new growth.

For these reasons, eradication of the honeysuckle in wild areas is an important goal for botanists ([oC20]).

3 Phase IV Procedure and Results

After re-watching the lectures in Chapter 8, attention was focused on the Honeysuckle project. Using the model from Phase III, Data Augmentation was experimented with to try to improve model accuracy.

3.1 Model Changes from Phase III

Due to considerably low accuracy from Phase III, large steps were made to try to improve model performance:

- The model was changed from a multi-class, single-label classification to a binary classification. This has the effect of lowering the number of possible predictions, but also concentrating the training sets on just two data categories.

  This Binary Classification change had the effect of greatly amplifying the accuracy rate. It went from 64% in Phase III, to over 93% in this phase.

- Additional images were added to both the Honeysuckle and Non-Honeysuckle categories. This also had a dramatic effect on overall model accuracy.

3.2 Model Change Specifics

The best-case accuracy model from Phase III was initially chosen. Because it is now being rebuilt as a Binary Classification model, several changes were made:

- The last layer's activation was changed from softmax to sigmoid.
- The loss function was changed to binary$_c rossentropy$

- The data normalization was moved from the Data Generator to the model input declaration. This change worked better while trying to ensure normalization was consistent across both Augmentation and Non-Augmentation tests.

The new Best Accuracy Model can be seen in figure 3.2.

Best Accuracy Model

Layer (**type**)	Output Shape	Param #
input_2 (InputLayer)	[(None, 150, 150, 3)]	0
sequential_1 (Sequential)	(None, 150, 150, 3)	0
conv2d_5 (Conv2D)	(None, 148, 148, 8)	224
max_pooling2d_4 (MaxPooling)	(None, 74, 74, 8)	0
conv2d_6 (Conv2D)	(None, 72, 72, 16)	1168
max_pooling2d_5 (MaxPooling)	(None, 36, 36, 16)	0
conv2d_7 (Conv2D)	(None, 34, 34, 32)	4640
max_pooling2d_6 (MaxPooling)	(None, 17, 17, 32)	0
conv2d_8 (Conv2D)	(None, 15, 15, 64)	18496
max_pooling2d_7 (MaxPooling)	(None, 7, 7, 64)	0
conv2d_9 (Conv2D)	(None, 5, 5, 128)	73856
dropout_1 (Dropout)	(None, 5, 5, 128)	0
flatten_1 (Flatten)	(None, 3200)	0
dense_2 (Dense)	(None, 4)	12804
dense_3 (Dense)	(None, 2)	10

Total params: 111,198

Trainable params: 111,198

Non-trainable params: 0

3.3 Model Without Data Augmentation

Without Augmentation, the best model accuracy was 91.7%. While this was higher than the Phase III results, this was just because extra images were added to the system and for the change to a Binary Classification.

Accuracy: 0.917

Precision: 0.938

Recall: 0.9

F1: 0.911

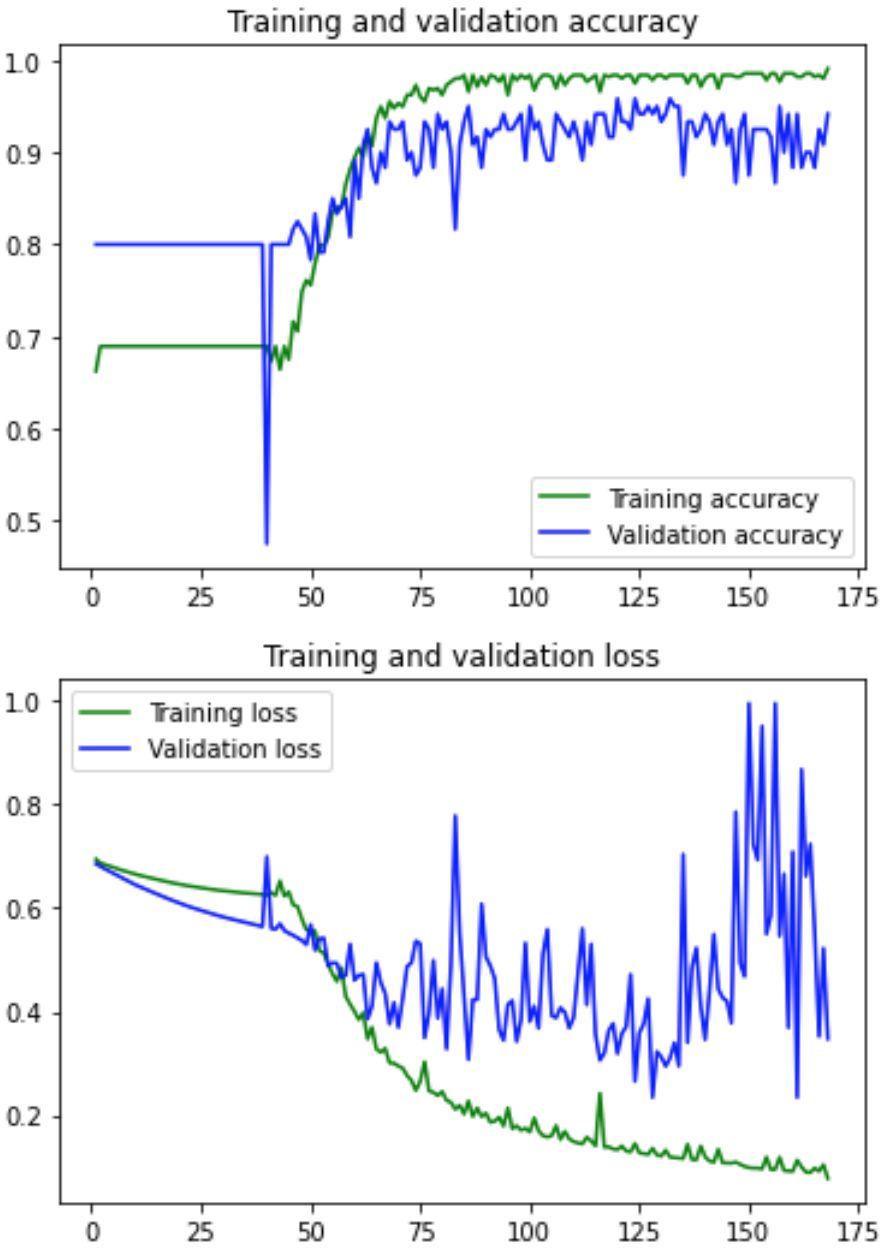

Figure 2: Best Model Without Data Augmentation

3.4 Model With Data Augmentation

Data Augmentation was very helpful for the model accuracy. The best Data Augmentation parameters studied were:

```
data_augmentation = tf.keras.Sequential(
    [
        layers.RandomFlip("horizontal"),
        layers.RandomRotation(0.1),
        layers.RandomZoom(0.2),
    ]
)
```

Almost all metrics for the augmented models jumped dramatically along with the overall accuracy:

Accuracy: 0.938

Precision: 0.9

Recall: 0.958

F1: 0.923

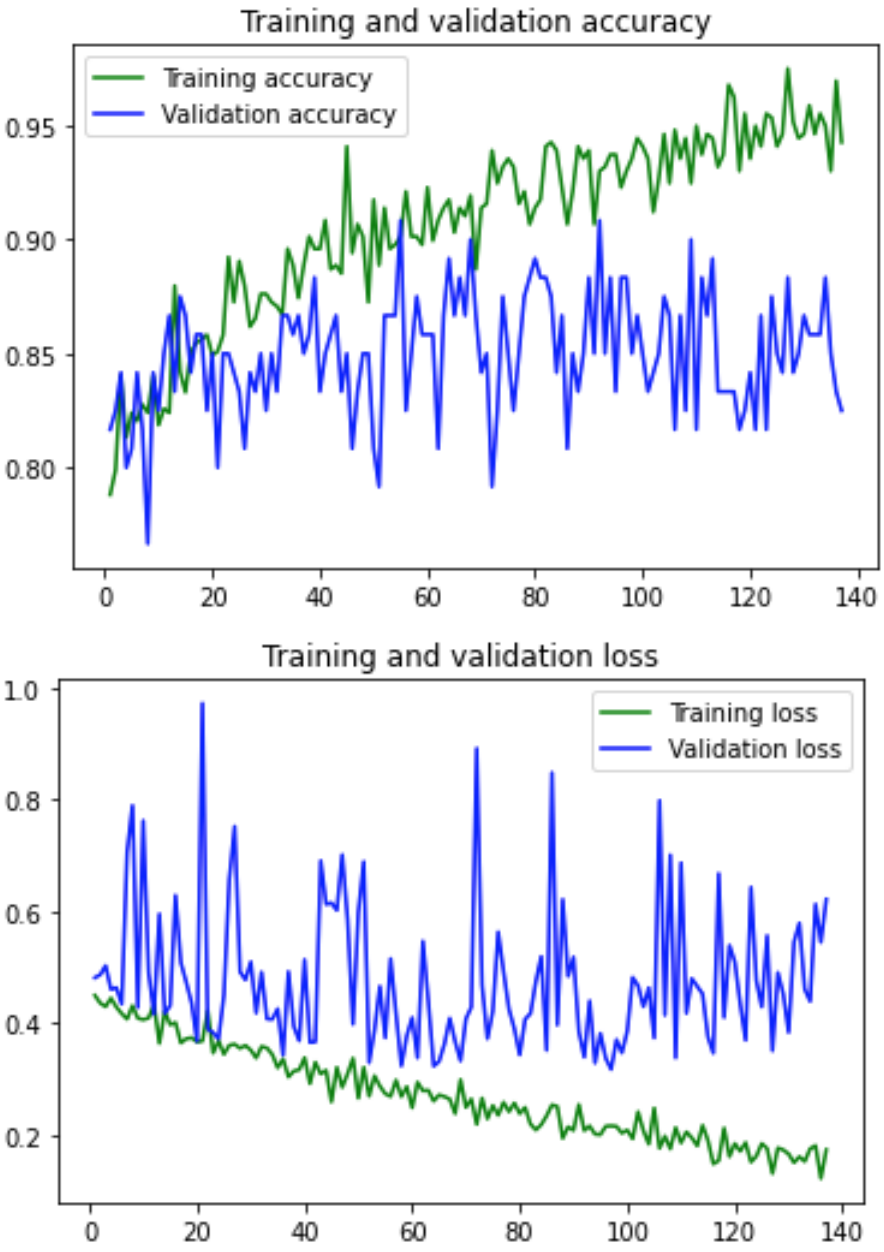

Figure 3: Best Model With Data Augmentation

4 Conclusion

Data Augmentation definitely had a large impact on improving the accuracy of the Honeysuckle model. It will definitely be used in the later phases of the project.

References

[oC20] Missouri Department of Conservation. Bush honeysuckle control. https://mdc.mo.gov/trees-plants/invasive-plants/bush-honeysuckle-control, 2020.

[Web20] Integrated Pest Management Website. Weed of the month: Bush honeysuckle—an ornamental gone wrong. https://ipm.missouri.edu/ipcm/2015/9/Weed-of-the-Month-Bush-honeysuckle-an-ornamental-gone-wrong/, 2020.

[Wik22] Wikipedia. Lonicera japonica. https://en.wikipedia.org/wiki/Lonicera_japonica, 2022. Invasive Honeysuckle Species Description.