Lidar in ArcGIS Exercise

In this exercise, you will explore using Lidar data in ArcGIS. This exercise will focus on scenario-based problem solving using an integrated workflow. The scenario used in this exercise feature using Lidar data as the primary data source and Lidar analysis as the primary skill focus. Lidar is a powerful, and increasingly popular, data source used to create elevation and terrain models with high accuracy.

Setting up your Scenario

1. Start ArcMap
2. In the ArcCatalog tab, create a Folder Connection to your student data located in **C:\Esri\Lidar in ArcGIS**
3. Rename the new folder connection "Lidar in ArcGIS"
4. Locate your new folder and expand the Baltimore subfolder.

The Baltimore folder contains the data you will need for this portion of the exercise:

- Baltimore_data: LAS_Files directory containing four sample LAS files covering the city of Baltimore
  Baltimore.gdb – geodatabase containing various data layers
- BaltimoreResults: folder for output files
- Geodatabase: folder containing empty file geodatabase for output features.
- Maps: folder for saving map documents.

Setup working environment:

1. In ArcMap, open the data frame properties. Set the Map projection to

   Projected Coordinate Systems > State Plane > NAD_1983 (US Feet) > StatePlane_Maryland_FIPS_1900_Feet

   a. On the **General** Tab, name the Data frame *Baltimore*
2. Click **Apply**, then **OK** to set the Coordinate System.
3. On the **Geoprocessing Menu**, Click **Environments**
   a. Set **Current Workspace** to**:** *C:\Esri\Lidar in ArcGIS\Baltimore\baltimore_data*
   b. Set **Scratch Workspace** to: *C:\Esri\Lidar in ArcGIS\Baltimore\BaltimoreResults*
   c. For the **Output Coordinate System**, select *Same as Display*
4. Click **OK** to set the environment.
5. Add the ***water*** and ***Baltimore_city*** layers from Baltimore.gdb to the map.

Creating a LAS Dataset.

Lidar data and optional surface constraints can be added to a LAS dataset directly. A LAS dataset is not stored in the geodatabase, rather a binary file is created and stored in the file system. Creating a LAS Dataset is a quick process, as it is a pointer to the LAS file, no data loading or conversion takes place. The file extension created is ***.lasd***.

Make sure the LAS files you use are reasonably sized. A file size of 25-50 Mb is recommended. LAS files should be no bigger than 100 Mb for optional performance.

1. In ArcCatalog panel, right-click the *BaltimoreResults* folder, then **Click New** > **LAS Dataset**
2. Name the LAS Dataset ***Baltimore tiles***
3. Double click the Baltimore_Tiles LAS dataset to open the dataset properties dialog.
4. On the *LAS Files* tab, use the **Add Files…** button to add the four LAS files in the LAS_Files folder (*C:\Esri\Lidar in ArcGIS\Baltimore\baltimore_data\LAS_Files*).
5. On the *Surface Constraints* tab, use the **Add…** button to add the **Baltimore_city** feature class from the Baltimore.gdb.
6. Set the *Surface feature type* to **Hard Clip**.

Surface constraint features are used to constrain feature-derived elevation values that represent the surface characteristics in the LAS Dataset. The Baltimore_city polygon defines the boundary of the LAS Dataset.

7. On the *XY Coordinate System* tab, set the **coordinate system** to: *Projected Coordinate Systems > State Plane > NAD_1983 (US Feet) > <u>StatePlane_Maryland_FIPS_1900_Feet</u>*
8. On the **Z Coordinate System** tab, expand *Vertical Coordinate Systems > North America*.
9. Right Click *NAVD_1988*, and then click ***Copy and Modify***.
10. Set the Name to NAVD_1988_foot.
11. In the Linear Unit Section, click the Name pull down menu and select Foot, then click **OK**.
12. In the *Statistics* tab, click **Calculate Statistics**. If statistics already exist, check *Force recalculation*, then click *Update*.
13. Click **OK**, you have now constructed a LAS Dataset.
14. From the ArcCatalog tab, drag the Baltimore_Tiles LAS Dataset to your map.
15. Make sure your LAS Dataset is positioned above the other layer in the Map table of contents.

You should see the footprint of the four LAS tiles in your map. Zoom to an area just around the outline of the four tiles. The LAS Dataset will display the extent of the files using a wireframe. All of the points cannot be displayed at the resolution of the wireframe because there are too many points.

Explore the LAS Dataset.

1. From the **Add Data** pull-down menu, select *Add Basemap…* and add the Imagery with Labels basemap to your map.
2. Observe the area covered by the Wireframe, then turn off the basemap layers.
3. **Zoom** into an area around the tile in the NW Quadrant.

When you zoom into the LAS Dataset in the NW quadrant, you will see the Lidar points. You will not see all of the points displayed (the percentage is shown in the table of contents).

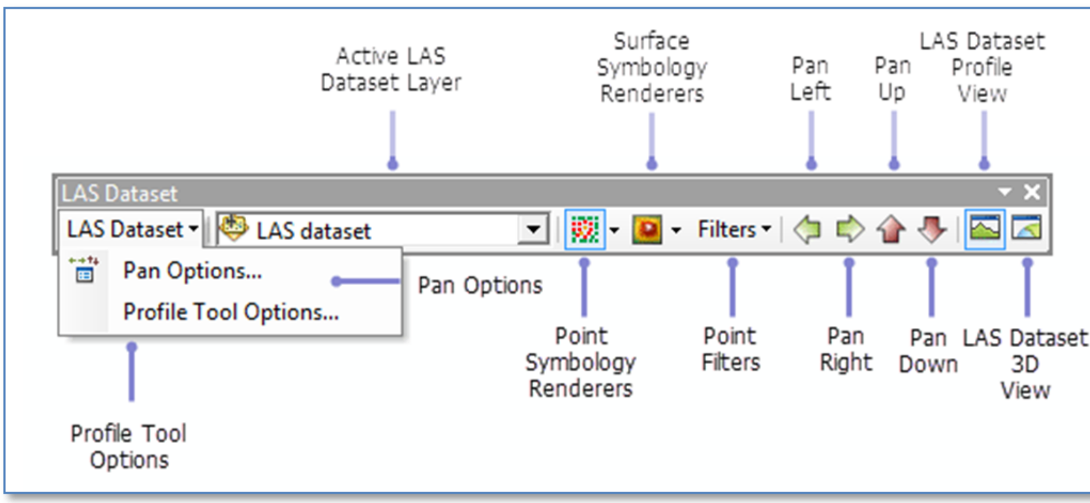
4. Right click the LAS Dataset in the Table of Contents, and select *Properties*.
5. On the Display tab:
    a. Increase the point limit to 5000000

b. Select “Use scale to control full resolution”
c. Set the Full Resolution Scale: to 5000
d. Move the Point Density slide to Fine.
6. Click **OK** to apply the changes.
7. Save your Map document as Lidar_Basics.mxd in the Baltimore/Maps folder.

Using the LAS Dataset Toolbar

The interactive LAS Dataset toolbar offers a collection of tools that will work in the ArcMap or ArcScene application. The toolbar allows you to display Lidar points as a TIN-based surface or as a point cloud. It allows you to filter the points so you can see them by class, return, or elevation. You can also produce slope and aspect surfaces as well as contours on the fly from the LAS Dataset. The toolbar also has a 2-D profile tool and a 3-D viewer.

1. Turn on the toolbar by going to Customize > Toolbars and clicking on the LAS Dataset toolbar.



2. Make sure only the Baltimore_Tiles LAS Dataset is turned on.
3. Change the point symbology in the *LAS Dataset toolbar* **Point Symbology Renders** to **Elevation**.
4. Zoom in and out of the LAS Dataset.
5. Change the point Symbology to **Class**.

Question: What classification are the stripes of Pink points running north and south throughout the dataset?

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6. Change the Point symbology to Return.

Question: How many returns are there, and what do they mean?

Explore surface symbology renderers: Elevation, aspect, slope and contour.

1. Click the Surface Symbology arrow and select Elevation.
2. Move around your LAS Dataset to observe the detail.
3. Use the Surface Symbology Renderer to display the LAS Dataset as **Slope**, and **Aspect**.
4. Display as **Contours**.
5. Double click the LAS Dataset in the table of contents to open the properties page.
6. On the Symbology tab, click on Contour in the Show: Box, then set the Contour Interval to 1.0 ad the Index Contour Factor: to 10.
7. Click OK to apply the changes.

Currently, you are displaying contours based on all the Lidar returns in the dataset. You can use the Filters pull-down to select one of several predefined filters:

- **All** uses all the lidar points
- **Ground** uses only lidar points classifies as ground
- **Non Ground** uses all the lidar points that are NOT classified as ground.
- **First Return** uses only the first return points.

8. Set the Return class to **Ground**.
9. Notice the changes in the contour renderer.
10. Set the Surface Symbology renderer to Elevation. Experiment with different return classes and observe the differences.

Explore the LAS Dataset toolbar profile view and 3D view.

The interactive LAS Dataset Toolbar has a profile view tool and a 3D view tool. The Profile View window allows the user to visualize, analyze and edit lidar data using a 2D cross section view. Visualizing a cross section of lidar data allows you to analyze collections of points from a unique perspective. It makes it easier to recognize features like valleys, buildings, forest canopies, roads and other structures. With the profile view, you can measure distance and height, manually edit and update LAS Class codes.

1. Click the LAS Dataset toolbar **Profile View** button on the LAS Dataset toolbar.
2. On the map, use the cursor to first draw the profile line, then with the second mouse click, set the width of the profile.
3. Locate the Stadium in the SW tile in your LAS Dataset.
4. Create a profile moving north/south across the stadium.
5. Using the Measure tool on the Profile window, measure the height of the stadium.

Question: What height did you measure? ____

6. Click the 3D View button.
7. Pan and zoom round the 3D view and observe the surfaces.
8. Save your map document, then close ArcMap

Creating Raster Data from your Lidar Data.

1. Open a new Map Document.

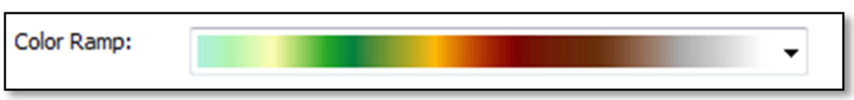
2. Rename the Layers *Data Frame* to **Oregon**.
3. From the Oregon folder in your class materials, add the OregonSample.lasd LAS Dataset to the map. This LAS Dataset consists of 9 LAS files in Oregon.

In order to create a bare earth model or a DEM, you need to filter the LAS Dataset so that only the ground points are selected.

4. On the LAS Dataset toolbar, set the filter to **ground**.

The LAS Dataset to Raster tool allows you to convert LAS Datasets to a raster surface model for additional analysis. You can create a raster using elevation, intensity, or RGB values stored in the Lidar files referenced in the LAS Dataset.

5. In the Search panel, search Tools for "*LAS Dataset to Raster*".
6. Open the tool and enter the following Parameters:
    - Set the Input LAS Dataset to **OregonSample.lasd**
    - Set the Output Raster to:
      C:\Esri\Lidar in ArcGIS\Oregon\Output\OregonOutput.gdb\Oregon_DEM
    - Set the Value field to **Elevation**.
    - Binning represents the interpolation method used to produce the raster. Enter the following binning settings:
        - Set cell assignment to **Minimum**
        - Set the Void fill method to **NATURAL_NEIGHBOR**
    - Set the Output data type to **INT** (integer)
    - Set the Sampling type to **CELLSIZE**
    - Set the sampling value to **5**
    - Click **OK** to run the tool.
    - When the tool finishes, classify the layer as stretched, using a color ramp appropriate for Elevation.



Creating a Digital Surface Model (DSM)

To Construct a DSM, you will repeat the process using the Non-Ground filter.

1. Set the Filters for your LAS Dataset to **Non-Ground**
2. Open the **LAS Dataset to Raster** tool and enter the following Parameters:
    - Set the Input LAS Dataset to **OregonSample.lasd**
    - Set the Output Raster to:
      C:\Esri\Lidar in ArcGIS\Oregon\Output\OregonOutput.gdb\Oregon_DSM
    - Set the Value field to **Elevation**.
    - Binning represents the interpolation method used to produce the raster. Enter the following binning settings:

- Set cell assignment to **Maximum**
- Set the Void fill method to **NATURAL_NEIGHBOR**

1. Set the Output data type to **INT** (integer)
2. Set the Sampling type to **CELLSIZE**
3. Set the sampling value to **5**

2. Click **OK** to run the tool.

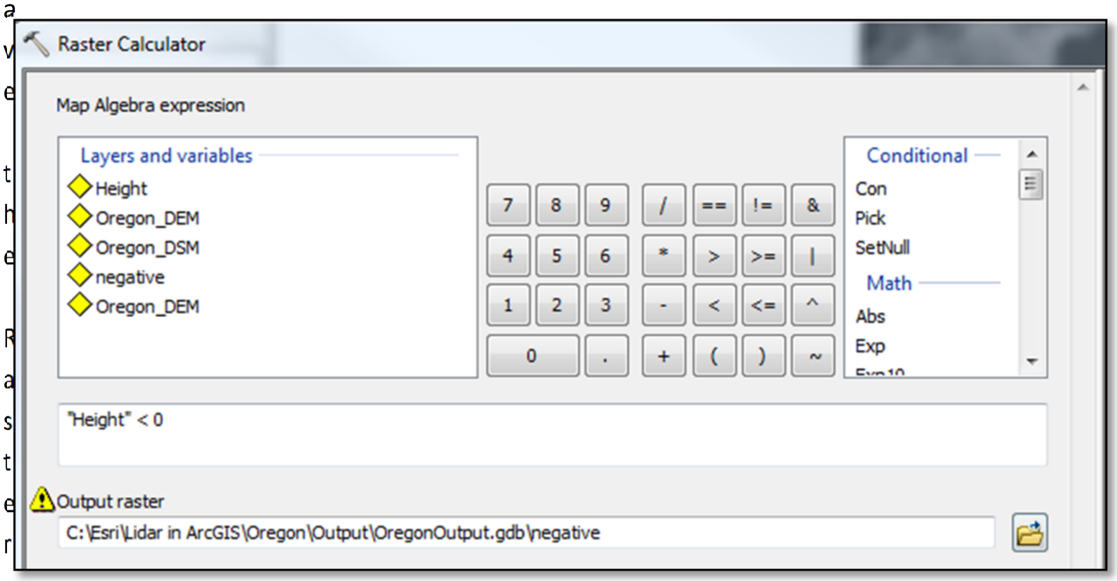
Calculate Canopy Tree Height

To determine the height of the tree canopy, you will subtract the DEM (bare earth surface) from the DSM (non-ground returns).

1. In the Search panel, search for the **Minus** tool, click on the tool to open the tool dialog.
   - For input raster or constant value 1: select **Oregon_DSM**
   - For Input raster or constant value2: select **Oregon_DEM**
   - Save the output in the *OregonOutput* Geodatabase and name it **Height.**
2. Click **OK** to run the tool**.**

The output height layer contains some negative values. These are probably errors in the data or edge pixels. You can use the Raster calculator to isolate the negative values for additional processing.

3. In the Search panel, search for Raster Calculator. Click on the Raster Calculator to open the tool dialog.
4. Use the Raster calculator to select all the pixels in the Height raster that are less than **0**.
5. Save the Raster



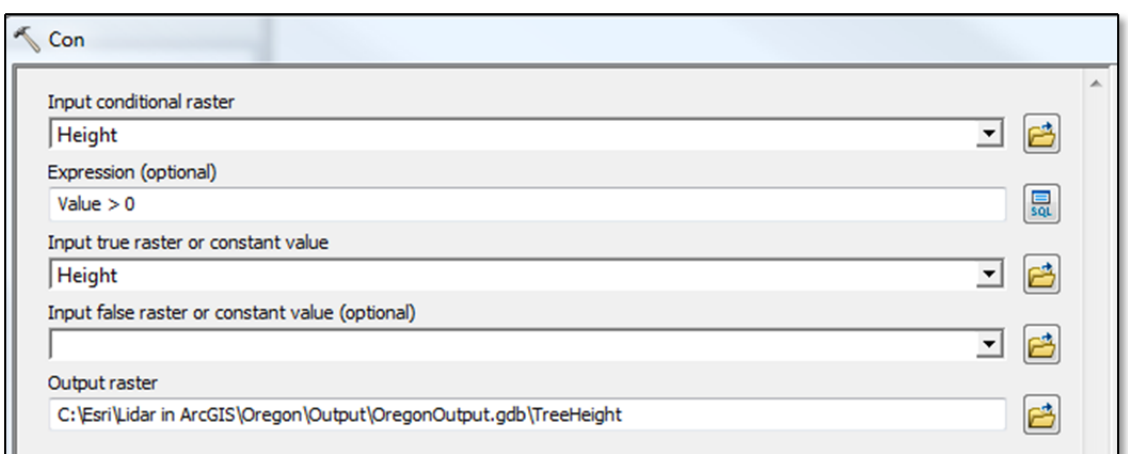
in the *OregonOutput* workspace and name it **Negative**.

6. The results of the Raster Calculator produces a raster with values of 0 that are pixels that are >= 0 and, values of 1 for pixels < 0.
7. Double click the ***Negative*** raster to open the properties page.
8. On the Symbology tab, the cell count for both values will be shown for the Unique Value Renderer.

Question: How many pixels are below 0: ____

There are several different ways to extract only the positive heights from the Height raster. In this exercise, you will use the Con tool.

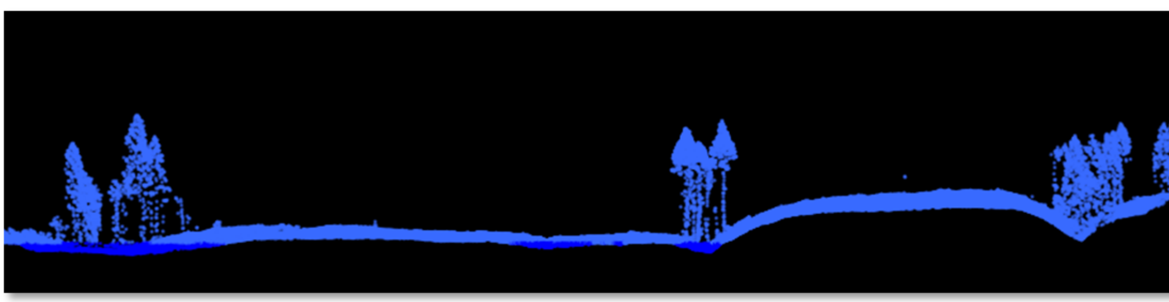
9. In the Search Panel, search tools for Con.
10. Click on the tool to open the dialog.
    - Set the Input conditional raster to: **Height**
    - Set the Expression to: **Value >= 0**
    - Set the input true raster or constant value to: **height**
    - Leave the Input false raster field blank.
    - Save the output raster to the *OregonOutput* workspace and name it **TreeHeight**



11. Turn off all of the layers in your map document except the **TreeHeight** raster.
12. Right click the **TreeHeight** raster and select *Properties*.
13. On the *Symbology* tab, in the show panel, select *UniqueValues*.
14. In the *Symbol* field, select values **0** through **5**, then right click the selected symbols and select *Group Values*.
15. Change the Label text to "***Bare Ground/Regeneration***" for the first group.
16. Set the symbol color for the "***Bare Ground/Regeneration***" group to "*Topaz Sand*" (column 7 – row 1)
17. Select Values **6** through **20**, repeat the grouping process, set the Label to "*Pole/Sapling*", and set the symbol color to "*Olivine Green*" " (column 9 – row 1).
18. Select Values **21** through **40**, repeat the grouping process, set the Label to "*Pole*", and set the symbol color to "*Light Apple*" " (column 10 – row 2)
19. Select Values **41** through **100**, repeat the grouping process, set the Label to "*Small Tree*", and set the symbol color to "*Medium Apple*" " (column 10 – row 3).
20. Select Values **101** through **200**, repeat the grouping process, set the Label to "*Medium Tree*", and set the symbol color to "*Leaf Green*" " (column 10 – row 5)
21. Select Values **200** and Greater, repeat the grouping process, set the Label to "*Large Tree*", and set the symbol color to "*Fir Green*" " (column 10 – row 6)
22. Click **OK** to set the colors.

Using the TreeHeight raster as a guide, use the Profile tool on the Las Dataset toolbar to create a profile view across areas of changing tree height. Set the Filters to all, and the Point Symbology to Elevation.

Your Profile should look something like this:



End Exercise.