



EXERCISE 1

Visualizing Lidar Data:

LAS Dataset Navigation and Visualization in ArcGIS Pro

Introduction

What is a LAS Dataset? A LAS Dataset is basically a reference to .las files you have stored on the computer. It tells ArcGIS where the .las files are and can read statistics about the .las files, such as the point location, classification, and return number. Because the LAS Dataset can read the .las files and determine which points are in your map window in ArcGIS Pro, it allows you to quickly apply a variety of filters, which you'll learn about below. Be aware, however, that because the LAS Dataset is just referencing the .las files, there are very few operations you can run in ArcGIS that will actually manipulate the raw .las files. If you actually need to run some function on the raw point cloud, it will likely need to be done outside of ArcGIS in a software such as [FUSION, which can be downloaded from this link](#).

This tutorial will guide you through using LAS Datasets in ArcGIS Pro, but it isn't an ArcGIS Pro tutorial. If you'd like to learn some basics of ArcGIS Pro before beginning [you can find another GTAC tutorial by clicking on this link](#).

Learning Objectives

- Create a LAS Dataset
- Filter a LAS Dataset
- Use different techniques to visualize lidar data

Required Data

- NAIP2015.tif
- 36112F3222.las
- 36112F3402.las

Prerequisites

- If you are unfamiliar with lidar data, you should review GTAC's intro to lidar awareness webinar, here:
https://usfs.adobeconnect.com/p93bl180pa76/?OWASP_CSRFTOKEN=64099535af62813f31d3025bb0da704216a30583b0ce6c5f2d134b4870e848c1





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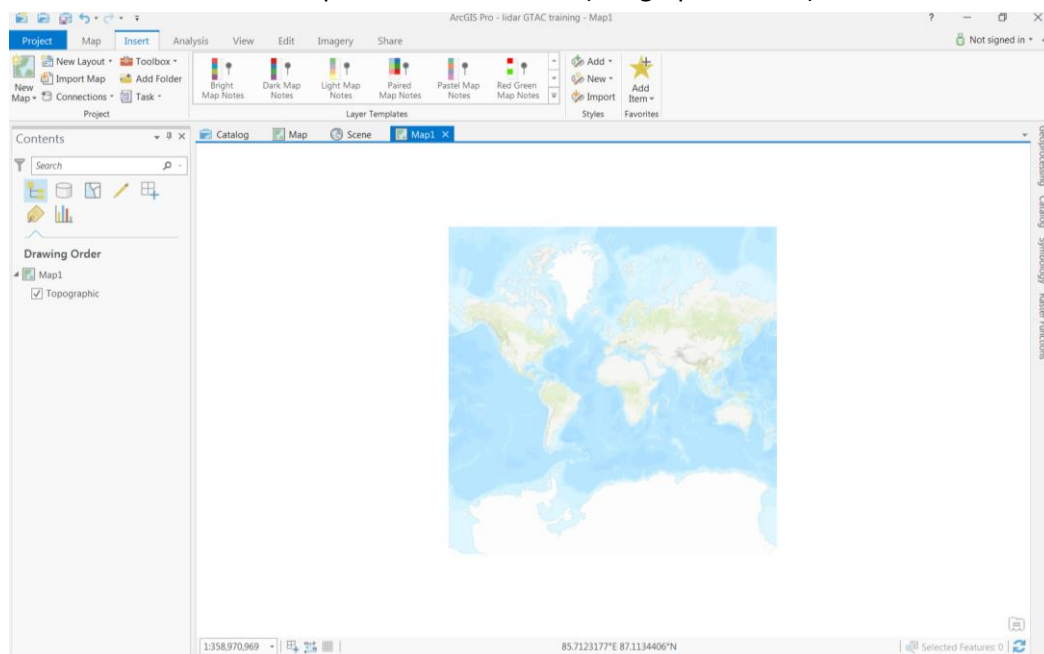


Part 1: View the LAS Dataset in Two Dimensions

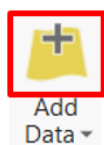
Before you can begin exploring, filtering, and analyzing your lidar data in ArcGIS, you'll need to create a LAS Dataset. You need to be aware that a LAS Dataset is not the same as your .las files. The .las files are the raw lidar data. The LAS Dataset is an ESRI file type that simply references the .las files. Because of this there are very few tools in ArcGIS that will directly manipulate the .las files. Below you'll learn to create and filter a LAS Dataset file.

A. Open ArcGIS Pro and Load a Map

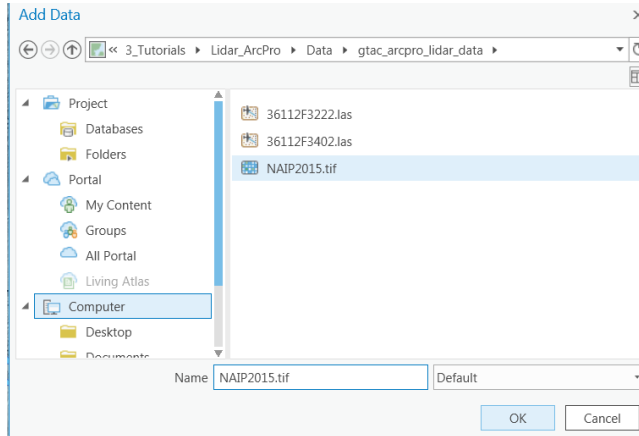
1. Launch ArcGIS Pro from the start menu by clicking **Start, All Programs, ArcGIS, ArcGIS Pro, ArcGIS Pro**.
2. In the window that opens, create a new project. In the **Create a new project** pane on the right, click **Blank**.
3. In the Create a New Project pop-up, name the project **lidar_GTAC_training**. You can save the project location at the default location.
4. Click **Ok**.
5. Your ArcGIS Pro project will now be open, but you don't have a map loaded. In the upper left corner click **New Map**. If you don't see the New Map button, make sure you're on the **Insert** tab in the toolbar at the top.
6. You'll now see a world map with no data added (see graphic below).



7. In the **Map** tab, click the **Add Data** button (you don't need to click the dropdown menu).

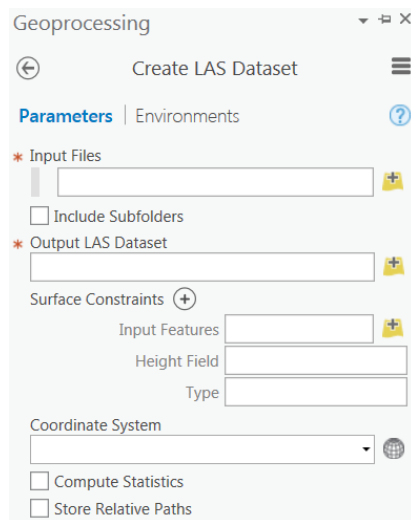


8. In the explorer window that appears, **navigate** to the course data folder that you downloaded. Click the **Naip2015.tif** image. Click **Ok** to add the image to the map (see graphic below).



B. Create a Las Dataset (.lasd)

1. Click the **Analysis** tab on the toolbar at the top of the ArcGIS Pro window.
2. In the analysis tab, click **Tools**. This will open a geoprocessing pane on the right side of your screen.
3. In the geoprocessing tab, click on the **Find Tools** search bar and type **Create LAS Dataset**.
4. The top option will be **Create LAS Dataset (Data Management Tools)**. Click that tool to open the Create LAS Dataset tool.



5. On the line labeled **Input Files**, click the yellow **Add Data** icon on the right. This will open an explorer window where you can add the las tiles.
6. In the explorer window, **navigate** to the folder where you downloaded the course data. **Select** the two las files and click **open**.
7. The files will take a moment to load. In the Output LAS Dataset line, click the same yellow icon on the right.

8. In the explorer window that opens, **navigate** to a place on your computer where you'd like to save the LAS Dataset. You can save it to a folder next to the data folder that you downloaded to your computer for this course.
9. Name the LAS Dataset **GTAC_lasd_training**. Click **save** to save the LAS Dataset to your computer.

Note: If you're saving the raster outside of a geodatabase, you'll have to give it a shorter name. ESRI only allows you to have 13 characters in the output file name. If you run into this issue, you can give the output raster a shorter name (trainingLasd, for example).

10. The rest of the options can be left in their default state. Click **Run**.
11. When the tool runs, you'll see the GTAC_lasd_training.lasd added to the table of contents pane in your ArcGIS Pro window. You may see the .lasd file loaded below the NAIP image in the table of contents. If so, **click and drag** the .lasd file above the NAIP image in the table of contents (see graphic below).

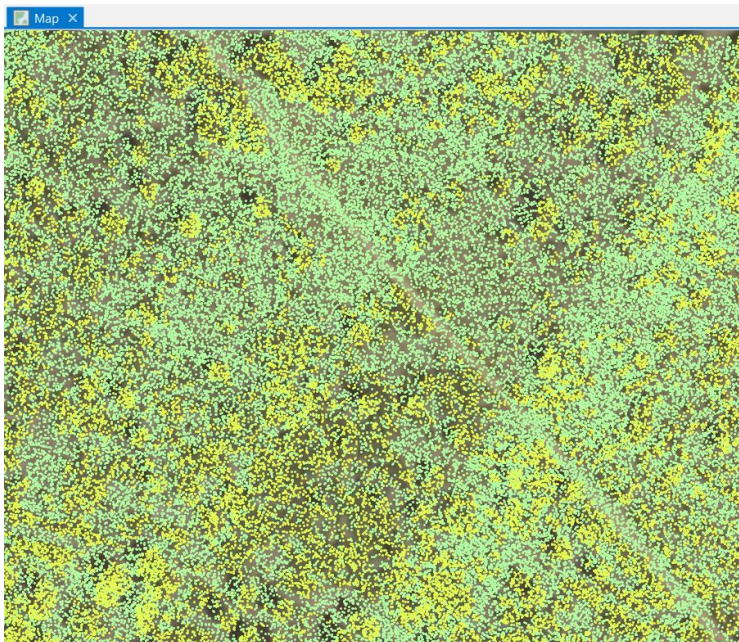


C. Visualizing the Point Cloud in ArcGIS Pro

1. When you are at the outermost zoom level, like in the photo above, you will not be able to see any points in the point cloud, just the red outline of the tiles. To view some points you'll need to zoom in. Use the center scroll wheel on your mouse to **zoom in** to the upper left area of the LAS Dataset, indicated on the image below. To zoom the map you can also click and hold the *right* mouse button and slide your cursor down.



Zoom in to about the zoom level shown in the image below. This will allow you to see points from the lidar point cloud, displayed through the LAS Dataset. Notice here that you can pick out individual trees. The higher points are colored differently, making them easier to see. The color ramp will be different depending on what area in the LAS Dataset you're looking at, so it may not look identical to the image below.

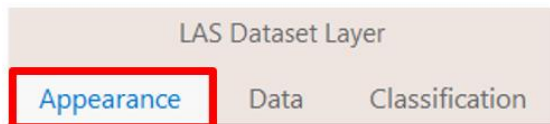


Note: If the points look too small for you to easily see them, you can click on the *GTAC_lasd_training* layer in the table of contents, then click the *appearance* tab in the toolbar at the top. Clicking the *symbology* button to open the *symbology* pane. There you'll see a slider labeled *Symbol Scale*, which you can use to make the points larger or smaller.

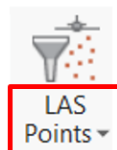
D. Filtering the LAS Dataset

Typically, looking at all of your lidar points at once is a little overwhelming, and doesn't yield that much information. When you want to extract some useful material from your LAS Dataset, it will likely need to be filtered down just to the points that you're interested in (e.g. just the ground points, or just the highest points in the canopy). Below are some simple built in tools that you have for filtering the LAS Dataset.

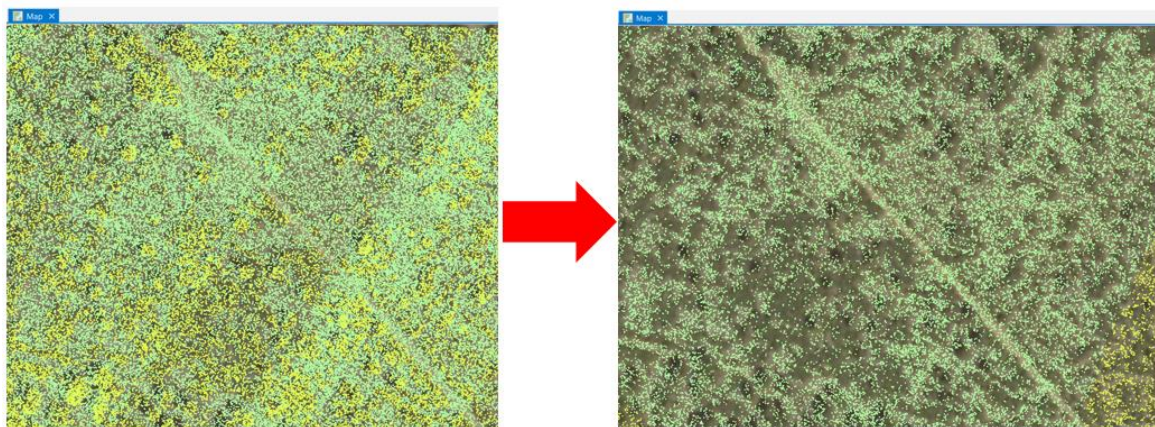
1. Keep the map window where it is so that you can view the same data while you filter the LAS Dataset. In the table of contents, click the **LAS Dataset** so that you have it selected.
2. When the LAS Dataset is selected, you'll see three tabs appear in the top most toolbar. These tabs are labeled LAS Dataset layer, and have the titles Appearance, Data, and Classification. Click the **Appearance** tab.



3. The appearance tab is divided into 5 sections. The section on the far right is called "Filters". These are simple filters that you can apply to your LAS Dataset to automatically pick out various points. Click the **LAS Points** drop down (make sure you click the dropdown menu).

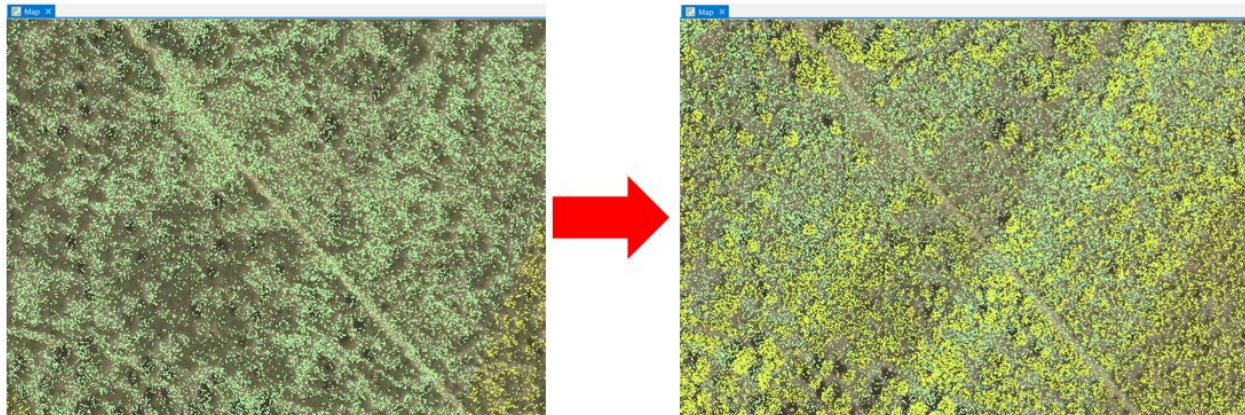


4. When the drop down appears you'll see that the All Points filter is selected. Try filtering to just the ground points by clicking **Ground**. It will take a few moments to load, but when it does, you'll see that the points that appeared to be trees are no longer displayed.



When lidar data is used to create a Digital Elevation Model (DEM), the ground points are used to interpolate a surface. In later exercises you'll use these points to create a bare earth surface.

5. Now try filtering to non-ground points. Just like you did in the previous step, click the **LAS Points** dropdown, then click **Non-Ground**. Again, this will take a few moments to load but when it does, you'll see points that mostly appear to be trees and shrubs.



E. Filtering the LAS Dataset by Return

Above you learned some simple tools that are available on the main toolbar. You can also filter the LAS Dataset with greater specificity using the las filter options in the layer properties window. You'll learn how to do that in this section.

1. Start by removing the filters you applied in the last section. In the Appearance tab click the **LAS Points** dropdown, then click **All Points**.
2. In the table of contents pane on the left, right-click the **GTAC_lasd_training.lasd** layer and click Properties, or double click layer.
3. In the layer properties window that opens, you'll see a number of tabs on the left side. Click **LAS Filter**. This will show the options that you have to filter points (see graphic below).

Select the LAS point properties to filter the LAS dataset

Classification Codes	Return Values	Classification Flags
<input checked="" type="checkbox"/> All	<input checked="" type="checkbox"/> All	<input checked="" type="checkbox"/> Not Flagged
<input checked="" type="checkbox"/> 0 Never classified	<input checked="" type="checkbox"/> Last	<input checked="" type="checkbox"/> Synthetic
<input checked="" type="checkbox"/> 1 Unassigned	<input checked="" type="checkbox"/> First of Many	<input checked="" type="checkbox"/> Key Point
<input checked="" type="checkbox"/> 2 Ground	<input checked="" type="checkbox"/> Last of Many	<input type="checkbox"/> Withheld
<input checked="" type="checkbox"/> 3 Low Vegetation	<input checked="" type="checkbox"/> Single	
<input checked="" type="checkbox"/> 4 Medium Vegetation	<input checked="" type="checkbox"/> 1	
<input checked="" type="checkbox"/> 5 High Vegetation	<input checked="" type="checkbox"/> 2	
<input checked="" type="checkbox"/> 6 Building	<input checked="" type="checkbox"/> 3	
<input checked="" type="checkbox"/> 7 Low Noise	<input checked="" type="checkbox"/> 4	
<input checked="" type="checkbox"/> 8 Model Key/Reserved	<input checked="" type="checkbox"/> 5	
<input checked="" type="checkbox"/> 9 Water	<input checked="" type="checkbox"/> 6	
<input checked="" type="checkbox"/> 10 Rail	<input checked="" type="checkbox"/> 7	
<input checked="" type="checkbox"/> 11 Road Surface	<input checked="" type="checkbox"/> 8	

Note: The classification codes are defined by ASPRS, not by ESRI. Many of the codes are reserved for a specific class (e.g. 2 = ground). But it is possible that lidar data you obtain won't have any classification, so don't necessarily assume that selecting "High Vegetation" will automatically find all the high vegetation points in your point cloud. If you want to read more about las codes, and the file format, read the ASPRS specifications here: <https://www.asprs.org/committee-general/laser-las-file-format-exchange-activities.html>

4. You're going to filter only the first return points, so in the second column, labeled **Return Values**, uncheck **All**, then check the box next to **1**.

Select the LAS point properties to filter the LAS dataset

Classification Codes	Return Values	Classification Flags
<input checked="" type="checkbox"/> All	<input type="checkbox"/> All	<input checked="" type="checkbox"/> Not Flagged
<input checked="" type="checkbox"/> 0 Never classified	<input type="checkbox"/> Last	<input checked="" type="checkbox"/> Synthetic
<input checked="" type="checkbox"/> 1 Unassigned	<input type="checkbox"/> First of Many	<input checked="" type="checkbox"/> Key Point
<input checked="" type="checkbox"/> 2 Ground	<input type="checkbox"/> Last of Many	<input type="checkbox"/> Withheld
<input checked="" type="checkbox"/> 3 Low Vegetation	<input type="checkbox"/> Single	
<input checked="" type="checkbox"/> 4 Medium Vegetation	<input checked="" type="checkbox"/> 1	
<input checked="" type="checkbox"/> 5 High Vegetation	<input type="checkbox"/> 2	
<input checked="" type="checkbox"/> 6 Building	<input type="checkbox"/> 3	
<input checked="" type="checkbox"/> 7 Low Noise	<input type="checkbox"/> 4	
<input checked="" type="checkbox"/> 8 Model Key/Reserved	<input type="checkbox"/> 5	
<input checked="" type="checkbox"/> 9 Water	<input type="checkbox"/> 6	
<input checked="" type="checkbox"/> 10 Rail	<input type="checkbox"/> 7	
<input checked="" type="checkbox"/> 11 Road Surface	<input type="checkbox"/> 8	

5. Click **OK** to close the layer properties window.
6. The points will take a few minutes to load. When they do, it may be difficult to tell the difference from All Points. But what you have loaded is the "highest hit" surface. The 2nd and 3rd returns on the vegetation won't be shown.

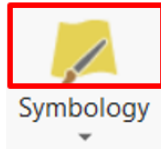


Part 2: LAS Dataset symbology

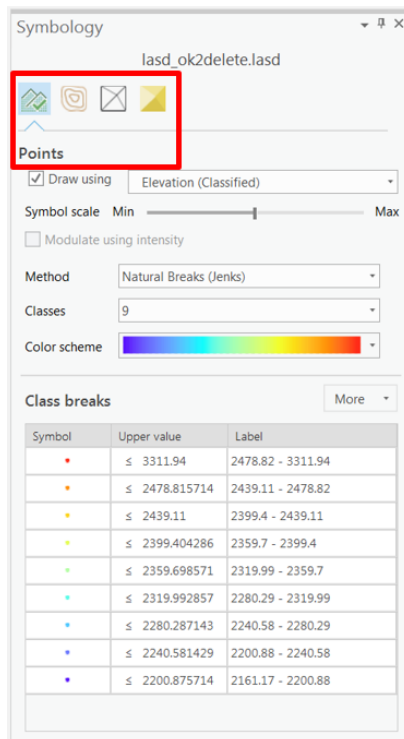
In ArcGIS Pro there are several different ways you can view your LAS Dataset. You can view the point cloud, as you've seen, and change the filters on the points. But you can also create surfaces from the point data, or create visual metrics such as topographic contour lines. You'll learn these methods below. There are other methods not covered in this exercise that you are encouraged to experiment with afterwards.

A. Viewing surfaces

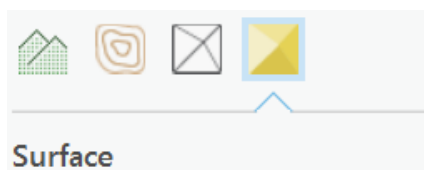
1. Click the **Appearance** tab in the toolbar at the top. If you don't see the Appearance tab, make sure you have the LAS Dataset layer selected in the table of contents.
2. Click the **LAS Points** dropdown filter, then click **Ground**.
3. Also in the Appearance tab, click the **Symbology** button (make sure to click the button, not the dropdown menu). This will open the symbology pane.



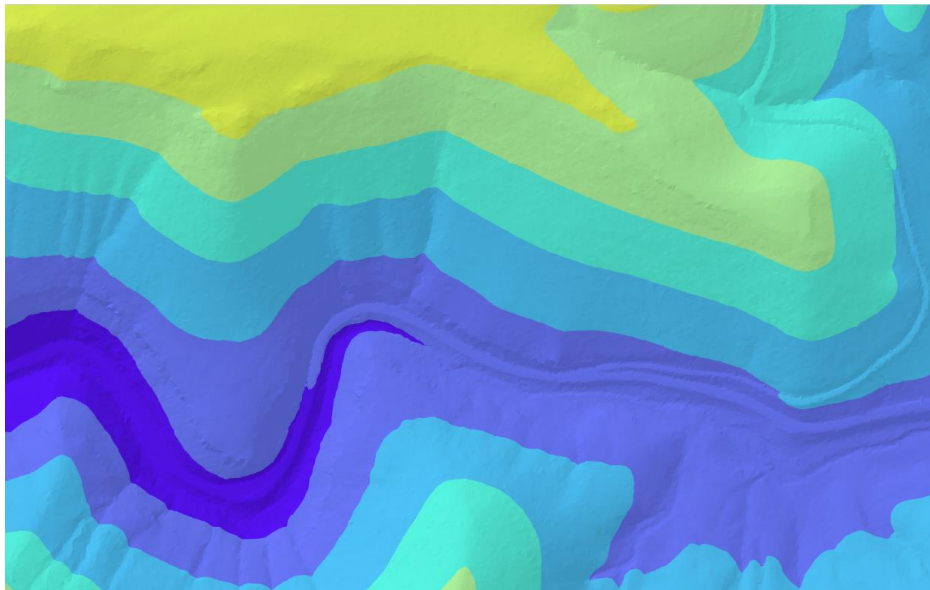
- When the symbology pane opens, you'll see that it is open to the points section (shown below).



- Uncheck the box at the top labeled **Draw using**. This will mean that the points are still filtered, but no longer drawn.
- Click the **Surface** section in the Symbology pane (outlined in light blue in the graphic below).

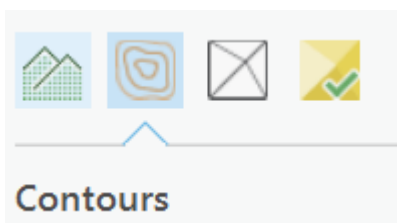


- In the box at the top, check **Draw using**.
- Click dropdown menu next to **Draw using**, and select **Elevation**.
- Now **Zoom and Pan** to the center of the LAS Dataset. You'll see that rather than visualizing the point cloud now, you're viewing the LAS Dataset as a surface. Be aware that this is not a viable DEM for analysis. This is simply a visualization technique. You'll learn to create DEM rasters and Hillshade in later exercises.

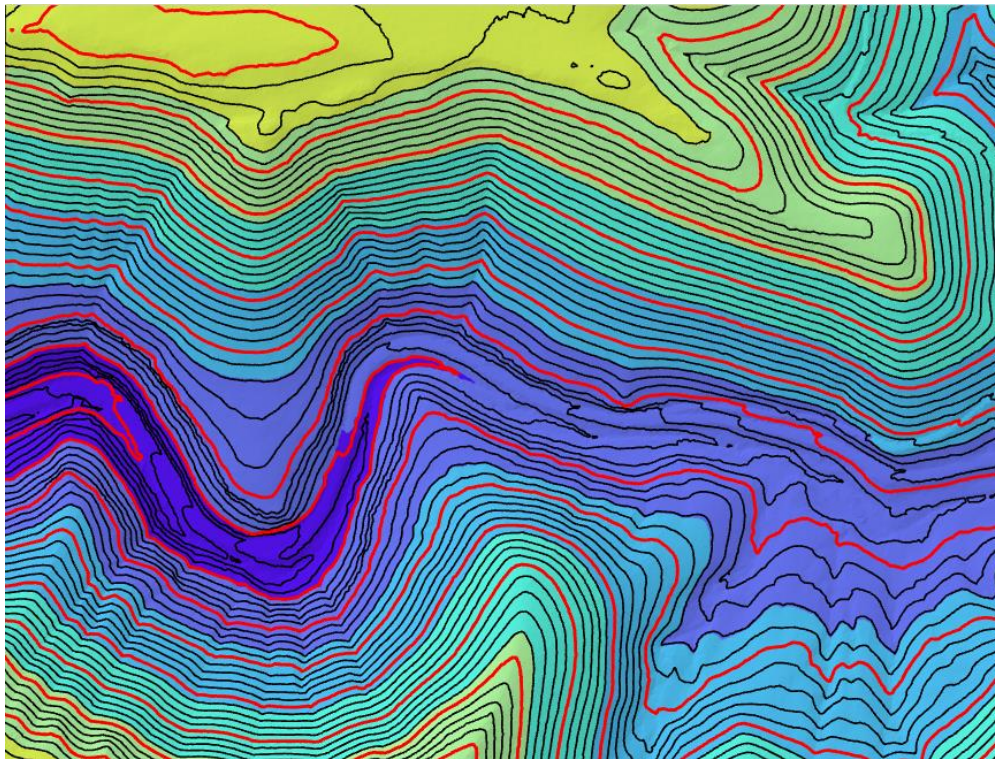


B. Creating Contours

1. You can keep your map window over the same area. Click the **Appearance** tab in the toolbar at the top. If you don't see the Appearance tab, make sure you have the LAS Dataset layer selected in the table of contents.
2. Click the **LAS Points** dropdown filter, then click **Ground**.
3. Also in the Appearance tab, click **Symbology**. This will open the symbology pane.
4. From the previous section, you'll have the points turned off, and the surface turned on. Now click the **Contours** section (shown below).



5. In the contours section, click **Draw contours**. You can keep the other settings at the default. The contours will take a few minutes to draw but when they do you'll see contour lines drawn over the surface you drew in the last section (see graphic below).

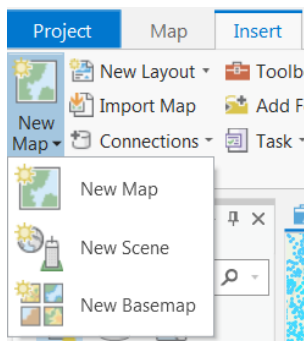


Part 3: View the LAS Dataset in Three Dimensions

In past versions of ArcGIS, a user could use ArcMap to view the LAS Dataset in 2D and view points and surfaces, much like you did in Part 2:. But if you wanted to view the 3D point cloud you would need to use another program in ArcGIS such as ArcScene, or use another program altogether. However, in ArcGIS Pro, you can open a map or a scene in the same project to view the points in 3D. Below you'll learn basic 3D visualization tools.

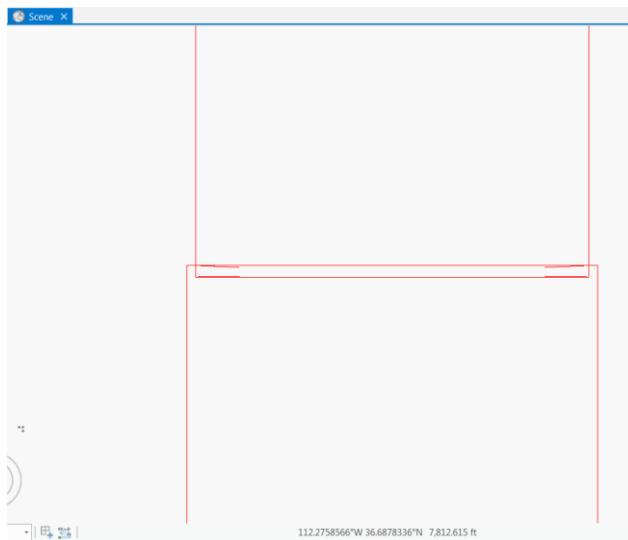
A. Load a New Scene

1. In the toolbar on the top of your ArcGIS Pro window, click the **Insert** tab.
2. In the Insert tab at the top, click the **New Map Dropdown**.



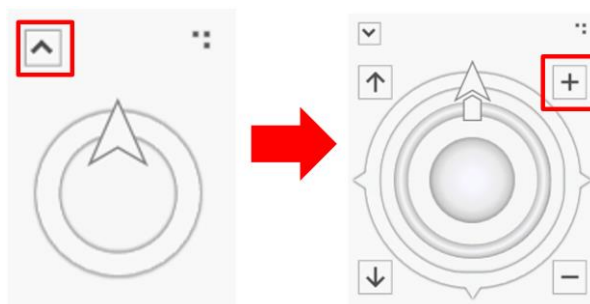
3. In the dropdown that appears, click **New Scene**. A new scene will appear, showing a blank globe.

4. In the toolbar on the top of your ArcGIS Pro window, click the **Map** tab.
5. In the Map tab, click **Add Data**.
6. In the Add Data window that appears, navigate to the **.lasd** file that you created in Part 1, Section B: Create a Las Dataset (.lasd). Double click it to open it.
7. The scene should zoom to the extent of the .lasd file. The points will start to draw, but will take a few minutes. Before the points draw, you'll see a scene similar to the one below.



B. 3D Navigation Tools

1. Even though there are only 2 las files that comprise this LAS Dataset, there are millions of points that can take a long time to load. To alleviate this, zoom to a smaller area of the LAS Dataset. There are a number of different ways you can do this.
 - i. Use the center scroll wheel to zoom the map in and out.
 - ii. Right click and hold using your mouse and slide your cursor up or down.
 - iii. Click the Expand button on the navigation tools in the lower left corner of your map window. Then use the + and - zoom tools to zoom in and out.



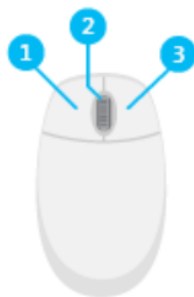
2. After you zoom in, you'll be able to start seeing points load. When this happens you should start experimenting with navigation tools so you can more easily explore your data.

Note: Depending on how many points you have in view and how much memory your computer has, they may load very slowly. You can choose to "thin" the point cloud so that not all points are displayed. To do this, make sure you have the LAS Dataset layer highlighted in the table of contents. Then click the

appearance tab in the toolbar at the top. In the Point Thinning section, use the slider bar to slide the density towards Min. This will decrease the number of points shown on screen, which should make viewing faster.

- i. You can pan through the data by clicking and dragging with the left mouse button.
- ii. You can tilt and rotate the view by clicking and holding the center scroll wheel on your mouse and moving your cursor.
- iii. You can easily zoom the view in and out by clicking and dragging up and down with the right mouse button.

Explore

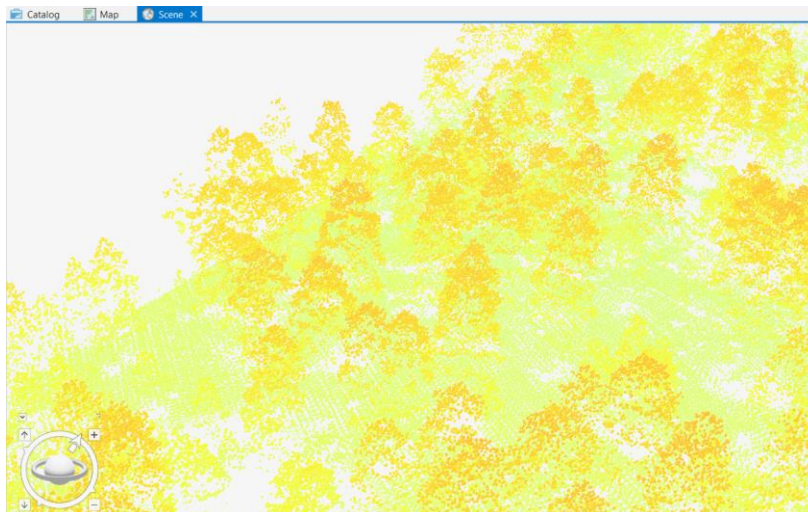


1. View pop-ups and pan
2. Zoom, rotate / tilt (3D-only)
3. Zoom continuous

Quick shortcuts:

Shift = zoom rectangle
 Shift + click = center and zoom
 N = point north
 B = look around (in 3D)
 C = explore when using another tool
 V = rotate / tilt

3. Experiment with the navigation tools until you're comfortable moving through the point cloud. In this exercise you won't be doing any additional processing with the point cloud in 3D. However, all of the same filtering and symbology techniques that you learned above in the 2D section can be used in this 3D scene.



Congratulations! You have learned some basic techniques for loading, navigating, filtering, and visualizing a LAS Dataset in ArcGIS Pro. In future exercises you will use all of these tools to create products in order to study vegetation and bare earth surfaces.