

Tree Classification and Carbon Stock Estimation Utilizing Convolutional Neural Networks

Team Trees: Payel Mukhopadhyay, Michael Cerchia, Dounia Lazreq, Carissa Moore, Margaux Joe, Irit Huq-Kuruvilla

Mentor: Chase Harpole

<https://github.com/lazreqd/Trees>

The Problem

- Increased carbon dioxide in the atmosphere is a major contributor to climate change
- Reforestation projects are one method to sequester carbon from the atmosphere to reduce impacts of climate change
- ***Current techniques tend to overpredict the carbon stock estimations due to the need of intensive manual labor, vast scale inaccurate maps etc.***

Our Goal

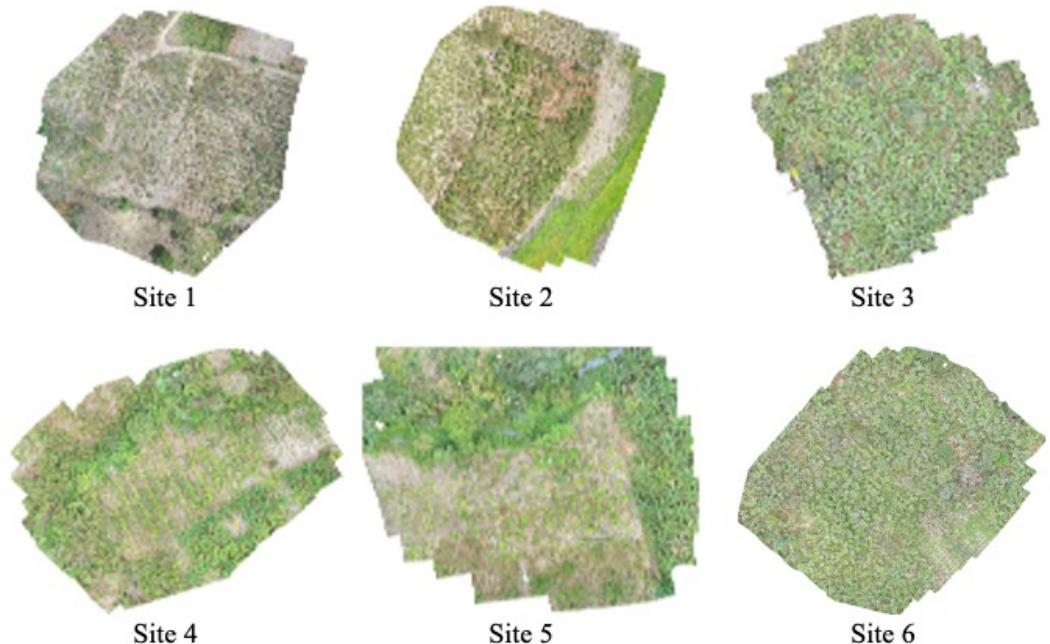
Explore the potential of tree species classification and carbon stock estimation using a state-of-the-art dataset that combines field data and low-cost drone imagery of forest sites

Data Extraction

Data Source: ReforesTree Dataset

6 tropical agroforestry sites in Ecuador

- Hand-collected field data (e.g., tree height, diameter, species, biomass, location) for each site
- RGB drone imagery for each site
- Drone images matched to tree crowns of field data using DeepForest Python package
- Data for ~5000 individual trees



Site 1: *Carlos Vera Arteaga*

Site 2: *Carlos Vera Guevara*

Site 3: *Flora Pluas*

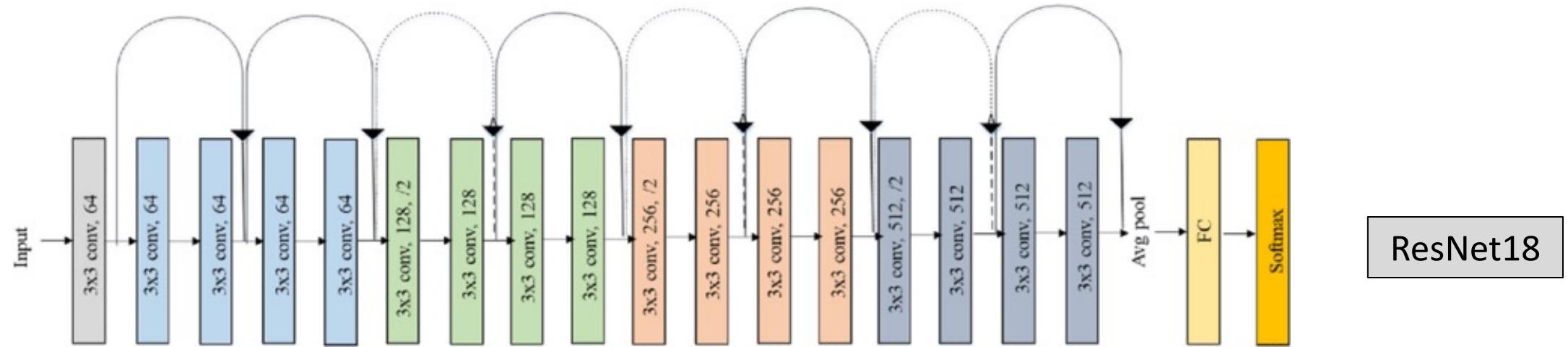
Site 4: *Leonor Aspiazu*

Site 5: *Manuel Macias*

Site 6: *Nestor Macias*

Reiersen, G., Dao, D., Lütjens, B., Klemmer, K., Amara, K., Steinegger, A., Zhang, C., & Zhu, X. (2022). ReforesTree: A Dataset for Estimating Tropical Forest Carbon Stock with Deep Learning and Aerial Imagery. *Proceedings of the AAAI Conference on Artificial Intelligence*, 36(11), 12119-12125. <https://doi.org/10.1609/aaai.v36i11.21471>

CNN Architecture

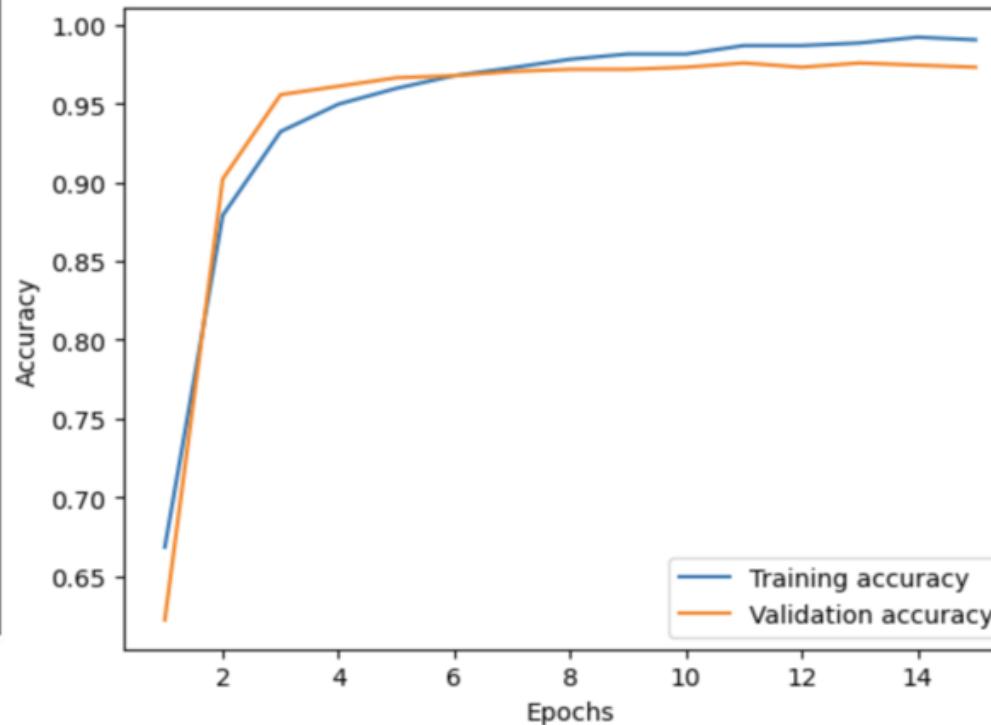
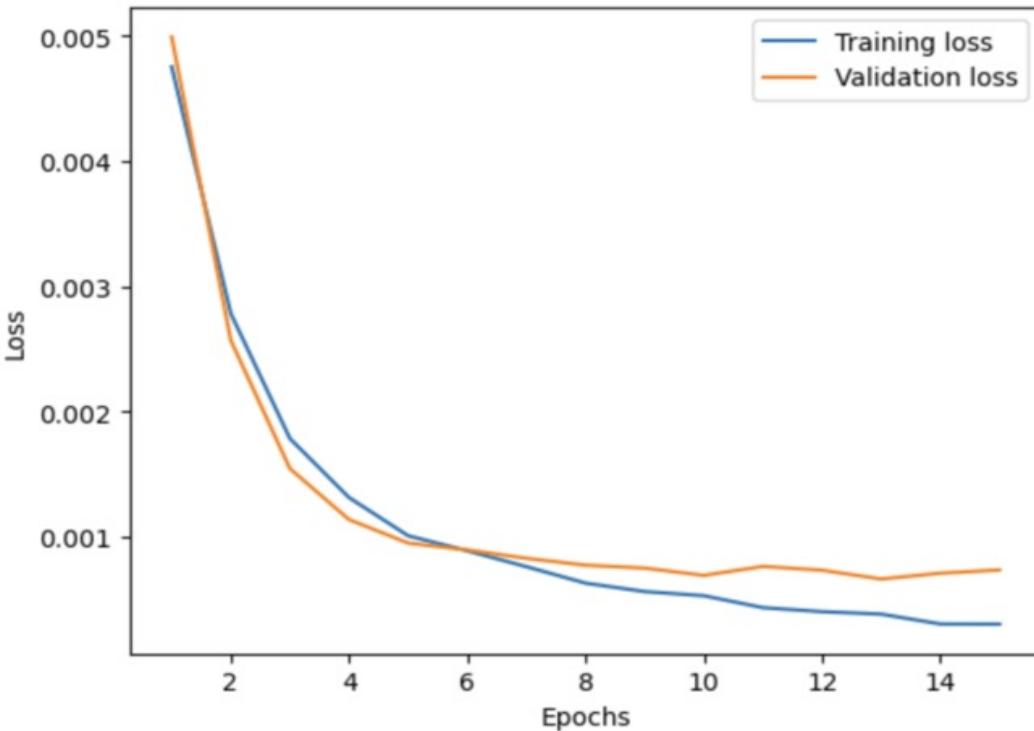


ResNet18 has a 72-layer architecture with 18 deep layers

- CONV layers with 3x3 filters
- 2 pooling layers
- Relu activation
- Identity connections between every two CONV layers

Binary Classification Results

The model is very good at binary classification of banana trees.

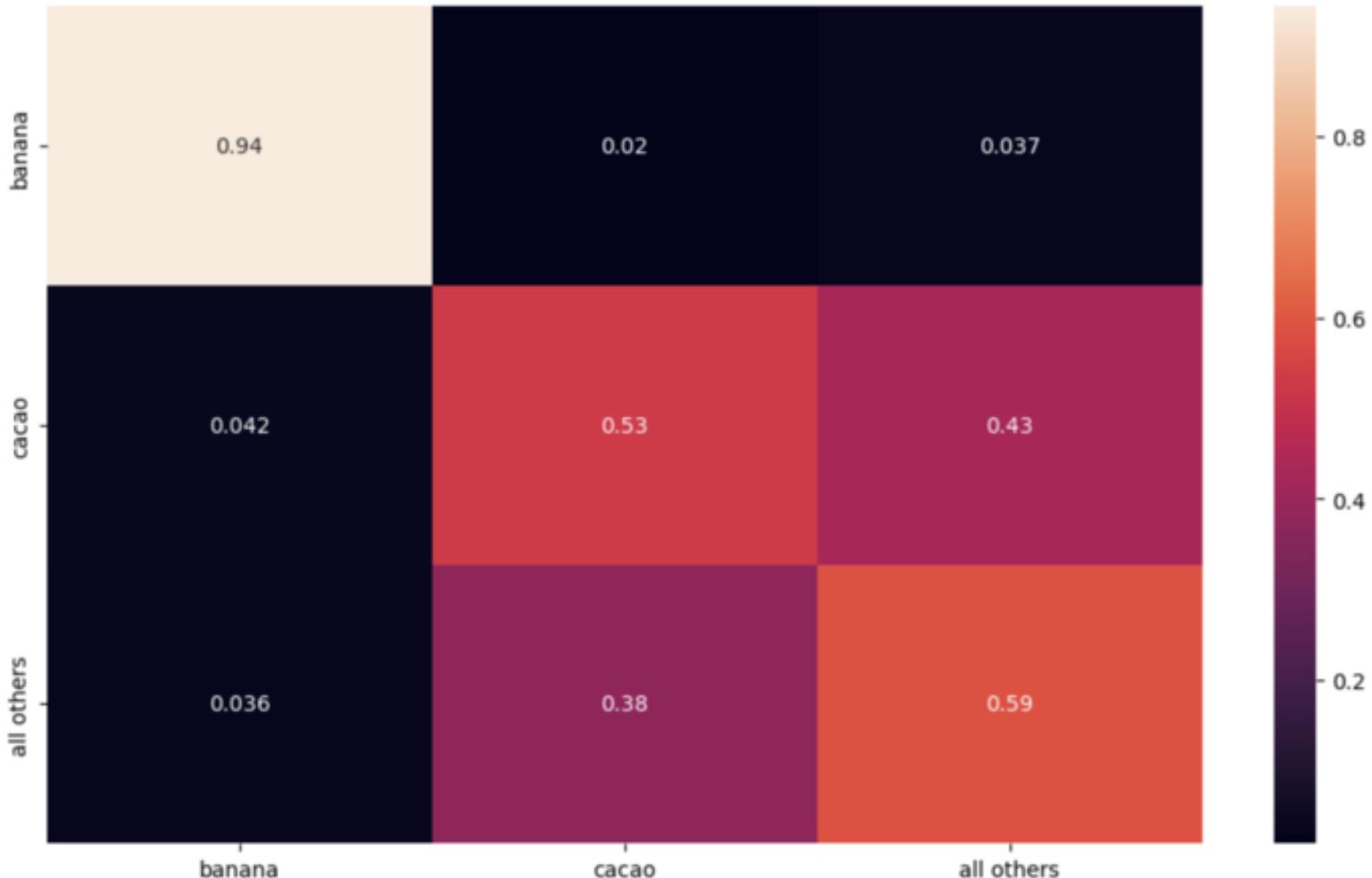


Precision	Recall
97%	95%

Multi-class Classification Results

The model is not good at classification of 3+ tree species.

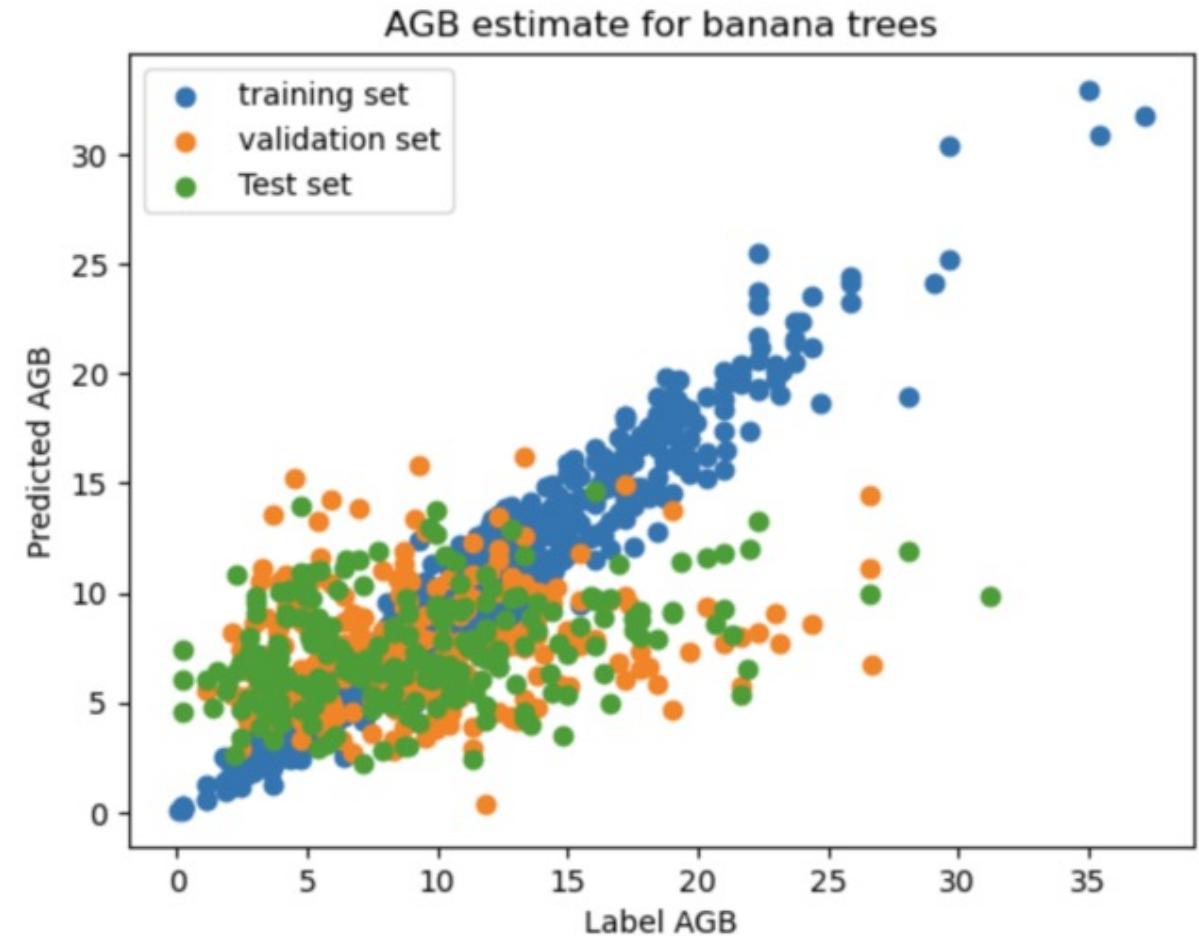
Tree Species	Precision	Recall
Banana	92%	94%
Cacao	58%	55%
Other	58%	60%



Above Ground Biomass Prediction Results

The model learns the AGB estimates of the training set well, but it fails to generalize as well on the validation and test sets

It does not, however, vastly overestimate the carbon stock, unlike other models, a consequence of being able to learn from the field data



Challenges

- GPS noise leading to data pre-processing issues
- Drone imagery and deep learning without hand collected field data may not provide meaningful predictions of the carbon stock

Future Work

- More complex data cleaning and pre-processing
- DeepForest rework
- Refine multi-class classification
- Improve CNN for AGB predictions
- Updated and more detailed field data and drone imagery data

Thank you!

Team Trees

Payel Mukhopadhyay

Astrophysics

U.C. Berkeley

Michael Cerchia

Mathematics

Emory University

Irit Huq-Kuruvilla

Mathematics

U.C. Berkeley

Dounia Lazreq
Mathematics
University of Virginia

Margaux Joe
Environmental Science
The Ohio State University

Carissa Moore
Environmental Science
The Ohio State University

Mentor: Chase Harpole

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