Lab Report

Title: Analysis for .LAS file and .bil file.
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Project Repository: *https://github.com/Samikshya036/GIS5571/tree/main/Lab2*
Time Spent: 15 hrs

Abstract
This lab required me to develop ETLs to download lidar and PRISM data, and then build Python Notebooks that showed the data using Python code. I built a DEM and TIN file from the lidar data. Both Pdf are available on GitHub and examined the various visualization options for lidar data with ArcGIS Pro which supports both 2d and 3d presentations. I converted the PRISM data to Space Time cubes after downloading it to summarize the average monthly precipitation readings for the continental US.

Problem Statement

1. To build an ETL in ArcPro Jupyter Notebooks and arcpy that downloads .LAS files from MN DNR, converts .LAS files into both TIN and Dem file and export pdf of DEM and Tin with correct visualization.
2. To build an ETL in ArcPro Jupyter Notebooks that downloads the annual 30-Year Normals .bil files for precipitation from PRISM, converts data into a spacetime cube and export to disk and export animation to timeseries.

Table 1: Table showing data requirement from MNDNR and PRISM Climate Group

#	Requirement	Defined As	(Spatial) Data	Attribute Data	Dataset	Preparation
1	Elevation data	.LAS files from MN DNR	Point (lidar) data	Point (lidar)	MNDNR	NA
2	Precipitation data	Annual 30-Year Normals .bil files for precipitation from PRISM	Raster	Precipitation value (inches)	Prism Climate Group	NA

Input Data
Las data includes various other features (intensity, classification, return, etc.).St. Paul, Minnesota, is covered by the region that is currently available and may be used to produce a DEM, and TIN model.

The PRISM data set covers the whole continental United States and has a cell raster size of 4km. This statistic describes monthly precipitation over a specified area over a 30-year period. As a result, an analysis should be able to detect seasonal precipitation fluctuations throughout the year.

Table 2: Table showing purpose in analysis for .las file and bil.zip file.

#	Title	Purpose in Analysis	Link to Source
1	4342-12-05.las	To convert .LAS files into both TIN and Dem file and export pdf of DEM and Tin with correct visualization.	MNDNR
2	PRISM_ppt_30yr _normal_4kmM2 _01_bil .zip	To convert data into a spacetime cube and export to disk and export animation to timeseries.	Prism Climate Group

Methods

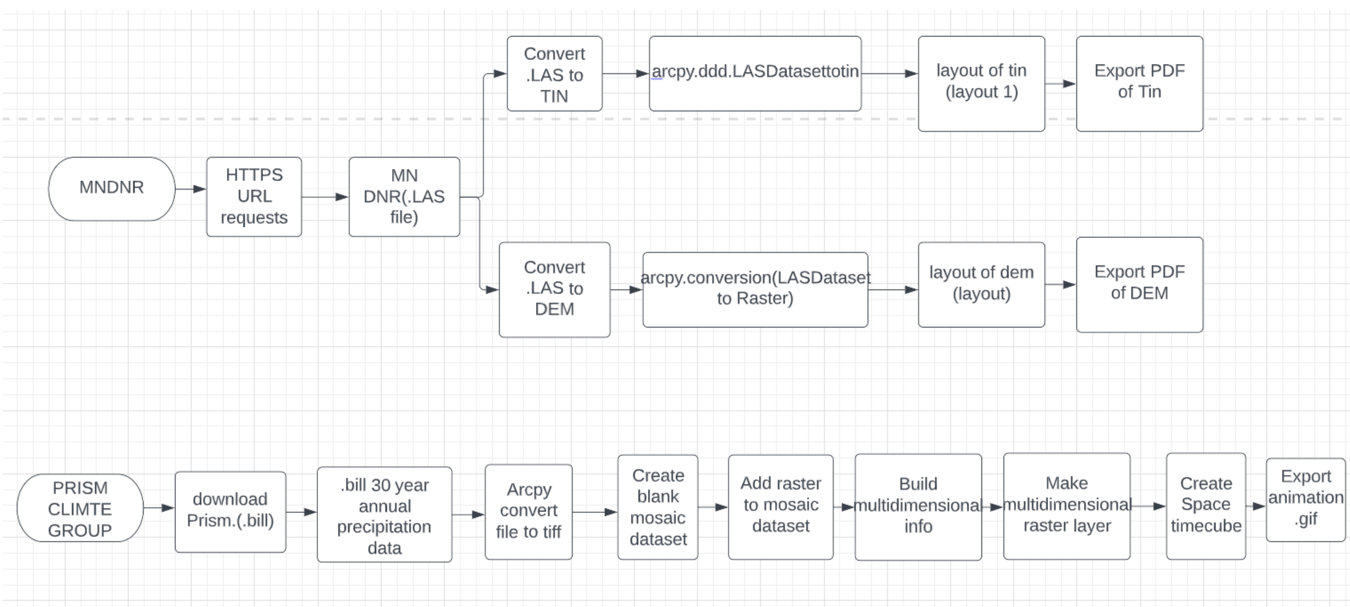

Figure 1. Data flow diagram.

MNDNR . Las file Methods

-
- Download .las file using url from MNDNR in Jupyter notebook
- Convert .LAS into both .tin and DEM
- arcpy.conversion.LasDatasetToRaster
- arcpy.ddd.LasDatasetToTin
- Exports PDFs of the DEM and TIN with correct visualization
- lyt.exportToPDF
-

Converts the .LAS file into both a DEM and a TIN

In [132]:
```
with open(path_to_las,'wb') as f:
    f.write(las_file_obj.content)
```

In [137]:
```
arcpy.conversion.LasDatasetToRaster(r"C:\Users\subed036\Desktop\LAB02\outputlas.las", r"c:\users
```

Out[137]:

Messages

In [163]:
```
arcpy.ddd.LasDatasetToTin(r"C:\Users\subed036\Desktop\arcgislab2\outputlas.las", r"C:\Users\sube
```

Out[163]:

Messages

Run Code

In [90]:
```
print(aprx.filePath)
```

```
C:\Users\subed036\Desktop\LAB02\LAB02.aprx
```

In [1]:
```
aprx = arcpy.mp.ArcGISProject(r"C:\Users\subed036\Desktop\LAB02\LAB02.aprx")
```

In [121]:
```
arcpy.server.GetLayoutTemplatesInfo(r"C:\Users\subed036\Desktop\LAB02\RasterFunctionTemplates")
```

Out[121]:

Messages

In [176]:
```
lyt = aprx.listLayouts('Layout')
```

In [165]:
```
lyt.exportToPDF(r"C:\Users\subed036\Desktop\LAB02\DEM.pdf")
```

Out[165]:
```
'C:\\Users\\subed036\\Desktop\\LAB02\\DEM.pdf'
```

In [171]:
```
lyt = aprx.listLayouts('Layout1')
```

In [172]:
```
lyt.exportToPDF(r'C:\Users\subed036\Desktop\LAB02\Tin1.pdf')
```

Out[172]:
```
'C:\\Users\\subed036\\Desktop\\LAB02\\Tin1.pdf'
```

Figure 2: Figure showing Python codes for .LAS file (MNDNR)

Exploratory 2D and 3D visualization:

- Open the project file to start visualizing the scene. In the Insert tab, select "New Local Scene" by performing a right-click on "New Map." Onto the scene, drag the LAS file
- Open the project file to start creating a map visualization. In the Insert tab, select "New Map." Onto the map, drag the LAS file. To view the visualization, go to the new Appearance Tab and select symbology > elevation.

Prism Climate Group

- Download .bill 30 year annual precipitation data file from Prism climate group using url in Jupyter Notbook
- Convert file to tif (raster to other format)
- Create mosaic dataset (arcpy.management.CreateMosaicDataset)
- Add raster to mosaic dataset (arcpy.management.AddRastersToMosaicDataset)
- Build multidimensional info (arcpy.md.BuildMultidimensionalInfo)
- Make multidimensional layer (arcpy.md.MakeMultidimensionalRasterLayer)
- Create space time cube
- Export animation.gif

Convert to tif

```
In [2]: arcpy.conversion.RasterToOtherFormat(r"C:\Users\subed036\Documents\ArcGIS\Projects\LAB2\bils\PRISM_ppt_30yr_normal_4kmM3_01_b
Out[2]:
Messages

In [37]: arcpy.management.CreateMosaicDataset(r"C:\Users\subed036\Documents\ArcGIS\Projects\LAB2\LAB2.gdb", "mosaic", 'PROJCS["WGS_198
Out[37]:
Messages

In [3]: arcpy.management.AddRastersToMosaicDataset(r"C:\Users\subed036\Documents\ArcGIS\Projects\LAB2\LAB2.gdb\mosaic", "Raster Datas
Out[3]:
Messages

In [4]: arcpy.management.CalculateField(r"C:\Users\subed036\Documents\ArcGIS\Projects\LAB2\LAB2.gdb\mosaic", "Timestamp", "$feature.C
Out[4]:
Messages
```

Build Multidimensional Info

```
In [5]: arcpy.md.BuildMultidimensionalInfo("mosaic", "Variable", "Timestamp # #", "mosaic # #")
Out[5]:
Messages
```

Make Multidimensional Raster layer

```
In [4]: arcpy.md.MakeMultidimensionalRasterLayer(r"C:\Users\subed036\Documents\ArcGIS\Projects\LAB2\LAB2.gdb\mosaic", "mosaic_Multidi
Out[4]: 'C:\\Users\\subed036\\Documents\\ArcGIS\\Projects\\LAB2\\mosaic_MultidimLayer_1.nc'
```

, Figure3: Figure showing Python codes for .bill file (PRISM)

Results

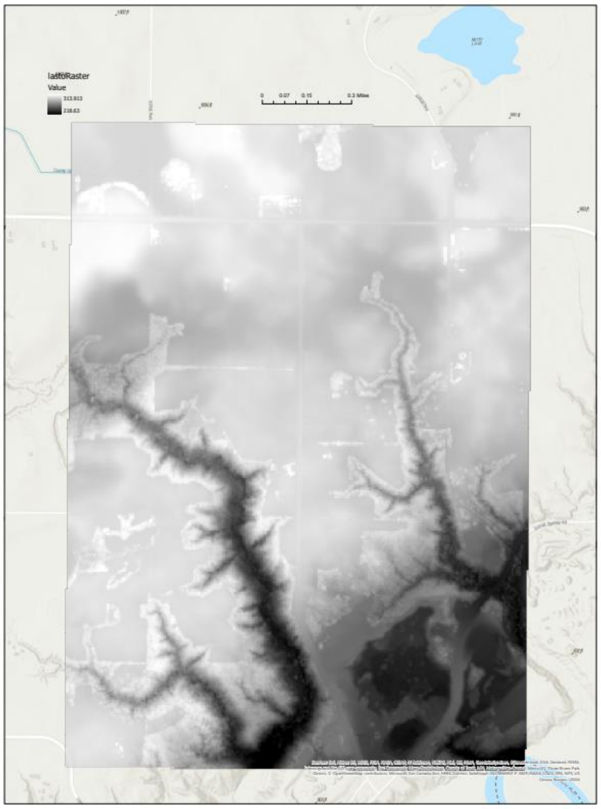

Figure 4: Figure showing Screenshot of exported PDF of DEM

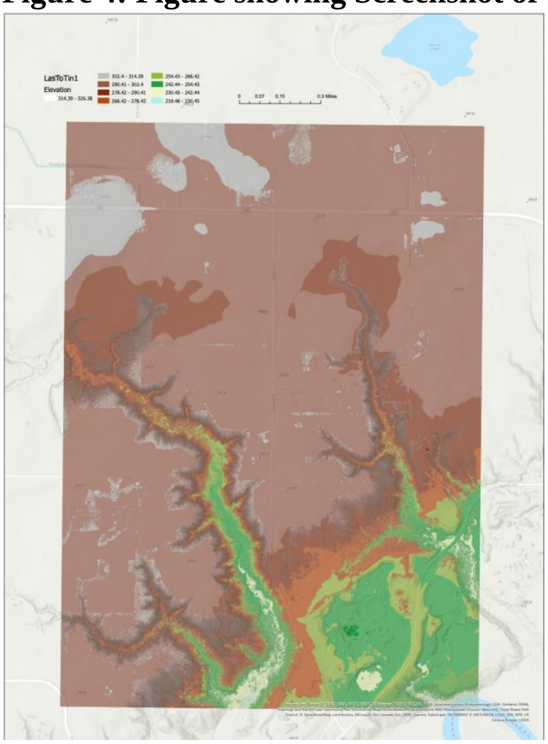

Figure 5: Figure showing exported PDF of TIN.

Exploratory 2D and 3D visualization:
The 3D and 2D representations of the downloaded LAS file are shown in Figure 6. Both visualization options display the LAS data as a gradient of elevation or elevation-related attributes. The Scene version includes the unique ability to move about a 3D version of the landscape, which makes it easier to observe in space than a 2D surface but requires more processing power.

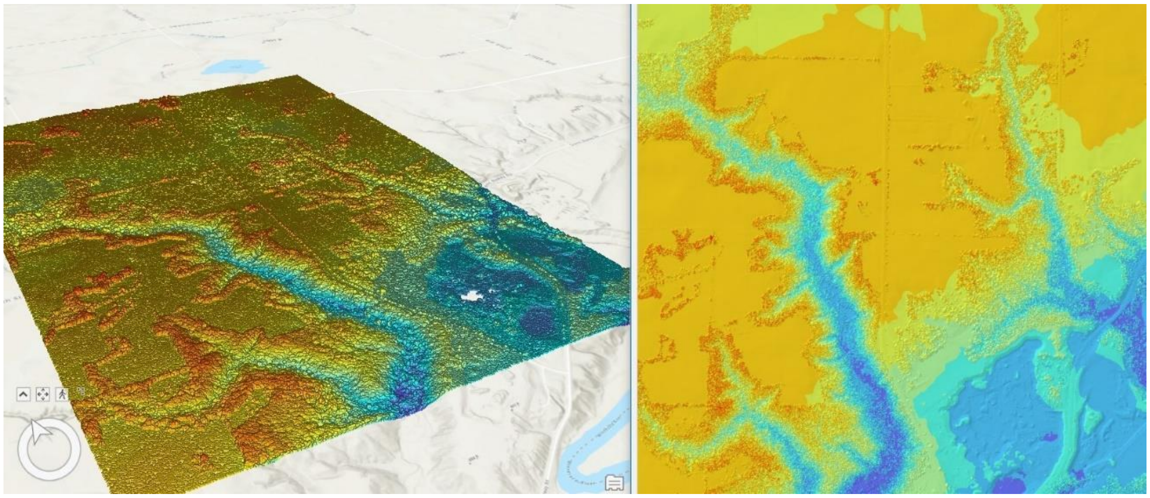

Figure 6: 2D and 3D visualization of LAS data

Time cube results:

Figure 7: Mosaic multidimensional layer.

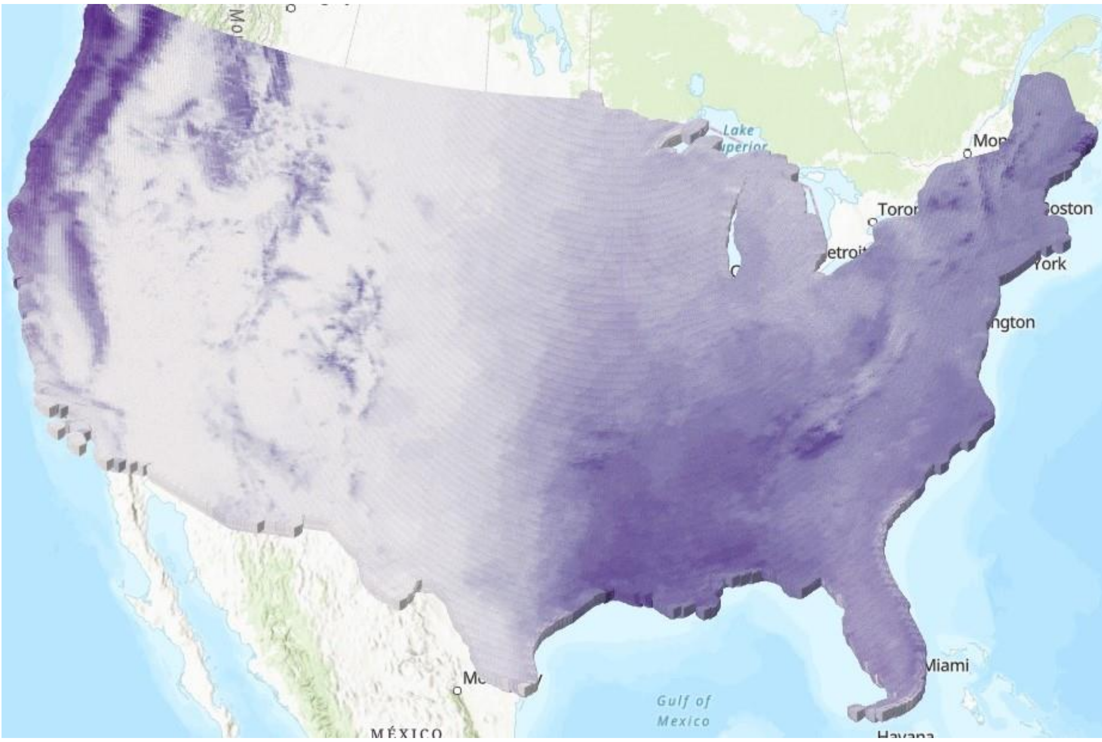

Figure 8: Figure showing time cube results of visualization of 30-year precipitation normal.

Results Verification

For LAS results I verified if the code is retrieving the correct file is to manually download it and compare it to the automatic download. These documents appear to be identical. Run the same tools in the GUI to test the LAS to Raster/Tin conversions. The GUI and code yield the same results when the parameters are the same.\

For 2D/ 3D LAS I verified it if visualizations match with the TIN version from the LAS, and each other.

For Space timecube, By visually inspecting the raster files within the ArcPro interface, I was able to validate the monthly raster pictures produced. This confirmation validated my output. The Space Time cube was more difficult to verify because I couldn't quickly evaluate the result visually.

Discussion and Conclusion

I learnt about rasters in this lab. I learnt to convert them in different files I also learned about space time cube but visualization was little tough for me. I learnt to download .LAS files from MN DNR, convert .LAS files into both TIN and Dem file and export pdf of DEM and Tin with correct visualization and to build an ETL in ArcPro Jupyter Notebooks that downloads the annual 30-Year Normals .bil files for precipitation from PRISM, converts data into a spacetime cube.

References

https://pro.arcgis.com/en/pro-app/latest/arcpy/mapping/introduction-to-arcpy-mp.htm

https://pro.arcgis.com/en/pro-app/latest/tool-reference/space-time-pattern-mining/createcubefrommdrasterlayer.htm

Self-score

Category	**Description**	**Points Possible**	**Score**
Structural Elements	All elements of a lab report are included **(2 points each)**: Title, Notice: Dr. Bryan Runck, Author, Project Repository, Date, Abstract, Problem Statement, Input Data w/ tables, Methods w/ Data, Flow Diagrams, Results, Results Verification, Discussion and Conclusion, References in common format, Self-score	28	**28**
Clarity of Content	Each element above is executed at a professional level so that someone can understand the goal, data, methods, results, and their validity and implications in a 5 minute reading at a cursory-level, and in a 30 minute meeting at a deep level **(12 points)**. There is a clear connection from data to results to discussion and conclusion **(12 points)**.	24	**24**
Reproducibility	Results are completely reproducible by someone with basic GIS training. There is no ambiguity in data flow or rationale for data operations. Every step is documented and justified.	28	**24**
Verification	Results are correct in that they have been verified in comparison to some standard. The standard is clearly stated **(10 points)**, the method of comparison is clearly stated **(5 points)**, and the result of verification is clearly stated **(5 points)**.	20	**20**
		100	**96**