Abstract

Tracking invasive species can be a slow and costly process. In my project, I aim to create a new type of system for invasive species identification and create an easy way to take identified invasive species and store them. To accomplish this task, I used the power of machine learning and Convolutional Neural Networks. In this paper, I will talk about the methods I used to create the classifier, and how I created a new technology that uses the power of community action to control the spread of invasive species.

Introduction

As a community, it is essential to track and keep track of the invasive species in our area. They can harm both humans, plants, and animals and can also rip apart ecosystems. Currently, there are a few ways invasive species are being tracked. However, the most common form is experts going out into the open and trying to find and identify species by hand. One other method for tracking that has shown promise is passive surveillance using the help of community action. One example of a community-based system is EDDmaps. On its website, it has hundreds of different invasive species that also have hundreds and sometimes thousands of species sightings. The one problem with EDDmaps is that experts have to check all the photos and sightings uploaded and not all people can upload information to it which does not make it useful across the entire United States.

Although community action is useful as a method for tracking invasive species, there are a few issues with it. As Cacho et al. describes, while single community engagement activities help out, its effects do not last long and have very little effect on the species in the long term. Hester et al. have instead proposed a novel model of community engagement. They suggest that invasive species surveillance should combine the work of conservation departments and universities with community efforts. My research project seeks to use this methodology and create a new form of community engagement for those who care about invasive species. Our solution is to create a classifier and mapping system in which you can upload a photo of a species that you think is invasive, and the site will tell you which species it might be. My system is specialized for townships and areas without conservation departments. The system is easy and accessible for use by the community. There has been little effort to combine invasive species identification technology and a surveillance database, but through this project, I hope to prove why this combination will be very important for invasive species surveillance in the future.

Methodology

Before making the actual classifier I decided it would be smart to talk to some of the town's conservation departments. I talked to the Weston conservation department and they said that having a classifier would be useful along with a place to store invasive species that have been found. That is why I decided to have both the classifier and the map instead of just the classifier. I created a website to host both the map and the classifier (http://www.invasivetracker.com/). I was not sure how to code a website on my own, so instead what I did was use a tool called wordpress editor. This allowed me to easily create the pages, edit the website and add plugins to it like the mapping system. This website is the place where people can both classify and mark invasive species all in one place.

There have been many attempts to make novel identification tools. Before I made my own identification tool, I looked at previous literature creating similar things. One of the classifiers I looked at used feature extraction, which would look for unique characteristics of a leaf or flower, like the shape and color. Another one that I looked at used the leaf's veins patterns. It would look very closely at the patterns on different leaves and would memorize that pattern for later when it needed to identify a species. The third classifier I looked at would look at the entire plant and try and learn the entire body of it. It would use pictures of large groups of the plant and pictures of the full plant itself.

In the development of my classifier, I tried to find which invasive plant characteristic would give us the highest accuracy. I found that combining leaves, flowers and other parts of the plant allowed the tool to r`un quickly while retaining high accuracy. In this way, my tool has its roots in a study Sunny et al.

which similarly found that a combination of multiple unique characteristics resulted in a novel classifier tool that presents the highest accuracy. However, I departed from the study's classifier by using a convolutional neural network (CNN) to build the classifier. The convolutional neural network presents a few benefits over similar systems that allowed me to optimize the classification software. The way a CNN works is it takes a set of images that you want to classify and tries to learn and recognize what it looks like. It zooms into the image looking at it part by part. After it is done looking through the images and learning them, you can now give it an image of a species and it will tell you what class (or species) it is.

The first CNN that I coded was written in Python using Keras and Tensorflow. That was a 3 layer deep CNN which means that the CNN zooms into the image 3 times. In the end did not produce the results I wanted, being very inaccurate and very unreliable. After more research, I came across the GoogLenet format which is a very well-known image classification CNN. I used it's latest version, called inception V_3 which has high accuracy. I found the core of the code on github, but made changes to it so it would only create the classes I needed. I also had to change it so that it would run on the training image resolution(our images were 150x150). After that I need to retrain the model. To do this I first needed a training dataset with 500+ images of the species. I found those on plantnet.org. I retrained the model using the dataset and tuned the model parameters. Finally, I did some coding in Python to take the saved model and used it to classify an image.

Conclusion

Through the development of my system, I attempted to optimize the experience for the user. My system is efficient because a person can check if a species is invasive or not and mark that on a public database, which can then later be checked by experts to see if it is a threat. Because my system has both the classifier and marker, there is no wait to get your photo verified and no need for an expert to use their time to check photos. In addition, my system is easily accessible. It can be used from almost any device from almost anywhere. Even if a person is not an expert they still have access to this system which allows them to do a lot of what the experts do when finding invasive species. Small towns don't have as many resources as larger towns and universities, and this system gives them some more support.

In the future there are changes I want to make to the website, classifier and map to make it easier to use for the community. When making the classifier part of the system, we were not able to include multiple classifiers due to processing power. In the future, if we have more processing power and the capabilities to have multiple classifiers, I would like to add classifiers that segment pictures to target specific characteristics. This would increase the overall accuracy for the classifier while potentially increasing the potential number of users on the website.

Overall, my project addresses an important disconnect in invasive species tracking systems. By integrating a classifier, the identification mechanism, with a map system, a data repository, I have created a more efficient and accessible method to track invasive species.

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