FINDING STRUCTURE POINTS USING AI TOOLS IN ARCGIS PRO

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Summary

To effectively classify structures using deep learning tools in ArcGIS Pro, a few extra steps must be taken in addition to using the `Detect Objects using Deep Learning` tool. By itself, the tool over classified a substantial amount of bare ground as structures (high error of commission), but effectively captures most structures (low error of omission). To fix this problem, the predicted structure polygons generated by the deep learning tool were input into the `Zonal Statistics as Table` tool along with a height above ground layer to help eliminate false positive structure polygons. A few intermediate steps for tool conformity and cleanness were also used and are detailed in the processing details below.

Data

The data used for the process of finding structures in Bannock County, Idaho using AI tools in ArcGIS Pro include:

- National Agricultural Imagery Program (NAIP) raster imagery (0.3-meter spatial resolution): Bannock ortho_1-1_hm_s_id005_2025_1.sid layer
- Building Footprint Extraction polygon feature class derived using the USA deep learning package from Esri
- Height above ground (HAG) raster layer (1.0-meter spatial resolution). This layer was derived from best-available lidar data by subtracting the bare earth digital terrain model (DTM) data from top of canopy digital surface model (DTM) data.

Detect Objects Using Deep Learning Geoprocessing Tool

The `Detect Objects Using Deep Learning` geoprocessing tool was used for the initial detection and classification of structures. For the input raster, the NAIP raster imagery layer was used. The output polygons were written to a file geodatabase for further processing. For the model definition, the Building Footprint Extraction – USA [1]deep learning package from Esri was used. For the arguments, padding – 128, Batch Size – 4, Confidence Threshold – 0.5, Bounding Boxes – False, Test Time Augmentation – False, Merge Policy – Mean, and Tile size – 512 were used (**Figure 1**). This task required approximately 28 hours to complete. The results were subpar as the tool overclassified many patches of bare ground as structures with a total of 46,279 structure polygons created as the result of Detect Objects Using Deep Learning geoprocessing tool.

[1] https://isu.maps.arcgis.com/home/item.html?id=a6857359a1cd44839781a4f113cd5934

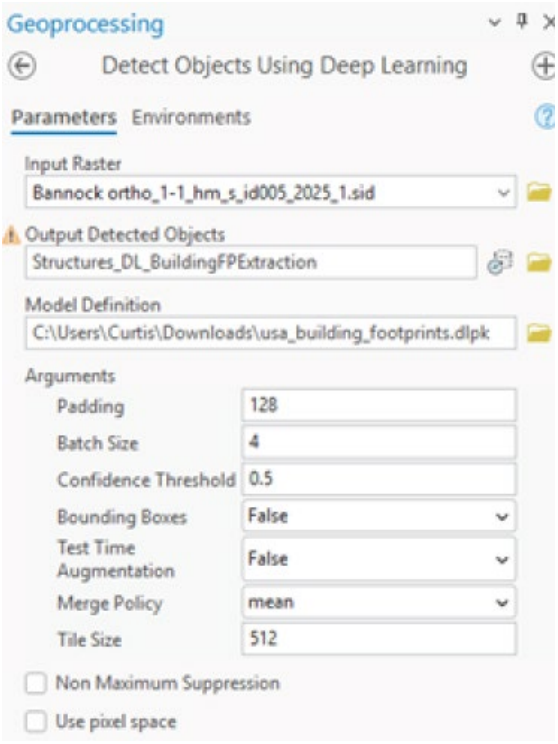

Figure 1. Settings used to run the deep learning structure extraction tool.

Dissolve tool

The dissolve tool was used to combine overlapping polygons. Using visual inspection sampling, it was clear that in most cases these were actually the same building but were identified as separate structures during feature extraction. This reduced the number of predicted structure polygons from 46,279 to 40,559.

Zonal Statistics as Table Geoprocessing Tool

The `Zonal Statistics as Table` geoprocessing tool was used to attribute each polygon with a HAG value using the mean value of pixels within each polygon's footprint. The input layer was the predicted structure polygons layer (n = 40,559). The zone field was the unique `OBJECTID` field. The input value raster was the HAG raster layer. The statistics type was set to `All` and the Ignore `NoData` in Calculations was checked. This tool ran for about 14 minutes. Using the Output Join Layer setting, the HAG can be directly referenced for each polygon (**Figure 2**). The mean HAG for all predicted structures was 3.9 meters and the median was 3.9 meters (standard deviation was 1.9 meters).

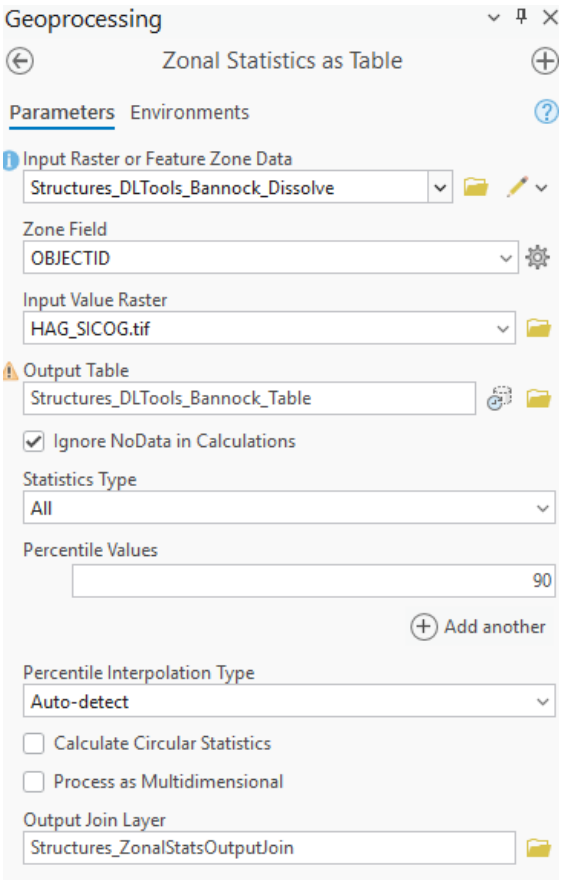

Figure 2. Settings used to assign height above ground values to each structure polygon.

Select by Attributes

The select by attribute tool was used to select all structure polygon where its HAG was greater than 2 meters. This value was used because it can be assumed that most structures are taller than 2 meters, and if the median value of 3.9 meters were used, effectively half of all polygons could be excluded, including many actual structures. The selected polygons were exported to a new polygon feature class with 36,097 features (a reduction of 4,462 features).

Feature to Point tool

The Feature to Point geoprocessing tool converted all final structure polygons to points as required by the Bannock disaster management project.

Manual editing

While the resulting data was quite good a close visual inspection revealed some additional errors. Specifically, the resulting structure points layer had a few omissions in newer neighborhoods most likely because the lidar data used to derive the HAG layer was acquired prior to the construction of new structures. To account for these missing structure points, it was necessary to manually add them into the structure points layer. In addition, close inspection revealed a few points (n = 26) were trees which were identified as structures (misclassification). These were manually edited (deleted). The final structure points count after adding missing points and removing misclassified objects was 36,637, a change of 540 points compared to the previous structures layer developed using 2023 imagery.