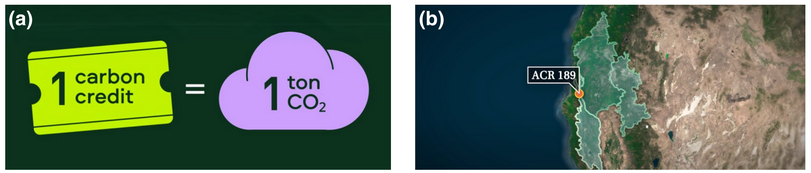
Advancing Carbon Credit Accuracy: A Machine Learning Approach for Precise Carbon Sequestration Estimation

Eric Mao[1]†, Tom Zheng[1]†, Chengtai (Richard) Li[1], Ken Cheng[1], Hudson Haas[1]

[1]Crescent School

†Authors contributed equally to this work

Introduction

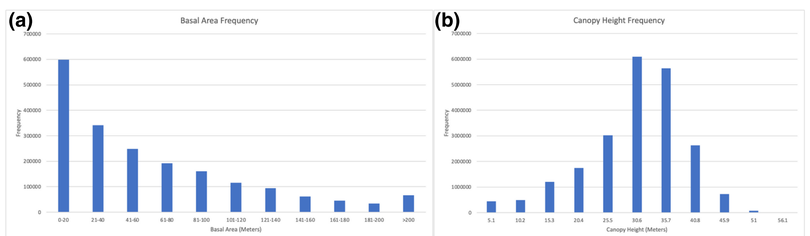


(a) CO_2 sequestration for 1 carbon credit (b) Super-sectioned eco sectors causing error baselines (ex. ACR 189) [1]

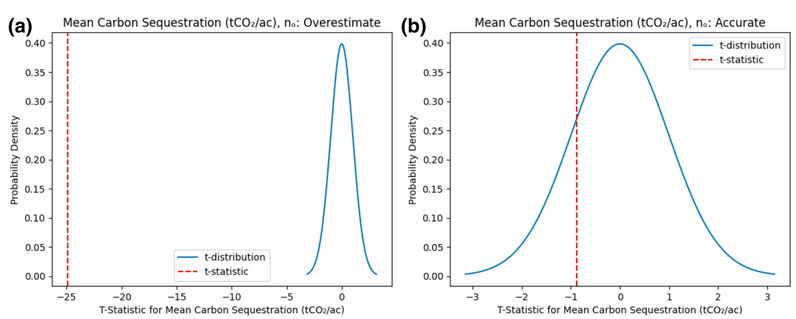
- Forests have **absorbed 30%** of all anthropogenic emissions in the last few decades [2]
- Carbon credits preserve forests for CO_2 offsets
  - **29.4%** over-crediting error due to crude baseline [1]
  - Highly time-consuming recrediting

Data Acquisition

- Global Ecosystem Dynamics Investigation Global Canopy Data
- U.S. Forestry Service Tree Species Data
- USDA + USFS + Esri ArcGIS Tree Species Density Data



(a) Frequency chart of basal area in CAR1190 (b) Frequency chart of canopy height in CAR1190



(a) T-test of modeled data against n_o=overestimate (b) T-test of modeled data against n_o=accurate

Highlights

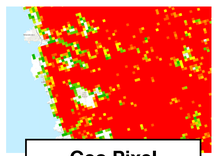
- **Effective and scalable carbon crediting solution**
- **Accurate machine learning model**
- **Correct over-crediting errors by 29.4%**

System Overview

What is the Carbon Sequestration Rate of...

Geo Data → **Post Processing** → **Mathematical**

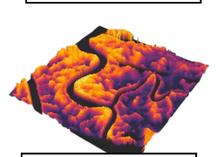
USDA Tree Frequency



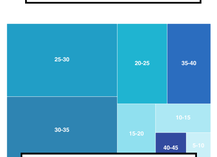
Geo Pixel Analysis

$$\sum_{i=1}^{n} \left(33.204 a H_i \sqrt{A_i}\right)$$

Sum of all Carbon Sequestration

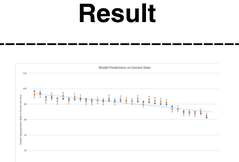


LiDAR Canopy Heights



Processed Pixel Data

Result



Model Prediction

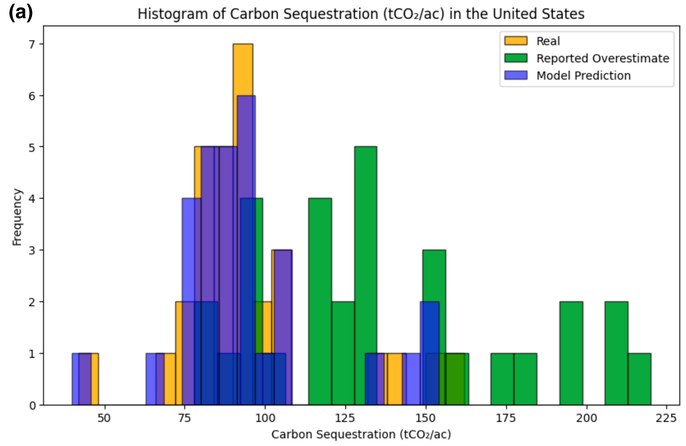
Sampled 30 conservatories, 150 million trees

Performance Comparison

	Plot Extrapolation	Lidar Analysis
Speed	Real-Time	Post Processing
Error Rate	±100%	±5%

Lidar Analysis provides an **20x improvement** in Error Bound in return for extra compute and time resources for post processing

Results



(a) Machine learning model prediction (blue) against overestimate (green) and accurate (real) data for 30 forests

A T-test against accurate mean yielded a p-value of p = 0.864

Summary, Analysis, & Future Work

- Processed scalable geographic data utilizing software programs
- Machine learning to calculate carbon sequestration in selected regions

In **future,** we plan to 1. Refine plots to include more complex geographic aggregation for more robust carbon calculations; 2. Implement model for *in situ* forest carbon sinks to better determine carbon sequestration over time anywhere in the world

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References

[1] Grayson Badgley, Jeremy Freeman, Joseph J Hamman, Barbara Haya, Anna T Trugman, William RL Anderegg, and Danny Cullenward. Systematic over-crediting in california's forest carbon offsets program. Global Change Biology, 28(4):1433–1445, 2022.

[2] Pan, Y. et al. Science 333, 988–993 (2011).