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Exercise 6 - Processing LiDAR images

One of the most important innovations in recent years has been the advent of LiDAR imagery. This imagery can be used in a lot of ways, but it is one of the most accurate ways we have of making maps of elevation. The potential uses of LiDAR go far beyond what we can do in this exercise, but we *can* begin to do some reasonably sophisticated analyses using the data we have.

Imagery to be produced

In this lab, we will produce three kinds of images. First will be a DEM (Digital Elevation Model). This is a model of the bare ground – i.e. what we would have if there were no trees or buildings. Second will be a DSM (Digital Surface Model). This is a model of the actual surface of the area in question, including trees, buildings, etc. Finally we will make a NDSM (Normalized Digital Surface Model). This is a model showing the absolute height above the ground of things *on* the ground – i.e. the trees, buildings, etc.

How to proceed

Raw LiDAR data come in several forms, but the most common is a tiled format designated .LAS. You can find LiDAR data for northern Ohio in R:\OGRIP Statewide Imaging Program\County Tiled LiDAR LAS files. We also have LiDAR data for Cuyahoga County in R:\Cuyahoga County GIS Data - 2006 (you will have to navigate to the tiled LAS files, since they are separated into east-side ands west-side directories). First, you need to choose a tile. Go to one of the LiDAR directories on the R: drive.

If you go to the State data set, you will first need to go to the directory containing the tiles for the county in which you are interested. All of the LiDAR tile files are in a directory called Unzipped LAS Files in the county directory. The files are named with the convention NYYYYZZZ.las and NYYYYZZZ.las.xml. The YYYY is the State Plane easting; the ZZZ is the State Plane Northing for the southwest corner of the tile. If, for example, you picked tile N2190655.las, the easting would be 2,190,000; the northing would be 655,000. Note that some of the tiles are not very well labeled, so you may be surprised when you actually pick out a tile in that it's not where you thought it was. You can blame the State's contractor for that little problem. You do *not* need to copy the tile to your X: drive, just know where it is.

If you go to the Cuyahoga County data set, you will have to choose between the East side and the West side. The tiles have names like YYYY_ZZZ.las, where YYYY is the State Plane Easting and ZZZ is the State Plane northing. The designators are approximately correct for the northing, but you should subtract 31,500 from the easting you want to go to in order to get the right tile. Again, you do *not* need to copy the tile to your X: drive, just know where it is.

First Step: Using ArcGIS

Click on ArcMap, and open a blank map.
Turn on the license for 3-D Analyst by clicking Customization -> Extensions, and choose 3-D Analyst.

1. You first need to create a personal geodatabase. If you've forgotten how, it's Data Management Tools -> Workspace -> Create Personal Geodatabase. Make sure this GDB is on your X: drive, and make it your default geodatabase. You do this by opening the Catalog tab (you may need to click on the catalog icon to do this), go to Folder Connections, choose X:, right-click on the GDB you've just created, and choose "Make Default Geodatabase."

2. You then need to establish a LAS Dataset (and no, in ArcSpeak, a LAS file is *not* a LAS dataset). To do this, right-click on your geodatabase, choose 'New.' When the box opens letting you decide what 'new' to add, choose the 'LAS Dataset.'

3. Your next step is to populate the LAS Dataset. In Catalog, click on the LAS Dataset. A dialog box opens that will let you do all sorts of things. Open the LAS Files tab (if it isn't already open), and click 'Add Files.' Navigate to the place on the R: drive from which you want to get your LAS data, and add one or more of the files to your dataset. Then open the XY Coordinate System tab and specify the coordinate system corresponding to your data. Click on OK to save your data. Alternatively, you can do the same things by clicking on the Data Management tools in the tool box and choosing the correct tools within the LAS Dataset tool collection. One of the things you might do regardless of how you populate your LAS Dataset is to click on the 'Statistics' button for each file you put into the Dataset. When the window opens, click 'Calculate.' See what classes of points are actually represented in the file.

4. You will want to make both a DEM and a DSM if you are to create an NDSM. To do that, you need to 'Make a LAS Dataset Layer' for each output you want. The 'Make LAS Dataset Layer' tool isn't in the LAS Dataset tool collection; it's in the Layers and Table Views tool collection. Make a Dataset Layer for each of the two desired outputs. Indicate that the DEM dataset layer will be limited to class 2 (ground), and the DSM dataset layer will include all returns.

5. The next step is to create the DEM and the DSM. These are both rasters. For these you go back to the Toolbox and click on Conversion Tools -> To Raster -> LAS Dataset to Raster. Your input dataset layers are those you just created in step 4. You may wish to change some of the parameters of this dialog, but you can generally accept the defaults. The most important field that you might wish to change is the 'Sampling Type' field. You might try 2.5, 5, or 10 in this field.

6. When your two rasters are created, look at them. Give them a meaningful color ramp.

7. The last step is to make the NDSM. To do this, you need to subtract the DEM from the DSM. Go to 3D Analyst Tools -> Raster Math -> Minus. The DSM is raster 1; the DEM is raster 2. The NDSM is the output raster. Again, give it a meaningful color ramp.

Now look at all of your images. Be sure that you understand what you did.

Second Step: Using QT Modeler

QT Modeler is a software package designed from the getgo to analyze LiDAR imagery. Here is what you will do with your tile file:

1. Open QT Modeler and import a LAS file (the "Import File" icon is the fifth from the left on the icon bar). Be sure that the input format is LAS and the Model format is QTT. What do you see? Using the same LAS file as you used in step 1, see what happens when you import the LAS file using other model formats.

2. Now try the options on file import. Start with classification. When you get the LAS Import dialog box, check the checkbox next to the Classification button and click on that button. Try various combinations, but the two most important will be for class 2 (ground) alone to be checked and for all classes to be checked. Your DEM will be produced when you choose class 2, and your DSM will be produced when you check all classes.

3. Now try to do the same thing with several adjacent LAS files. Choose ½ dozen or so files (perhaps two files high by 3 files across) and import them all in a single step. Be sure that the "Batch Import" checkbox is checked on the Model Import dialog and that you choose the "Processing as a Group" radio button on the LAS Import dialog box. You will have to save your model on your X: drive with a suitable name.

4. As you carry out step 4, you should try several options, but be sure to save two models – one

featuring classification as to ground (i.e. class 2), the other featuring either no classification or all classes checked. The model classed as ground is a DEM; the model classed with everything is a DSM.

5. To create an NDSM, you subtract the DEM from the DSM. You can do this by loading the DSM into the viewer of QT Modeler and clicking Edit -> Subtract Model on the Menu bar. Choose the DEM in the dialog box that opens, and give your NDSM a name.

6. The last step in the QT Modeler process is to export the model in a format that can be read by standard image-processing software such as ERDAS, ENVI, or ArcGIS. With the image you wish to export in the viewer, click on Export -> Export Model(s) on the Menu bar. Click on your image to highlight it, and choose an export format from among the various formats available to you. The most useful are GeoTIFF and ERDAS Imagine DEM. Next click the Export button.

7. Finally, look at your images. Be sure you understand what you did.

Portfolio

6-1 DEM created by ArcGIS

6-2 DSM created by ArcGIS

6-3 NDSM derived from 6-1 and 6-2

6-4 DEM created by QT Modeler

6-5 DSM created by QT Modeler

6-6 NDSM derived from 6-4 and 6-5