



Massive LiDAR Processing with SCALGO

Most GIS-based approaches to the analysis of LiDAR data, particularly hydrologic modeling, require that the LiDAR data be represented as a raster surface. Converting LiDAR point clouds to raster surface models is not a “niche” capability by any means, but doing it for very large datasets (i.e. billions of points) is.

Enter SCALGO. SCALGO is designed for generating raster surface models from massive datasets and for perform-

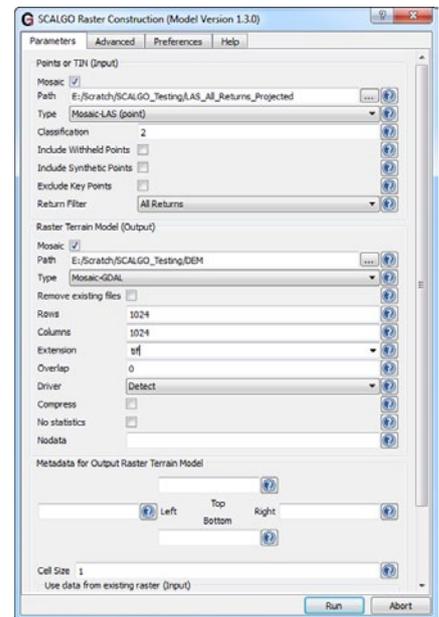
It focuses on a few key features, and what it does, it does very, very well.

SCALGO is short for Scalable Algorithmics, and the software shares its name with the [company](#) that makes it. Founded in 2009, SCALGO is relatively young, but the technology driving the software goes back a couple of decades to work done at Aarhus University (Denmark) and Duke University (USA). When the researches started having marked success generating raster surface

“SCALGO provides an impressive set of tools for processing massive LiDAR datasets on standard GIS workstations.”

ing associated hydrologic modeling functions such as computing flow direction and delineating watersheds. It’s best to think of SCALGO as a big engine. There is no point cloud viewer; in fact the software has no inherent data viewing capabilities (although it does have a handy ArcMap toolbar to aid with visualization). However, SCALGO fills a very important niche in the marketplace, and this is what I like about it. SCALGO does not try to be the jack-of-all trades.

models and associated flood maps from Denmark’s 26+ billion point LiDAR dataset, they felt it was time to make the technology available to the public. Working with massive LiDAR datasets typically forces the user to make some less than desirable choices: 1) process the data in memory, 2) thin the dataset, or 3) tile the dataset. While these options may work for certain applications, they are entirely unsuitable for hydrologic modeling because you will either 1) run



The Raster Construction Module, which is part of SCALGO Model, generates raster surface models from massive LiDAR point clouds.

out of RAM, 2) loose detail, or 3) create artifacts along tile edges.

The key achievement of the underlying technology powering SCALGO is I/O efficiency. Simply put, the folks at SCALGO figured out how to process massive LiDAR datasets using as little RAM as possible and do it relatively quickly. SCALGO can be run as either a stand-alone application or as set of tools within ArcGIS; both options offer the same functionality.



SCALGO provides detailed feedback on the system resources it is using.

- SCALGO Hydrology
 - Flooding
 - Flow Accumulation
 - Flow Directions
 - Flow Modeling
 - Sea-Levels
 - Stream Ordering
 - Stream Segmentation
 - Watersheds
- SCALGO Model
 - Point Coverage
 - Raster Construction
 - TIN Construction
- SCALGO Topology
 - Depression Filling
 - Depression Identification
 - Depression Mapping
 - Flat Areas
 - Topological Simplification
- SCALGO Utility
 - Aggregate
 - Burn
 - Calculate
 - Clip
 - Convert
 - Masks

The SCALGO modules can be run either inside or outside of ArcGIS. Within ArcGIS the SCALGO tools work just as any other ArcGIS tool, enabling them to be integrated into geoprocessing workflows.

SCALGO only runs on Windows, but it can take advantage of 64-bit operating systems and certain features will make use of more than one CPU. That being said, one of the major achievements of SCALGO is that you can process extremely large LiDAR datasets with what I would consider a “standard” GIS workstation (e.g. 8GB of RAM and dual core processor).

There are currently four SCALGO software packages, which can be purchased independently. SCALGO Model is what I would consider to be the core SCALGO package. Its primary

function is to generate raster surface and TIN models from LiDAR datasets, but it also has the ability to assess point coverage density. SCALGO Model can work with LiDAR datasets in LAS or CSV format. It offers the user the option to filter the points used for the surface model based on a number of criteria, such as classification and return number. SCALGO Model, like the other SCALGO packages, has the ability to treat the entire collection of LiDAR tiles as a single dataset and output the resulting surface model as either a composite raster or a set of

tiles. The real benefit of this approach to surface model generation is that there are never any edge effects. The only shortcoming of SCALGO Model is that it does not offer the option to produce raster tiles using the same extents as the input LAS files.

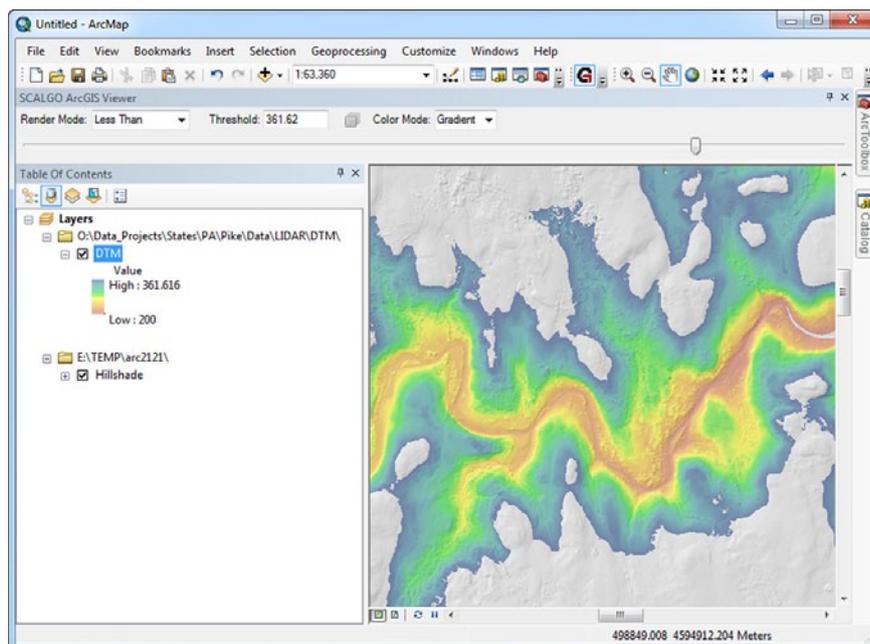
The SCALGO Topology software package’s primary function is for removing depressions in terrain data, a requisite for hydrologic modeling that is often referred to as “filling sinks”. SCALGO Topology offers four modules: Topological Simplification, Depression Identification, Depression

Mapping, and Flat Areas; the combination of which provide the end user with more advanced capabilities than are available within standard GIS software packages. Of particular note are the options to fill depressions based on geometry, area, or volume.

The core hydrologic modeling capabilities of SCALGO are contained within the SCALGO Hydrology package. SCALGO Hydrology has numerous modules that provide the functionality to do everything from flow direction to watershed delineation to stream ordering to flood modeling. As with SCALGO Model, SCALGO Topology and SCALGO Hydrology both benefit from the fact that tiled datasets can be treated as a virtual mosaics. The importance of this functionality for hydrologic modeling cannot be understated.

Finally, the SCALGO Utility program provides some basic raster processing capabilities, but using the SCALGO algorithms. One can burn, clip, calculate, aggregate, mask, or convert rasters using SCALGO Utility. Of course such functions are available in any GIS software package, but with SCALGO Utility you can work with much larger datasets and do so more efficiently.

To put SCALGO (Vers 1.3) through its paces I chose the Lake Tahoe Basin LiDAR dataset. The dataset, which is publicly available through the Open Topography web site (www.opentopography.org/), consists of over 11 billion points, which equates to over 320GB of data. The point spacing averages nearly 12 points per square meter. I used SCALGO to create a 1 meter Digital Elevation Model (DEM). I then applied SCALGO's topographic simplification technology to remove depressions (fill sinks), compute flow direction,



The SCALGO ArcGIS Viewer is a toolbar within ArcMap that allows for interactive thresholding of raster surface models.

and finally, derive watersheds. Using SCALGO I was able to accomplish all these tasks within a day. Generating the 1 meter DEM from those 11+ billion points took an impressive 311 minutes.

SCALGO won't replace your standard LiDAR software package, but if you are looking for a solution for raster surface model generation, and particularly hydrologic modeling, you should give SCALGO a serious look. The interface is clean and easy to use. The ArcGIS integration should please the GIS community, but the fact that the software works independently of ArcGIS is also a strength. The manuals are clearly written and I found the technical support staff to be very helpful. They even implemented one of my suggestions into the next build in a relatively short timeframe. I do think new users would benefit from having a tutorial to guide

them through an example workflow, but those with experience processing LiDAR and performing hydrologic modeling tasks should have little difficulty getting up and running with SCALGO in a few hours. Do note that SCALGO performs best when the data are stored locally for processing, so make sure you have a large local disk.

My only hope is that the good folks at SCALGO expand their product line to tackle issues such as watershed analysis and solar mapping, both of which would really benefit from the SCALGO approach to processing massive data. ■

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