Using lidar to digitize vegetation in orienteering maps

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Orienteering is a sport in which competitors use only a specially designed map and a compass to walk or run through a series of control points set on mapped features. The sport provides a unique combination of physical and mental challenges and requires no equipment other than a compass, a map and a pair of rugged shoes.

The maps used in orienteering are specialized topographic maps typically drawn to 1:10,000 scale and prepared according to a comprehensive set of standards published by the International Orienteering Federation. Among the standards are the competing requirements that the map be "clear and legible under competition conditions and sufficiently accurate, complete, and reliable." "Essential information" includes "…anything which impedes progress [including] dense vegetation" (International Orienteering Federation: Internal Specification for Orienteering Maps 2017-2, page 4).

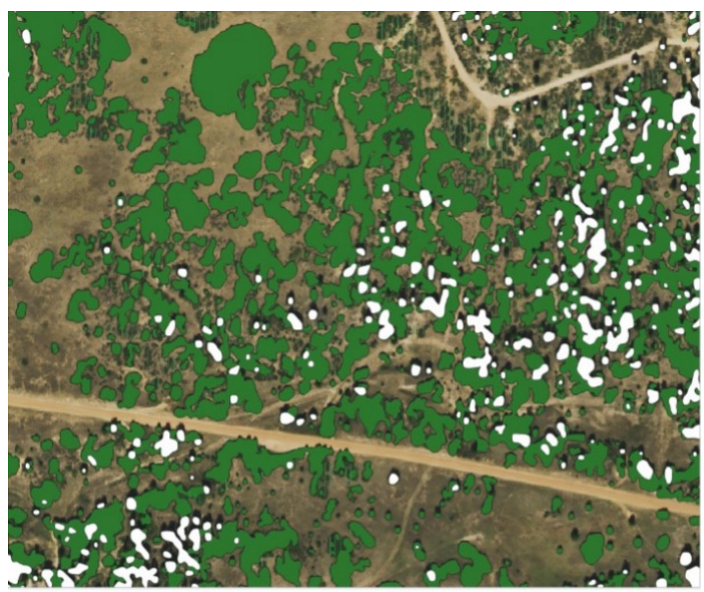
Finding the optimal solution becomes difficult in large areas of dense vegetation through which there are many small (1- to 5-meter) passages, such as in the scrub oak areas common to the Colorado Front Range.

As the study's author, I developed the following methodology using lidar data to create exploratory maps for prospective orienteering competitions on the property of the United States Air Force Academy in Colorado Springs. Scrub oak is difficult to distinguish from other trees and time-consuming to trace by hand at the level of detail required (figure 1). Fortunately, since scrub oak dominates a certain height range, lidar data can be used to identify it.

Figure 1:

Credit: U.S. Department of Agriculture Farm Service Agency

Figure 2:



Solid Green: scrub oak
White: other trees
Vertical green bands: low scattered brush

Credit: Image, U.S. Department of Agriculture Farm Service Agency, lidar, Colorado Governor's Office of Information Technology - geographic information systems, digitization, Galen A. Moore

Step 1: Generate a normalized digital surface model (also known as a canopy height model) raster bearing the above-ground height of the vegetation (and other features, such as buildings) in the subject area.

Step 2: Use the normalized digital surface model and a georeferenced image to determine the height range for scrub oak.

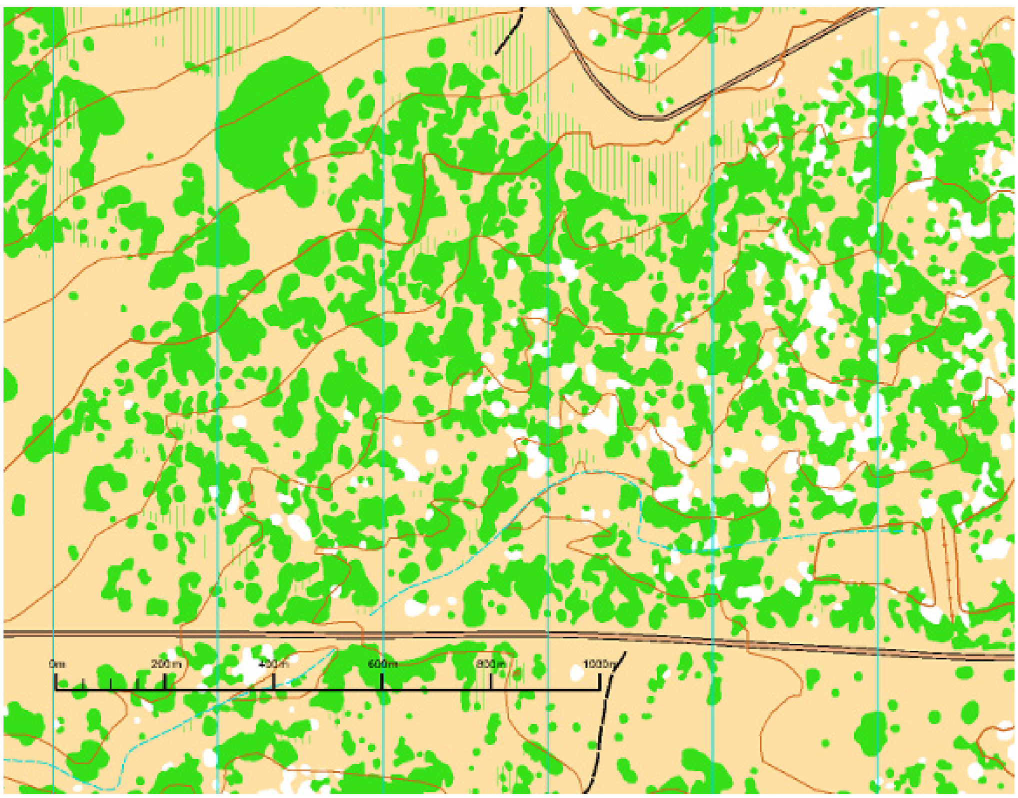
Step 3: Convert the normalized digital surface model to a shapefile according to a set of resolution, height and smoothing parameters.

Step 4: Add the layer to an orienteering map (figure 3).

The example shows that in an environment where a particular class of vegetation of interest is uniquely dominant in a height range, processing lidar data into a shapefile capturing the areas occupied by that vegetation can be an efficient and useful method for presenting that vegetation.

The approach is a special, not a general, solution to the problem. The process requires recalibration for different lidar densities and different vegetation, and works best when the vegetation of interest is in leaf. Lastly, while the approach generates useful maps very quickly, it leaves the subjective problem of balancing generalization, legibility and detail to human judgment.

Figure 3:



Credit: Galen A. Moore