MONITORING FOREST HEALTH FROM REMOTE SENSING IMAGERY

PURDUE UNIVERSITY | The Data Mine

intelinair

Mia Sartain, Anish Gorentala, Harshini Musku, Vibha Polisetty, Saumya Verma, Hardit Sandhu, Nitin Nallagatla, Animesh Joshi,

Objectives

Goal: Implement a model using both low and high-resolution satellite data to identify anomalies in tree health

1. Once anomalies are identified, determine whether it indicates that a tree is unhealthy or healthy.
   1. Using unsupervised data, no preexisting labels
2. Alert landowner of the severity of the problem in the tree(s)
3. Track and continue to monitor issues

Overall Process

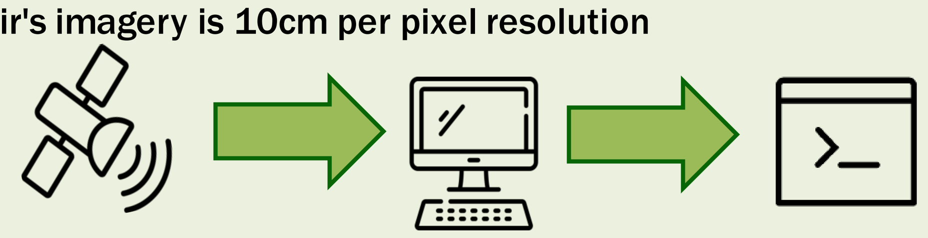
1. Conduct research into literature reviews on forest health issues solved with remote sensing
   a) Pest Detection (ex. Emerald Ash Borer)
   b) Forest Fire detection (⃠ an issue in Indiana)
2. Narrowed focus to identifying signs of tree infestation
   1. Sudden tree death
   2. Color change
   3. Out of Season Behavior
3. Working with Unsupervised Data
   1. Manually find anomalies
   2. No distinct labels without additional work
   3. No confirmation labels are fully correct

Semester 1 Progress

- Researched forest issues and potential
  - Forest Fires
  - Pests
  - Disease Detection
- Researched possible Machine Learning Solutions
  - Anomaly detection
  - Time Series Analysis
- Constructed an **autoencoder** to read in images
  - Differentiated between images with trees and images without trees
  - Then tested with images that had more green areas, but not necessarily trees

Sentinel 2 Dataset

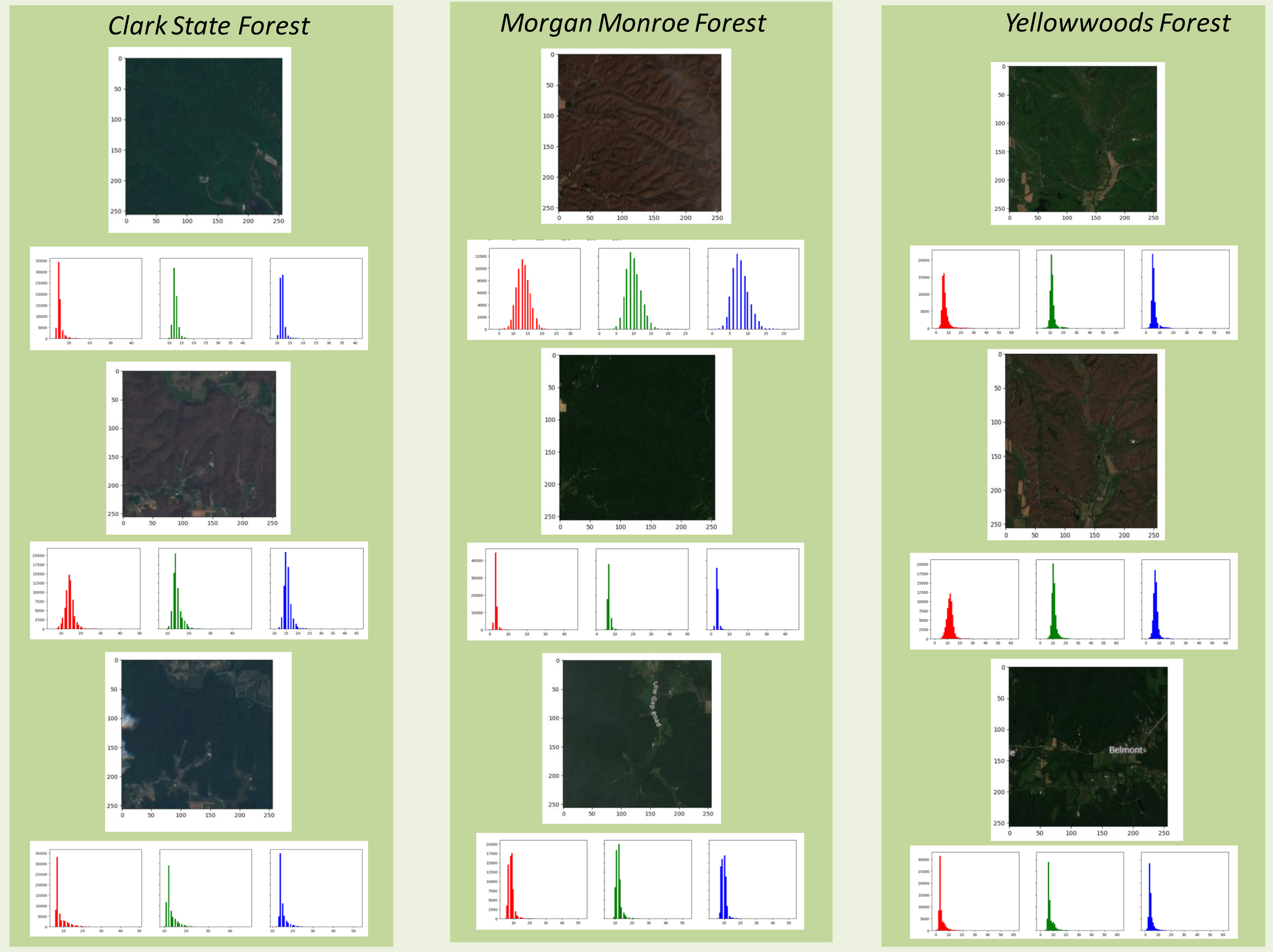
- Gathered from large **forests** in Indiana from **March – August** each year from **2018 to 2022**
- Over **300** images tiled to over **1000 256X256** images
- Unable to identify **anomalies** without further steps
- 10 meter – 60 meter per pixel resolution
  - Intelinair's imagery is 10cm per pixel resolution



Sentinel Images – Low Resolution

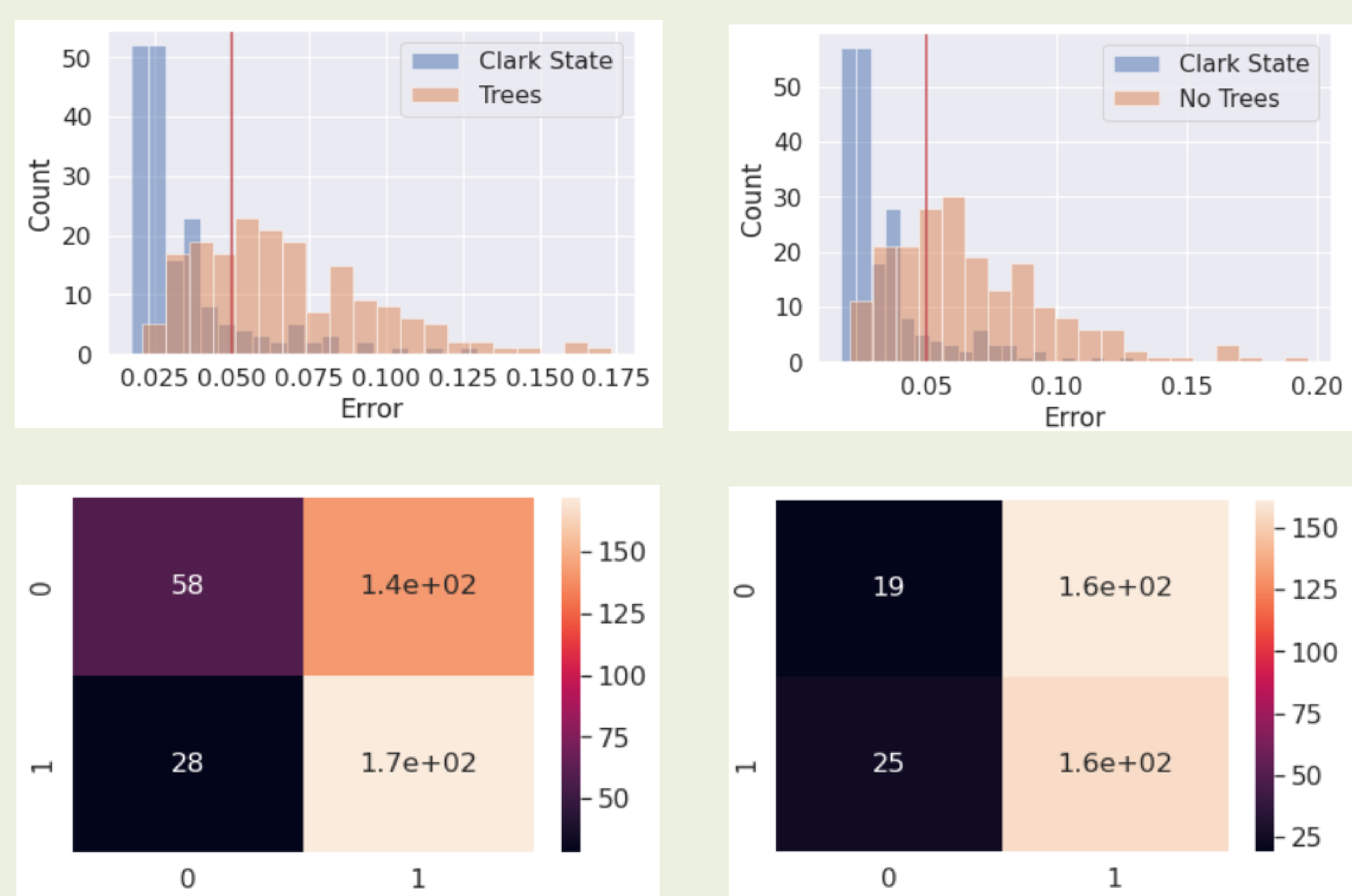
Forest Color Histogram Analysis

1. Processed images using b64 decode to find BGR values in images
2. Flipped values using cv2, so images look correct and are RGB
3. Plotted density and range of pixel values per pixel using pyplot



Anomaly Detection Using Auto-Encoders

- Trained an auto-encoder model on data of a particular label (grassland/trees) and
- Plotted mean squared error (MSE) after testing the model on both the previous label and a new, unfamiliar label (barren land/no trees)
- Observe the presence / lack of groups which could indicate what the auto-encoder sees as unfamiliar and therefore an anomaly



Color Histogram Conclusions

1. Color histograms showed patterns for specific commonalities in the dataset
   1. The more red colored images from late winter to early spring
   2. The more green/blue images from later spring into summer
   3. The mean of the images RGB values can be used to find large scale anomalies that show widespread forest damage.

Autoencoder Conclusions

1. The autoencoder has an accuracy of about 68.9%
2. Model can reconstruct images, though they appear blurry
3. Switching from the first to second dataset caused some errors, but the model was able to compensate

Future Goals

1. Test our models on a larger variety of datasets
   1. Intelinair's Data
   2. Other similar high resolution data
2. Expand the model to assess forest health by season (time-series)
3. Be able to define the characteristics/cause of an unhealthy tree

Image above is from a model that identifies health in palm trees

References and Acknowledgements

References:

- Bradski, G. (2000). The OpenCV Library. https://opencv.org/
- Copernicus Sentinel 2 data (2018-2022), processed by ESA.
- Chollet, Francios (2015) Keras Library, https://keras.io
- Lenhardt, Julia (2019) "Use deep learning to assess palm tree health", https://hub.arcgis.com/documents/LearnGIS::use-deep-learning-to-assess-palm-tree-health/explore

We would like to thank The Data Mine and Intelinair for providing us with this opportunity to work on this project.

In addition, we thank our mentors Jennifer and Daniel for their patient advice and support as well the other Data Mine staff.