EXERCISE 6: CREATING A FUSION PROJECT—PART 1

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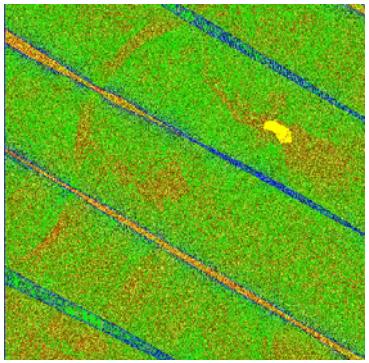
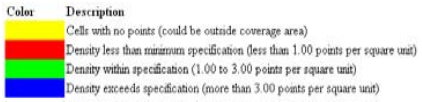
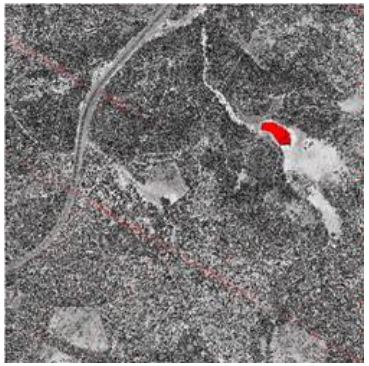




First Return (pulse) density (above) and (IR Return) Intensity (below) images—created from the lidar data.



Introduction

In the previous exercises you were provided a full Fusion LIDAR data set. In this exercise, you will begin with raw LIDAR data and create a new Fusion project—one that will be as complete as the previous example data set. The major sections of this exercise are:

1. **Examine the Raw Data**
2. **Create and Load the Reference Image**
3. **Explore the Catalog Command**

In subsequent exercises (Creating a Fusion Project Parts 2 and 3), you will continue creating a rich Fusion Project by: creating the bare earth surface, creating a Top of Canopy Model (TCM) and a Canopy Height Model (CHM).

Prerequisites

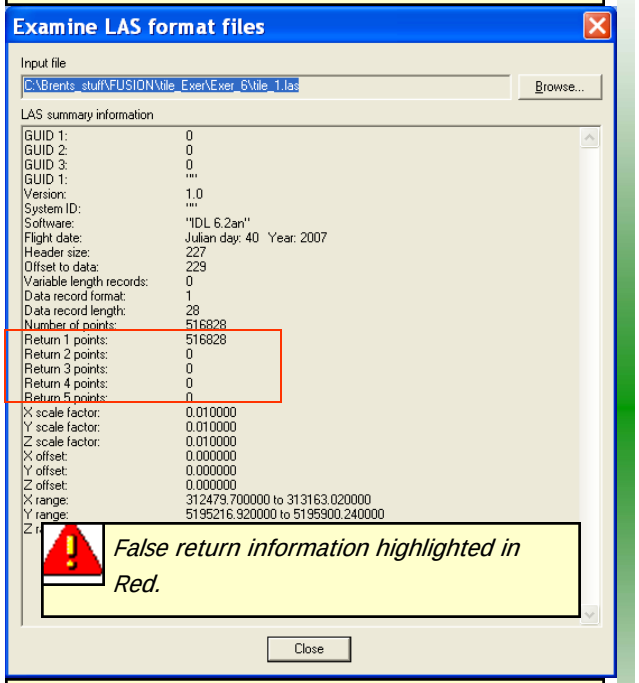
- **lubrecht.zip**, includes nine tiles of LIDAR data (**lub_tile1.las...lub_tile9.las**)

The LIDAR raw data files for this exercise are composed of nine **"tiles"** of data. Delivering LIDAR data in tiles is a common delivery method to split the data into a more manageable file size.

1. Examine the Raw Data (the files provided by the vendor).

- **Determine the Format**. Fusion's native LIDAR data formats are LDA and LAS, however, vendors will provide data in a number of different formats (usually not LDA) including: ASCII text, ASCII CSV (comma separated values) file, and LAS (The LAS file format is a non-proprietary file format for the interchange of LIDAR data between vendors and customers). ASCII text and CSV files must be converted to the LDA format. LAS files can be converted to LDA however, Fusion can read LAS files directly--the only step required is to generate an index file (*.idx). This happens automatically the first time an LAS file is loaded. The files we will use for this exercise are a set of 9 LAS files **(lub_tile1.las, lub_tile2.las...lub_tile9.las).**

After you've downloaded the data file (lubrecht.zip), we recommend that you extract the enclosed .las files to c:\lidar\lubrecht (you'll have to create the lubrecht folder).



*Note: All returns are counted as first returns in the LAS header file (above) . To view more information about each data point the **LAS file** can be converted to an ASCII csv file. **LAS files** are ready to use in Fusion, converting them to CSV files will give us additional information about the data which may help us in our data analysis)*

- **Various methods to Inspect the Content**. Use Fusion (Utilities | Examine LAS Files) to inspect LAS files. Use a text editor (e.g. Wordpad or Notepad) to open an ASCII text file, or use Excel to open an ASCII CSV file. Does the data include all returns (requires filtering)? Are additional attributes available: intensity (can be used to create a geolocated image), scan angle, return number, other?

***Note**: Fusion will read and write **LAS files**, but some of the fields for each return* are not populated (although the data is still there). Specifically the field that details the number of returns for a pulse is always set to one (1st return). This missing information is important to determine the number of returns that exist in the data, ie:*1st and last* or *multiple returns* (beneficial for forest structure modeling).

- **Inspect the LAS file headers**.

1. ***Open,* Fusion.**
2. ***Click,* Tools I Miscellaneous Utilities I Examine LAS file headers..**
3. Navigate to and ***Select*** one of the **LAS files.**

- **Convert one of the LAS files to a CSV file format *(optional step to learn more about your LIDAR data, see note in side bar)***

1. Click **Tools I Data Conversion I Export data from LAS or LDA files to other formats...**
2. ***Select*** one of your **LAS files** for the input file.
3. Navigate to an output folder of your choice and create an output file with an **.csv extension**
4. Ensure that you use the output format drop down box to select **(ASCII CSV format (XYZIPRS)).**
5. ***Click*, Convert.** When the process finishes close the window.
6. Navigate to and load the **CSV** file into Excel after the data conversion is complete. Excel will only open a portion of the file since it is limited to 65,536 rows (records)-but that is more then sufficient for our purpose.
   Do you notice additional information available in this data format? (for example the return #, nadir angle or intensity).

Exercise 6 continues on the following page...

2. Create and Load the Reference Image:

A georeferenced image is a critical requirement for exploring LIDAR data in Fusion—it provides the coordinate system and visual reference for the LIDAR data. There are at least three ways to input a useable reference image: 1) find an existing georeferenced image (e.g. NAIP)—remembering that you may have to reproject the image to match the LIDAR projection; 2) Use the **Create image using LIDAR data** utility (**Utilities** button); or 3) you can create a reference image automatically by running the **catalog.exe** DOS command line utility. In section 3 of this exercise, we'll explore the catalog command—for now, let's use the **Create image using LIDAR data** utility to create our reference image.

1. Open fusion (if it is not open)
2. ***Click,*** **Tools… | Miscellaneous Utilities… | Create an image using LIDAR point data…**
3. Navigate to and ***Select*** all nine **LAS files** (lub_tile1.las...lub_tile9.las)
4. ***Click,*** **Open**--this will open the **Image Creator** dialog:
    5. ***Click*** the **Browse…** button.
    6. Specify an output location and file name (suggested: **lub_ref.bmp**) and ***Click,*** **Save**.
    7. Change the **Pixel size** to **2**.
    8. ***Click*** the **Create image** button.
    9. Once the image is created ***Click*** the **Close** button.
10. In Fusion's main button panel, ***Click*** the **Image…** button.
11. Navigate to and select **lub_ref.bmp** and ***Click,*** **Open**.
12. Ensure that the checkbox is checked next to the **Image…** button. The intensity image will be displayed in Fusion (see example on next page).

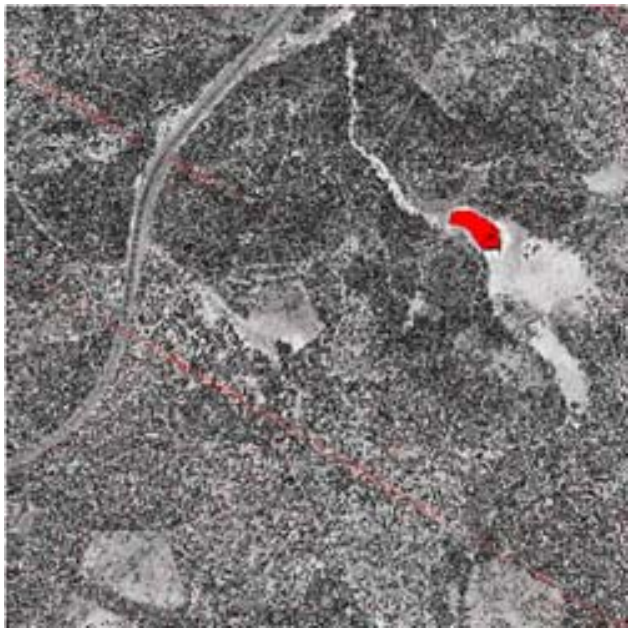
You can also use an existing image (e.g. NAIP or an orthocorrected photo). The image has to be in the same projection and same units as the LIDAR data but does not have to have

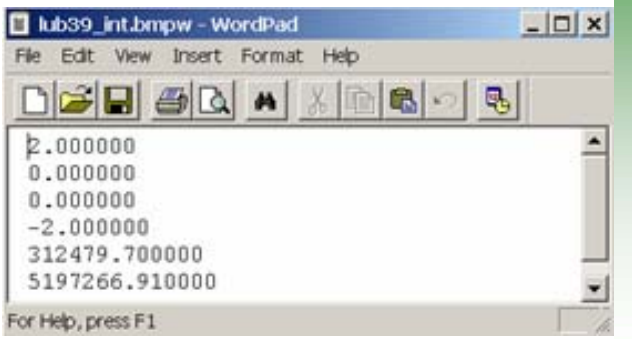
Note: *Even though your* ***.las*** *data is already compatible with Fusion—you can't view it in Fusion until you load an associated geo-referenced image. We'll create one now...*

Note: *The procedure described in the main body of this exercise for creating an image is fine if the data values are distributed somewhat evenly throughout their range. However, that may not always be the case. If your reference image lacks contrast or is too bright… Follow the enumerated procedure (steps 4-6) but before you click the* ***Create Image*** *button, click the* ***Scan for data ranges*** *button. This will display a histogram of the data. If, for example, the data range is 0-255 but there are very few intensity values greater than 200—you would click the* ***Clamp data range*** *button and enter a* ***min value*** *of 0 and a* ***max value*** *of 200 (not 255). This will improve the contrast and reduce the brightness of the image.*

the same geographical extent as the LIDAR data--it can be smaller (as small as a single pixel) or it can be larger.

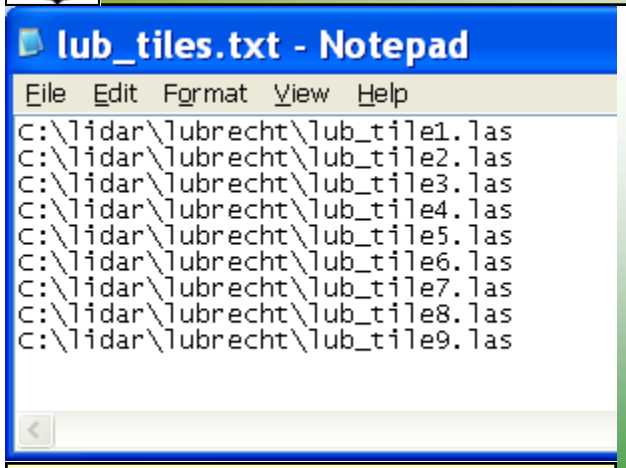
Note: *this reference image was created from the LIDAR data—thus, the reference image will have the exact same geographical extent as the point data file and be perfectly co-registered to the point data file. Also note: red pixels represent the background of the image (no data)--This is a fast way to check the distribution of the data, however, you can re-create the reference image (or create another) that has a less distinctive background color (a medium grey works well) or increase the pixel size (lower pixel size values give a more resolute image but with more gaps (red pixels) in the data, higher pixel values give fewer gaps but coarser resolution).*



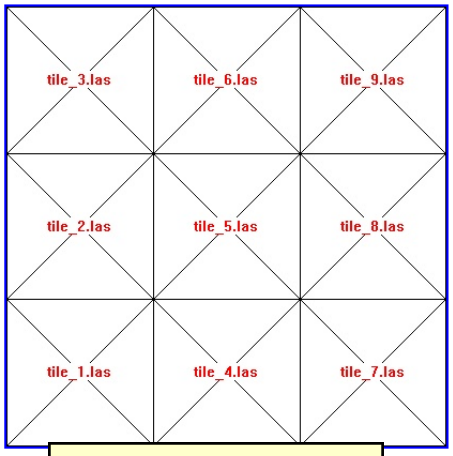


The Intensity image ***lub_ref.bmp.*** *Any image created will have an associated world file (for bmp files the associated world file has a bmpw extension—as shown in the side bar).*

Exercise 6 continues on the following page...



Input LAS data files compiled into one text file. This makes it easier to run the Fusion command line executables with multiple tiles (LAS files) and create one output file.



Overall Data Coverage JPEG.

3. Explore the Catalog Command

The Catalog utility has a number of useful functions: 1) it can automatically generate index files, data density images, return intensity images and more; 2) it provides a quick assessment of the file footprint (coverage) and point density statistics within the footprint; and 3) it provides an initial QA/QC of vendor-provided data. The catalog utility is most useful for a large number of vendor-delivered LIDAR data files, 9 in our case, but can also be used for single data files. We're exploring it now since it provides an alternate way to create reference images from the data.

Catalog.exe is a Fusion command line program—thus, it can be used in batch mode (as you did previously) or directly at the command line. In addition, it can be used directly at the command line on **large numbers of files**.

- ### Data Preparation

1. Create a text file containing the file paths to the nine **LAS data files**. *(Similar to the example in the side bar).* Suggested Name: **lub_tiles.txt**.
2. Save **lub_tiles.txt** to an intuitive location as you will call the file repeatedly in the following exercises.

- ### Run the Catalog Command

The syntax for the **catalog** command is:

> **Catalog** [switches] DataFile [CatalogFile]

1. Open a DOS command window: (***Click,*** **Start** | **Run...** | type "**cmd**" and ***Click***, **Okay**)
2. Navigate to the Fusion program directory. (**cd c:\Fusion** <Enter>)
3. ***Type*** **"Catalog"** <Enter>) to get the full syntax description.

***Suggestion**: since the syntax is complex, it's reasonable to create a small text batch file (using Notepad or similar) containing the catalog command and parameters. That way, if you have a typo, it is easy to re-create the command. This also allows you to easily change the parameters. Remember to save the file with a .bat extension (also, if you save the batch file in your batch folder, you will need to enter the path to the catalog command (c:\fusion_25\catalog.exe, or ..\catalog.exe)).*

4. Use the catalog utility to create a catalog file (and other files) for the **9 LAS data files (lub_tiles.txt)** Use the following parameters:
    5. Add these Switches (with a single space between each switch):
        - /image
        - /index
        - /coverage
        - /firstdensity:2,1,3
        - /intensity:2,0,255
        - /outlier
    6. And add these parameters (again with single spaces between):
        - <in path>**lub_tiles.txt** (this is the data file)
        - <out path>**lub_cat** (this is the output catalog file)

The syntax should look similar to:

```
> catalog /image /index /coverage /firstdensity:2,1,3 /intensity:2,0,255 /outlier <in path>\lub_tiles.txt <out path>\lub_cat
```

<inpath> and <outpath> will be used from now on to denote the files paths for your data. You will have to copy or type the complete path (c:\lidar\sampledata\...or where ever your data is) into your script, typing in <inpath> will not work!!!!!!!!!

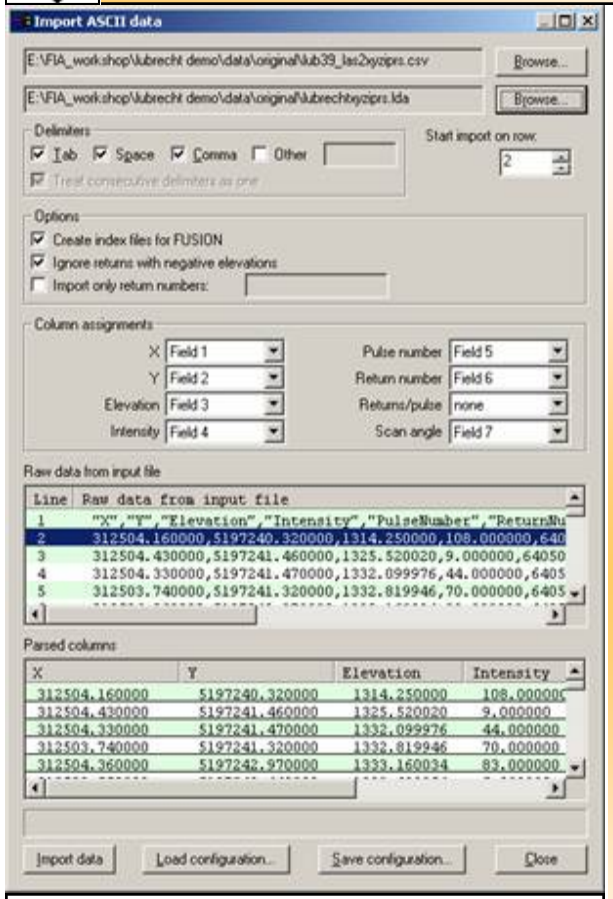
***More DOS command tips:** you can use the up and down arrows to recall previous commands executed in the same command prompt window. This is very useful when you mess up the syntax and only need to change a character or two. You can edit the commands by moving the cursor with left and right arrows and using the insert key to control insert/overstrike modes.*

After you have successfully run the catalog command...

7. Navigate to and open the output **lub_cat.html** file (it will open in a web browser).
8. Note the File Summary Statistics (includes Extent and Elevation Mins and Maxes, ~5.2 Million returns, nominal return density of 1.23 returns/default unit area).
9. Examine the **First Return (Pulse) Density Image** and legend—pay special attention to the red and yellow pixels in the image. These areas have a low number of first returns (pulses). Can you explain the large yellow area in the upper-right quadrant of the image?
10. Finally, inspect the **Intensity Image**—how does it compare with the Intensity image you created earlier in this exercise?
11. **Save** the current project as **Exer06.dvz**.

We stated earlier that the catalog utility provides a means to perform a quick QA/QC of vendor-provided data. What is your assessment of this data?

Exercise 6 Appendix: Importing Generic ASCII .CSV to an LDA format



Note: Although they're not labeled, the upper input box (with associated browse button) is for the input file, and the lower input box is for the output lda file.

Convert the Raw Data

While examining the raw data near the beginning of this exercise, there was an optional step to create a **CSV file** to examine the data more closely. In some cases you may receive data in this format. The following steps outline the process of converting a **CSV file** to an **LDA format and generate an index file (an index file makes working with the data faster):**

1. Open fusion
2. ***Click,*** **Tools… | Data Conversion…**
3. ***Select*** the option that is appropriate for the file format—your CSV file is a generic ASCII file so choose the **Import generic ASCII lidar data…** button. This will display the Import ASCII data dialog as shown in the sidebar graphic. Within the Import ASCII data dialog:
    4. ***Click,*** the upper **Browse…** button to select the **CSV** file you created earlier (note: you will have to change the **Files of type** to **All files** to see the csv file).
    5. ***Click,*** the lower **Browse…** button to specify the output binary LDA file location and name. (Suggested name: **lubrechtxyziprs.lda** (lubrecht experimental forest and xyziprs represents the first letter of the imported fields)).
    6. Start import on row **2**
    7. The default Column assignments are correct through Intensity (Field 4), but you will need to change the last four column assignments:
        8. Select **Field 5** for Pulse Number
        9. Select **Field 6** for Return Number
        10. Select **none** for Returns/pulse (the default)
        11. Select **Field 7** for Scan Angle
    12. Ensure that the **Parsed columns** section appears as expected.
    13. ***Click*** the **Import data** button.

This is the end of Exercise 6 Appendix.