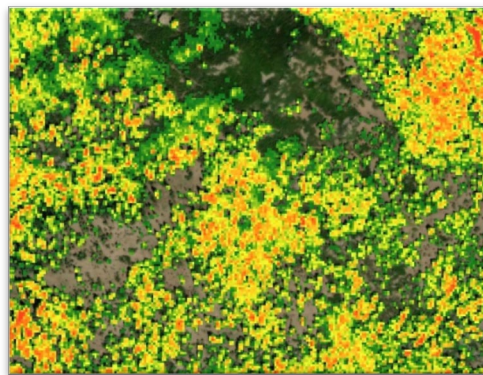


EXERCISE 5

Estimating Canopy Density and Height Statistics in ArcGIS Pro



Introduction

Canopy density and canopy height are valuable metrics that lidar can provide for forestry and environmental applications. These can be used as inputs to model biomass and vegetation cover. To estimate canopy density we take the ratio of above ground vegetation points to all points. We can use height statistics to find mean, standard deviation and percentiles. These metrics are useful for understanding height distribution, for example we often use 95th percentile to estimate the canopy height because it cuts out upper noise.

Objectives

- Learn to estimate canopy density
- Learn to use LAS Statistics to create height metrics

Required Data

- COW_024.las and COW_025.las from Exercise5 folder in the course downloads
- Naip.tif from the Exercise5 folder in the course downloads

Prerequisites

- Completion of Exercises 1, 2, 3, and 4



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Part 1: Open ArcGIS Pro and Create a LAS Dataset

In Part 1 of this exercise you will open ArcGIS Pro, if you haven't already, and create a new LAS Dataset with the data from the Exercise5 folder. You will then explore the classifications. You learned how to do this in previous exercises but, as a review these steps will walk you through it again.

A. Open ArcGIS Pro and Load Data

1. Launch ArcMap from the start menu by clicking **Start, All Programs, ArcGIS, ArcGIS Pro, ArcGIS Pro**.
2. In the window that opens, you can either create a new project or load the project you created in the last exercise. If you start a new project, click Blank in the Create a new project pane on the right.
3. In the **Create a New Project** pop-up, give the project a name. You can save the project location as the default.
4. Click **Ok**.
5. 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 on the toolbar at the top of the ArcGIS Pro window. This will open a global map.
6. In the **Map** tab click the **Add Data** button.



7. In the explorer window that appears, navigate to the course data folder download. Open the **Exercise5** folder. Click the **Naip.tif** image. Click **Ok** to add the image to the map.

B. Create LAS Dataset (.lasd)

1. On the **Analysis** tab click **Tools** to open the Geoprocessing search window.
2. Search for "**Create LAS Dataset**" and click that tool to open it.
3. On the line labeled **Input Files**, click the yellow **Add Data** button icon on the right. This will open an explorer window where you can add the las tiles.
4. In the explorer window, navigate to the folder where you downloaded the course data. **Open** the **Exercise5** folder and **select** the two las files **COW_024** and **COW_025**.
5. Click **Open**.
6. In the **Output LAS Dataset** line, click the same yellow icon on the right. In the explorer window that opens, navigate to a place on your computer where you'd like to save the dataset. You can save it to a folder next to the data folder that you downloaded to your computer for this course. Name the LAS Dataset **GTAC_lasd_exercsie5** . Click **save** to save the LAS Dataset to your computer.
7. The rest of the options can be left as the default. Click **Run**.

C. View LAS Classifications

1. View the point cloud by zooming in.

2. **Right click** on the **GTAC_lads_exercise5.las** in the **Contents** pane and open **Properties**.
3. Click **LAS Filter**.
4. Under Classification codes click **All** then unselect **1** (unassigned).
5. Click **Ok**.
6. View the LAS Dataset. Pan around the image and view the point cloud. Notice that most of the points are visible.
7. **Right click** on the **GTAC_lads_exercise5.las** in the **Contents** pane and open **Properties**.
8. Click LAS Filter and switch the classification selection so that only **2** is selected. Click **Ok**.
9. View the point cloud again. You should now see all the ground points.

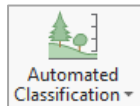
Note: It is common for LAS data to come classified as 0, 1 and 2 However, some data may come with additional classifications. You can check to see if there are additional classification by filtering and viewing the LAS Dataset by classification. Some Tools in ArcGIS Pro only use certain classifications, so it is important to understand how your data is classified before using these tools.

Part 2: Create Canopy Density Raster

You will now learn to reclassify LAS by height and create point density rasters that can be used in the raster calculator to estimate canopy density.

A. Classify LAS By Height

1. Make sure the **GTAC_lads_exercise5.las** is selected in the Contents pane. In the **LAS Dataset Layer** Toolbar click the **Classification** tab.
2. Click **Automated Classification** then **Classify by Height** to open the Classify LAS By Height geoprocessing tool.

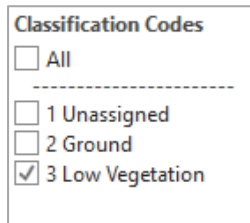


3. In the **Ground Source** box leave the default, **All Ground Points**. This defines the ground surface and allows the tool to calculate height above ground.
4. Under **Height Classification** enter **Class Code 3**, **Height 1**. This will reclassify points below 1 m as 3, or Low Vegetation. Notice the default suggests classifying points as 3, 4, and 5 for low, medium and high vegetation. You could classify your data this way with appropriate breaks for your landscape.

Height Classification	
Class Code	Height
3	1

5. Leave everything else as the default.
6. Click **Run**.

7. **Right Click** on the **GTAC_lads_exercise5.lasd** in the Contents pane. Open **Properties** and Select **LAS Filter**. Notice that you now have 3 shown under classification codes. Select only **Classification Code 3**.



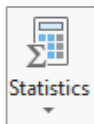
8. Click **Ok**.
9. Pan and zoom around the point cloud to view the newly classified points.

Note: Unlike most other LAS tools in ArcGIS Pro, the classification tools alter the original LAS files. This is difficult to undo so if you don't want to alter the original files make a copy of the LAS files before you create a LAS Dataset.

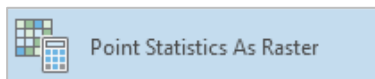
B. Create Point Density Raster

You will now create a point density raster for all points and a point density raster for points above 1 m. This allows us to estimate the canopy density by excluding low vegetation.

1. **Right Click** on the **GTAC_lads_exercise5.lasd** in the Contents pane. Open **Properties** and Select **LAS Filter**. Select **All**.
2. Click **LAS Dataset Layer** toolbar and go to the **Data** tab.
3. Click **Statistics**.



4. Click **Point Statistics as Raster**.



5. In the **Output Raster** box click the yellow folder and navigate to where you want to save. Name it **Pt_densityall**. Click **Ok**.
6. Under **Method** select **Point Count**.
7. Leave **Sampling Type** as the default, **Cell Size**.
8. For **Sampling Value** enter **10**. This will set the cell size to 10 meters. The sampling value must be at least four times the point spacing, which we calculated in exercise 2.
9. Click **Run**.
10. **Right Click** on the **GTAC_lads_exercise5.lasd** in the Contents pane. Open **Properties** and Select **LAS Filter**. **Turn off** all Classification Codes except **1** to exclude points classified as ground and points below 1 m.

Classification Codes

☐ All

☒ 1 Unassigned

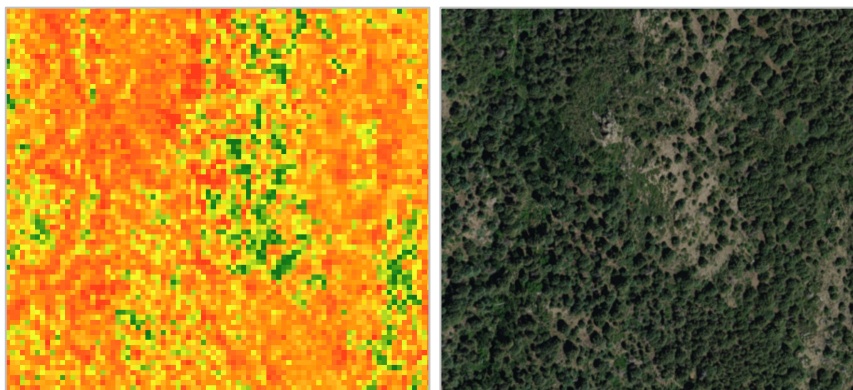
☐ 2 Ground

☐ 3 Low Vegetation

11. Open the **Point Statistics as Raster** tool again by navigating to the **LAS Dataset Layer** toolbar, **Data** tab, **Statistics**.
12. In the **Output Raster** box click the yellow folder and navigate to where you want to save. Name it **Pt_density1m**. Click **Ok**.
13. Under **Method** select **Point Count**.
14. Leave **Sampling Type** as the default, **Cell Size**.
15. For **Sampling Value** enter **10**.
16. Click **Run**.

C. Create Canopy Density Raster

1. In the **Analysis** tab click **Tools** to open the Geoprocessing window.
2. In the Geoprocessing window **search Raster Calculator**.
3. Click the **Raster Calculator (Spatial Analyst Tools)** to open.
4. In the **Map Algebra expression** box enter "**Pt_density_1m**" / "**Pt_density_all**".
5. In the output raster box navigate to where you want to save. Name the file **Canopy_density**.
6. Click **Run**.
7. View your results! The resulting raster will range from 0-1.0. Pan around the image and compare the raster to the imagery below. Notice that low density values occur on bare ground. There are even empty areas in the raster where there are no points above 1 meter.

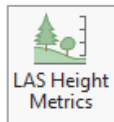


Part 3: Create LAS Height Metric Rasters

The LAS Height Metrics Tool allows us to easily view height statistics that can tell us about the distribution of vegetation heights. In this section you will learn how to use this tool and what the outputs mean.

A. LAS Height Metrics

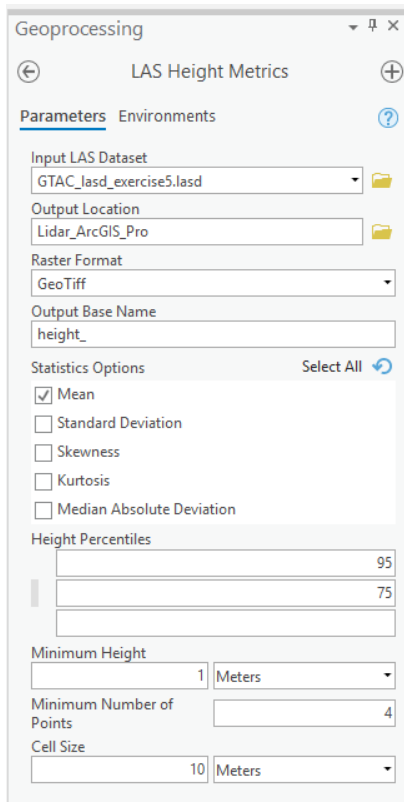
1. With **GTAC_lads_exercise5.lasd** selected in the Contents pane, click on the **Data** tab in the **LAS Dataset Layer** toolbar.
2. Click **LAS Height Metrics** to open.



Note: The LAS Height Metrics tool uses points classified as 0 or 1, which represent unclassified points and 3, 4, or 5 which represent vegetation according to the American Society for Photogrammetry and Remote Sensing (ASPRS) standards. To use this tool for forestry height metrics ground points need to be classified as 2 and all vegetation points need to be in one of those five classes. Points in a reserved class will not be considered in the height metrics.

3. In the **Output Location** box, click the yellow folder. In the explorer window that opens navigate to the folder where you want to save to. You do not need to name the file.
4. For the **Output Base Name** leave the default “**height_**”. This will be the base name for all the outputs.
5. Under **Statistics** options select **Mean**. You can choose multiple statistics here to evaluate different aspects of the data. The tool will create a raster for every statistic option you select.
6. In the **Height Percentiles** box enter **95**. This will give us a value at which 95 percent of points fall below. You can enter multiple values here and the tool will create a raster for every percentile you enter.
7. Set **Minimum Height** to **1 m**. This is the cut off for points to exclude. This dataset is a forest/woodland area where 1 m is an acceptable threshold to exclude from canopy measurements. This value varies by landscape. A value of 2 or 3 meter may be more suitable for your area.
8. Leave **Minimum Number of Points** as the default.
9. Set **Cell Size** to **10 Meters**.

10. Click **Run**. The tool may take several minutes to execute.



11. View your results. You should have two new layers, a **height_mean** layer and **height_95**. The **height_mean** layer shows the mean height of points above 1 m for each 10 meter cell. The **height_95** gives us the height at which 95% of points fall below. This can be used to determine canopy height as it cuts out tall noise.

Congratulations! You have successfully completed this exercise. You now know how to estimate canopy density by classifying LAS data and create height statistics using lidar in ArcGIS Pro.