Bondurant, Iowa
Tree Canopy Mapping

Completed by ICIGO at the University of Iowa as part of the Iowa Initiative for Sustainable Communities (IISC) 2023-24 partnership with the City of Bondurant.

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Introduction

The general goal of this project was to come up with the best ways to create a map displaying every tree in the city of Bondurant. A machine learning algorithm assisted in identification. The final product includes the general canopy cover of trees, but not individual information about each tree identified.

Data

Aerial imagery for this project was collected from Iowa GeoData in 2021. This website provides various GIS data for public use across the state of Iowa including LiDAR, aerial imagery, and various feature layers. The resolution for this layer is 60 x 60 cm per pixel.

Aerial imagery from USGS Earth Explorer from 2014 was also used. While out of date, its spatial resolution was much finer than the first data. Its resolution is 12.3 x 12.3 cm per pixel.

A set of pre-trained deep-learning AI tools from Arc Online were used on both sets of aerial images. One is called tree segmentation and the other is called tree detection. They both work similarly to each other. The tree segmentation tool places an irregular polygon around the trees. The tree detection tool places a rectangle around the trees.

Methods

To begin this process, a dataset containing some type of aerial or satellite imagery was required. It was not feasible for our team to take a site visit to Bondurant, so we had to use the resources that were available to us online. We ran both classification algorithms on both aerial imagery datasets, which produced different results. PyTorch, a machine learning library, was used to download the deep learning algorithms.

The 60cm imagery had a file size of around 100 MB, compared to the 12cm file, which had a file size of 15 GB. This meant that all the machine learning tools took way longer to run on the higher resolution file. The results of these algorithms produced very inaccurate classifications where half of the building footprints were classified as trees. This was the case for both imagery datasets. Because of this, the process required manually deleting false positives and adding in all the trees that were not caught by the algorithm. This process took a long time, and still is not totally perfect. However, the map does a good job at showing the general areas where trees do exist.

Tree segmentation did a better job at showing where trees were generally than the tree detection classifier. However, we included a tree detection layer that was used on the 60cm resolution dataset so that users can compare the differences with tree segmentation.

We also tried using supervised classifications to detect trees by manually entering in my own training samples, but this did not work out well. There were too many false positives and areas such as corn fields were classified as trees. One of the biggest issues with this method of classification is that you cannot manually draw in the areas where trees exist. For these reasons, this method was not used.

Deliverable

On this web map, you can toggle between the tree segmentation data (2014, better results) and the tree detection data (2021, but not as high quality and more inaccurate). The image layer provided on this map is from 2014, so some land cover features may be outdated. Keep this in mind when using the map. If a more accurate map of canopy cover is desired, city officials could physically geolocating each tree and/or use LiDAR technology to detect where each individual tree is located.

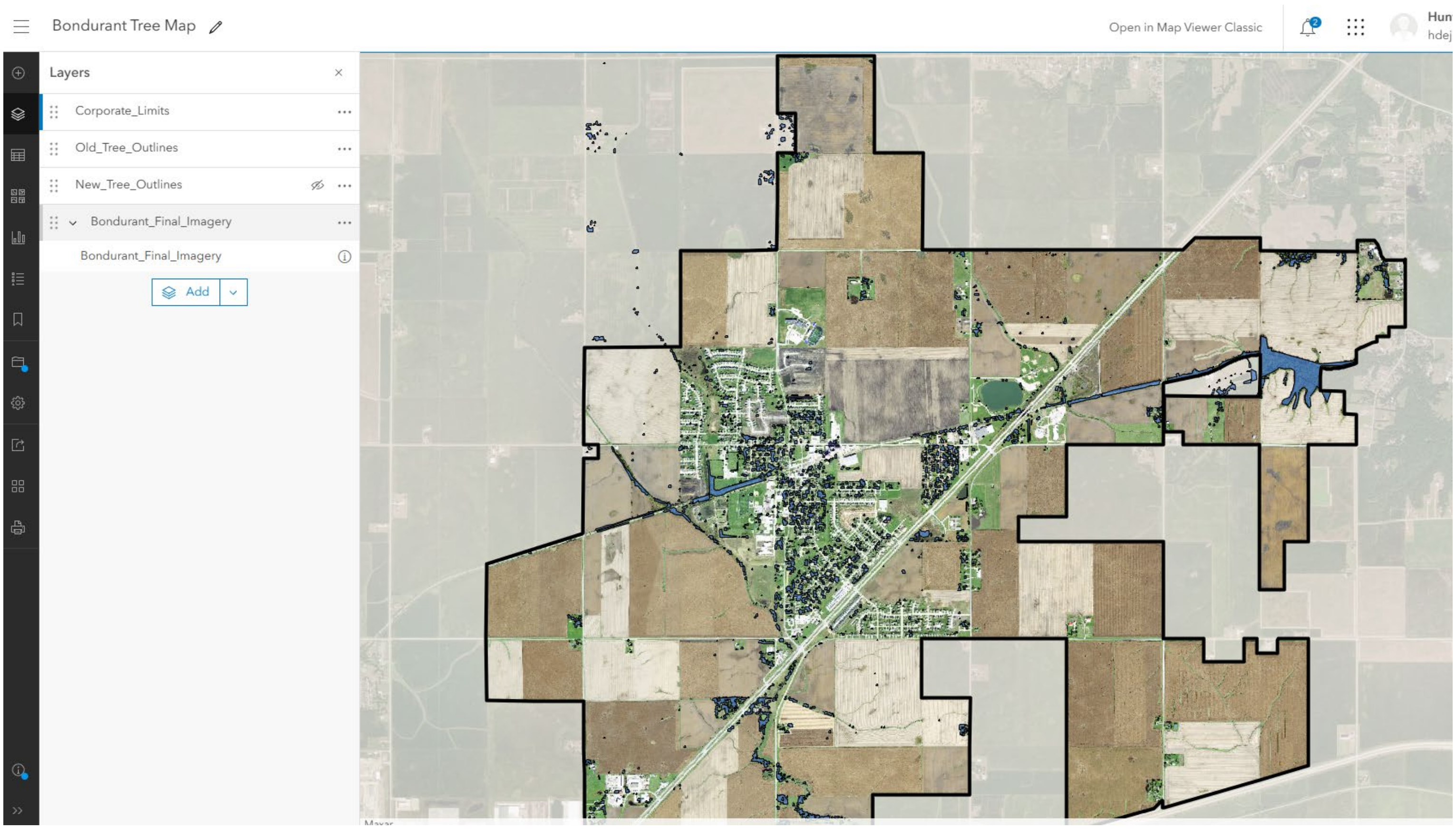

Figure 1: This is the current viewable map that is available on Arc online that contains the interactable canopy cover feature layers, which includes my old attempts (tree detection), and newer more accurate attempts (tree segmentation)

Bondurant Tree Outlines (Tree Detection)

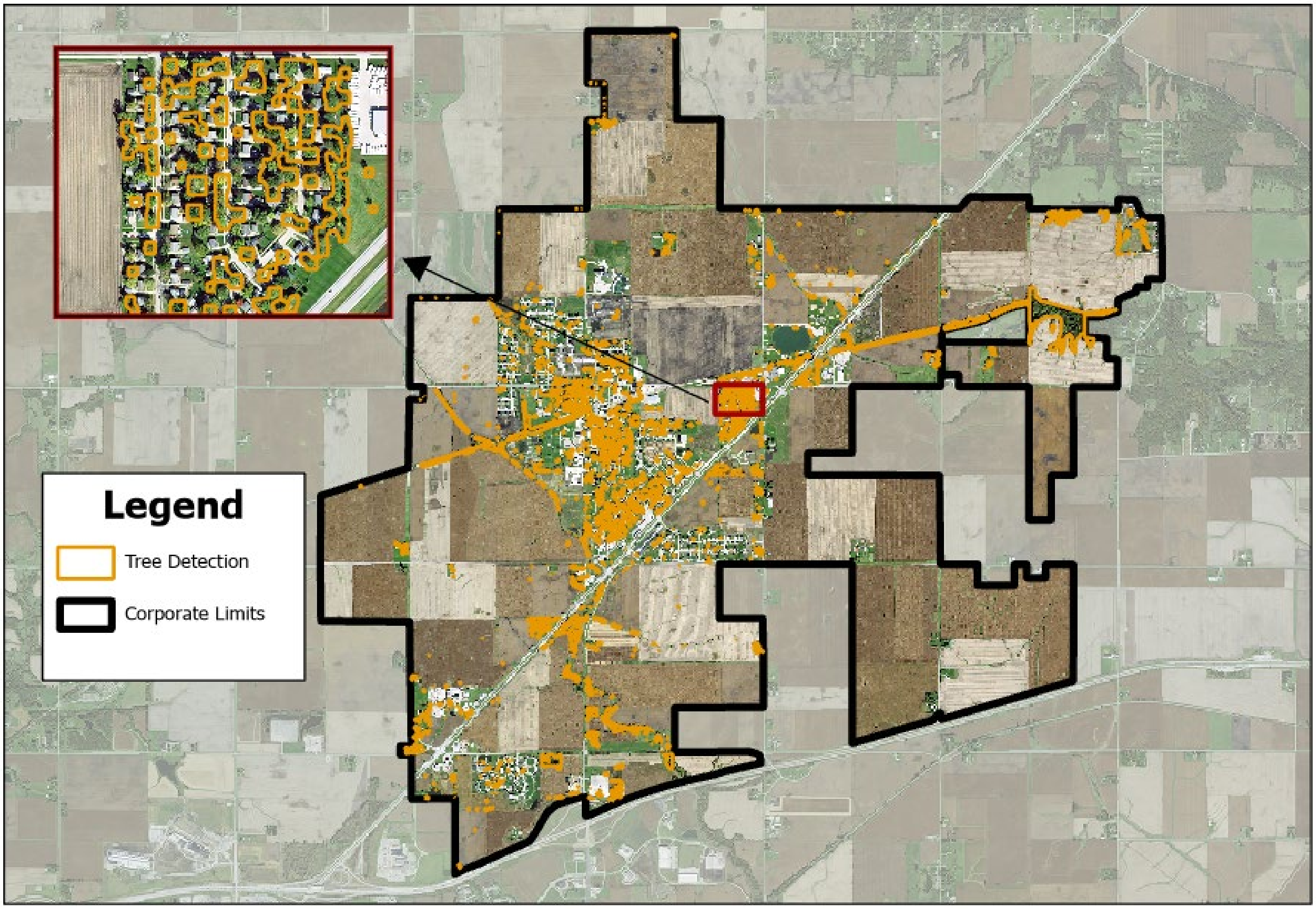

Figure 2: This map shows a more detailed view of the tree detection algorithm (old). As you can see, the classification has a more rectangular shape around areas that were detected as trees. However, this was not very accurate.

Bondurant Tree Outlines (Tree Segmentation)

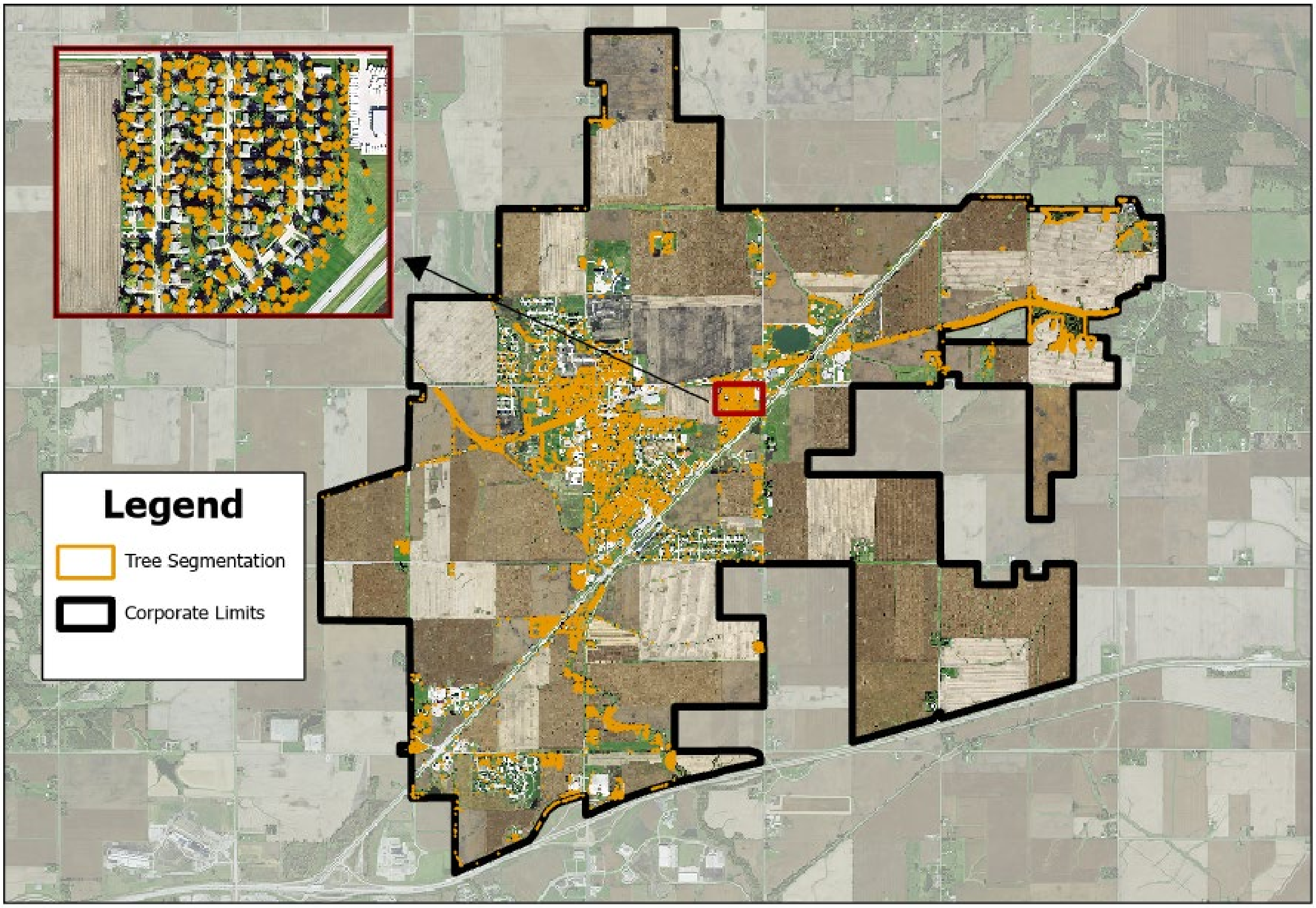

Figure 3: This map shows a more detailed view of the tree segmentation algorithm (new). This classification places more circular polygons around areas that were detected as trees.

Supervised Classification

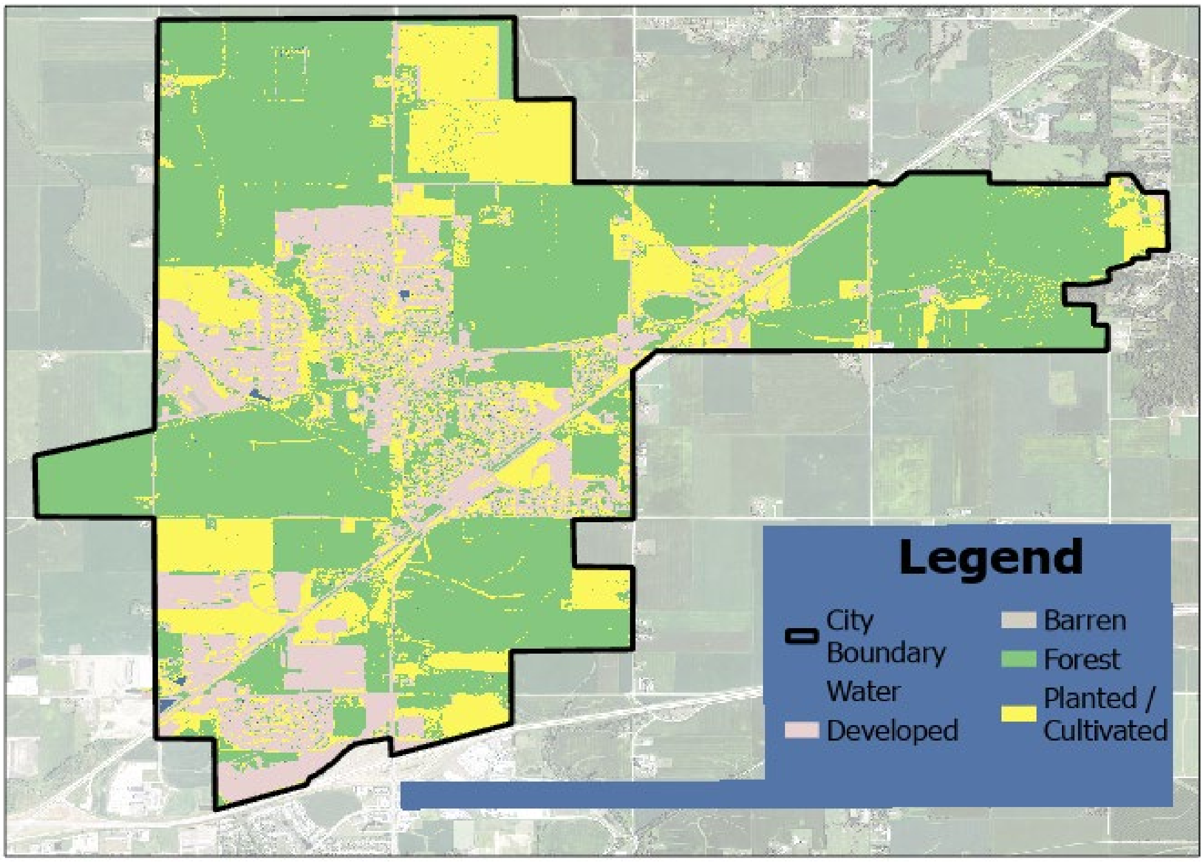

Figure 4: This map shows the results from the supervised classification, which required inputing training samples that were used in the classification algorithm. Here, all the corn fields were detected as forest due to the similar spectral characteristics they share with each other. However, the developed (urban areas) worked well.

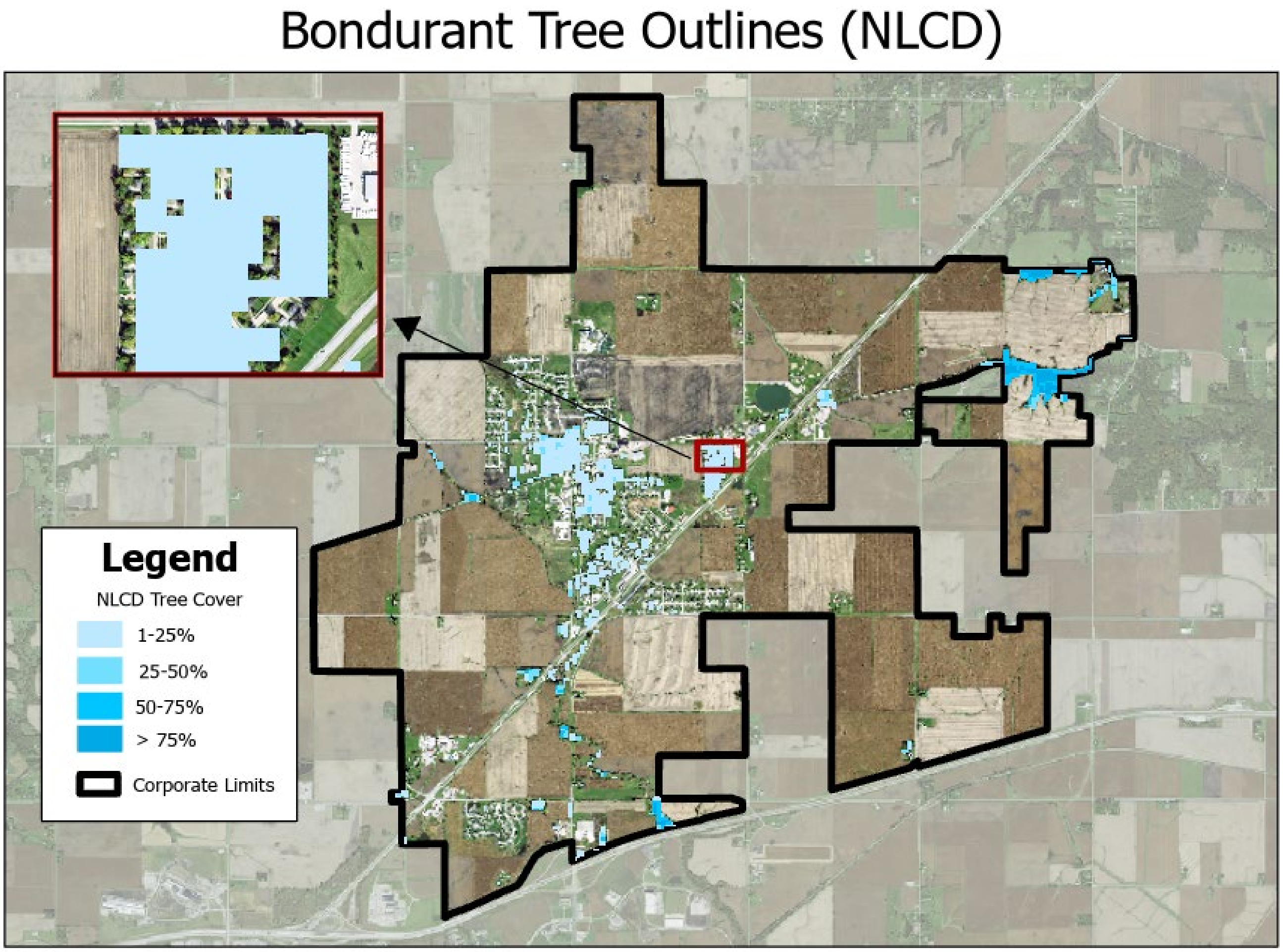

Figure 5: The NLCD provides an outline of tree canopy cover as well. It uses a much lower resolution than aerial imagery with a 30x30 M resolution, making it much harder to identify trees. This is the only downloadable tree canopy map available. This imagery was captured by Landsat 8-9.