Lab 2 Part One

Title: ETL of LIDAR Data Visualization and Spacetime Cube Animation
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Project Repository: https://github.com/ardumn/GIS5571/tree/main/Lab2
Google Drive Link: https://drive.google.com/drive/folders/1XVw91c_9BcQHZ44FHaGDDLJkGu-QY3sB
Time Spent: 24 hours

Abstract

LIDAR data can be visualized in a multitude of ways in many platforms/software that makes it well-purposed in spatiotemporal analysis and geovisualization. From two dimensionality to three dimensionality, geo analyst to remoting sensing scientists both use software such as ArcGIS Pro to analyze and visualize raster data. Exemplified for the LAS dataset (a LIDAR point cloud raster dataset) from MN GeoSpatial Commons and .BIL files from PRISM Climate Group, raster datasets are extensible in their types. Likewise, being able to be interchangeable to various other formats such as TINs, PDFs, DEMs, Space Time Cubes and vectors in some instances for further extendibility. Applying geovisualization techniques in displaying LAS, DEM, TINs, and animation are simplistic with programming, as integrating Python commands and specifying parameter expression for time series depend on layering. Affecting the layering weights and scaling of your three-dimensional impacts the quality, thus how realistic and applicable it can be for analysts in meeting criteria. Aforementioned, using many other expressions of code within a program to extract data and getting the raster formats acquired for purposes of analysis or visualizing. These help in assessing overall city infrastructure, environmental assessments, geological surveys and climatic indices depending on the data assesses and gathered.

Problem Statement

Raster data can be exemplary in many aspects when performing geovisualization and spatiotemporal analysis in GIS. Some of the disparities that occur are when to use either a two- or three-dimensional perspective in your analysis and what the assumptions/assessments are. Thanks to the innovations made to display data in these formats and in ArcScene, many statistical or geospatial analysis can be performed and can stem from social to the natural sciences. Such as Kriging and regression of geological implications or qualitative analysis of certain populations and shown in either two or three dimensionality

#	Requirement	Defined As	(Spatial) Data	Attribute Data	Dataset	Preparation
1	LAS Sample Dataset 4342-12-05.las	Point Cloud File of sample area of Minnesota	Raster/Point Cloud	Pixel/Points	Mn GeoSpatial Commons	None, except ETL into ArcGIS Pro and then operations in ArcGIS Pro.
2	PRISM Precipitation .BIL Files	The normals are baseline datasets describing	Raster	Pixel	All Normals 30 Year	None, except ETL into ArcGIS Pro and

		average monthly and annual conditions over the most recent three full decades			Annual .BIL Files	then operations in ArcGIS Pro.

Table 1. Unique raster datasets ranging from point cloud to binary interleaved by line filed and ETL creation construction.

Input Data

The two datasets in this lab are both used to establish an ETL, each are raster based, but have a different format and predicates. The LAS data sample is extracted from the Minnesota GeoSpatial Commons, in which it is founded from a file structure system. The LAS data is a LIDAR Point cloud which contains a multitude of points from multiple return layers interwoven together from light gathered sensor over a swath of land. The location is a river area southwest of the Twin Cities Metro, the data is used to juxtapose and analyze two- and three-dimensional geovisualizations in tandem. Both provide efficient exploratory analysis for decomposing spatial analysis in a project and have different ways to explore data options. (Including DEM/TIN conversions and to PDF)

All Normals 30 Year Annual .BIL files from the PRISM Climate group is a band interleaved by line format that is gathered by satellites and stores the actual pixels by the band for every line. Compared to pixels in bands and no lines, the data was implemented into the creation of Space Time Cube, that has properties of two and three dimensions intertwined together. Using multiple years in tandem and prior creating a raster dataset, assigning timestamps and making the .BILs multidimensional to layer the Space Time Cube, BILs add the facet in making the data multidimensional but nctCDF, cloud rasters and etc. are the former.

#	Title	Purpose in Analysis	Link to Source
1	LAS Sample Dataset 4342-12-05.las	Create an ETL and Side by Side 2D/3D Geovisualization to juxtapose an exploratory analysis.	Mn GeoSpatial Commons
2	PRISM Precipitation .BIL Files	Create an ETL to establish a Spacetime Cube and export an animation (GIF).	PRISM Climate Group

Table 2. Exploratory analysis of 2D/3D tools with LIDAR data and outputting graphically interchange format from Spacetime Cube.

Methods

As depicted in Figure 1 of the pseudo code denotes the commands performed write the files to C:/ disk in order to have the last prompt in order to recognize and visualize them in PDF format. Prior code used was simply utilized the pre-defined tools from ArcGIS Pro such as LAS to DEM and LAS to TIN and inserting the Python Command into the notebook. Including extracting the data from the MN GeoSpatial Commons website using modules such as zipfile, io and requests.

Figure 2 of the data flow charts depicts the enumeration of each step that is done with .BIL file from the PRISM Climate Group website. Unlike the extraction of MN GeoSpatial Commons, the data no accessible copy link or zip folder structure and the web inspector tool in the browser had to be utilized. Using base parameters and the payload of the get request for the .BILs data, extraction of all normal 30 year annual data was acquired, then each step-by-step procedure was used from Figure 2 to create the Space Time Cube.

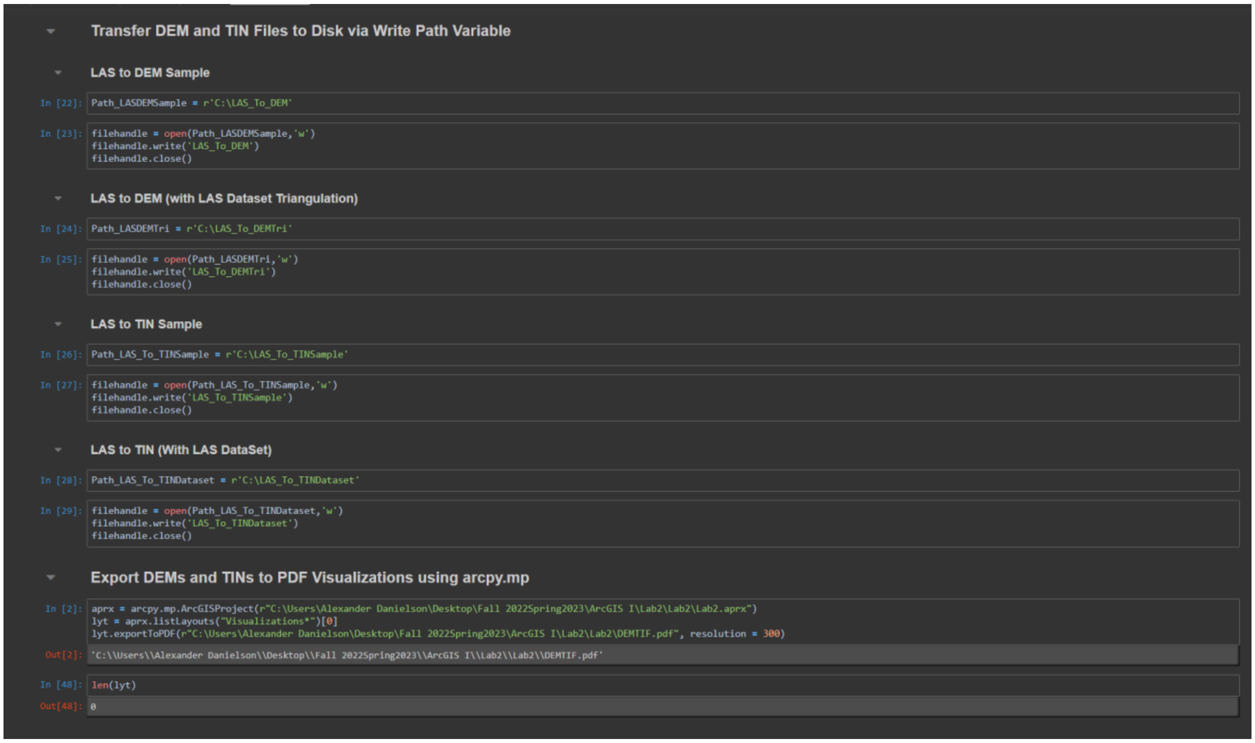


Figure 1. Commands in ArcGIS Pro Juypter NoteBooks for DEM/TIN conversion and PDF Visualization.

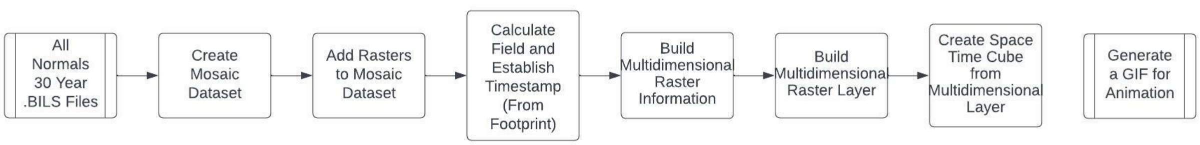
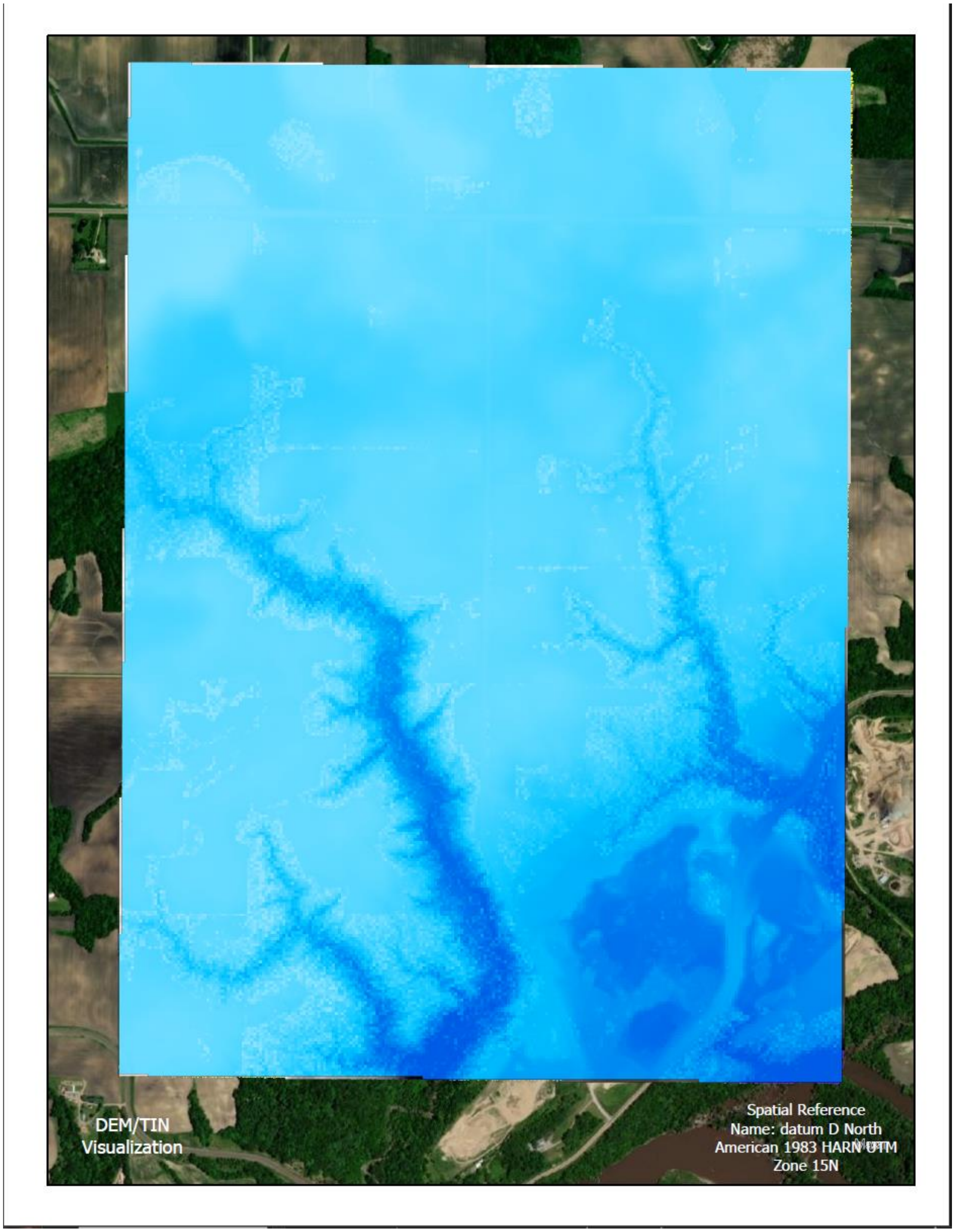


Figure 2. Enumeration of Space Time Cube Creation Operations.

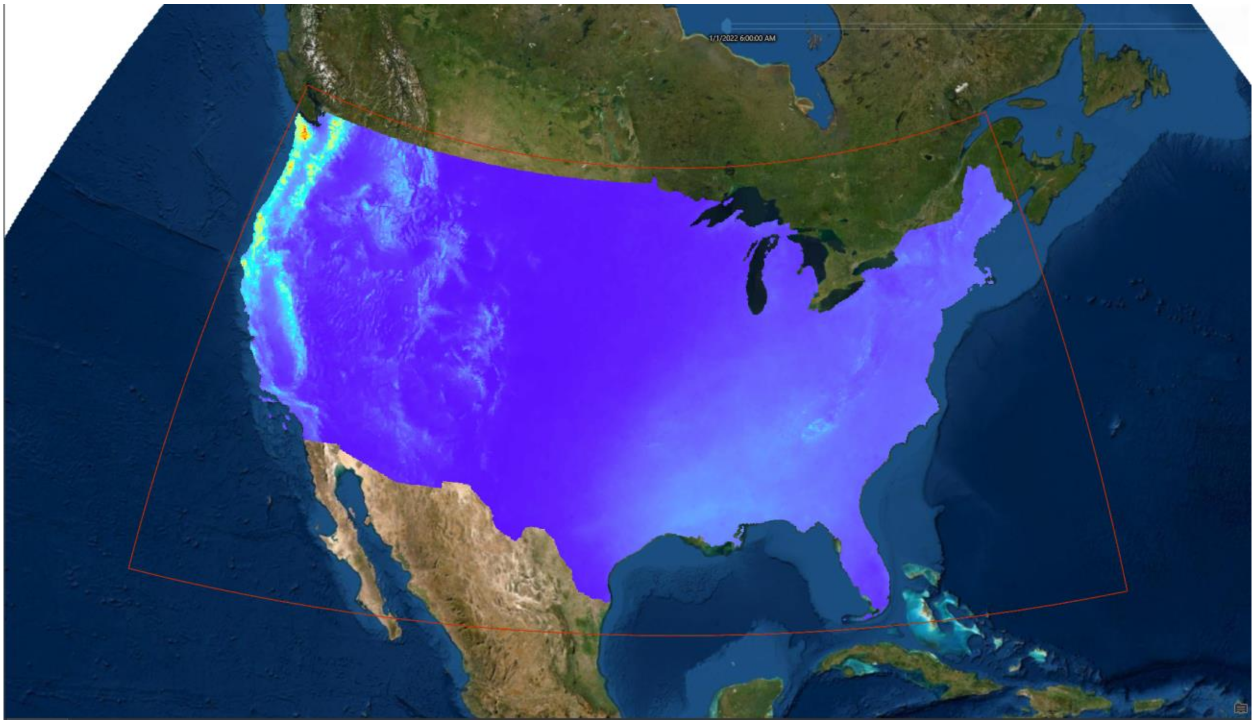
Results

Based on the last three lines of code in the cell in Figure 1, the out generated for Map 1 yields a DEM or TIN Layout that is similarly generated by exporting the layout manually in the ArcGIS Pro GUI. The user still has to make preferences based on layout type, legend, typography, nearline, and other cartographic elements, but this is a convenient coding alternative for curtailing GUI interactions. The amount of code used from the ESRI source is also fundamental as it uses only three lines of code respectively for the specific aprx file project and layouts you want to automate and export layouts for seamlessly.

The Space Time Cube (cannot animate in PDF) is able to animate because of the multidimensionality from the time annotation that it was placed from the calculate field variables in the fourth step. When the layers became multidimensional and interwoven in space for the graphics interchange format (GIF), they're graphically transitioned to each month based on the date/month assigned in each raster. This is also in part of the functionality of the spatial-temporal relationship and transformation of the .BILs files into the multidimensional layer to be cubed in time.



Map 1. General basic reference map of output DEM/TIN Geovisualization from LAS Data Sample.



Map 2. Multidimensional Animated Precipitation Timeseries.

Results Verification

The procedural steps undertaken for extracting the LAS dataset and PRISM Annual .BIL files are just one way that programmatically in constructing an ETL for acquiring the data. There are a plethora of other modules and expressions in extract the data such as urllib and shutil in requesting data from HTTP and transferring files from destination to source. Overall, the results of the conversions for LAS to DEM/TIN and creation of the Space Time Cube are qualitatively correct with the precipitation data used over the time span of 2021 being animated.

Discussion and Conclusion

The DEM/TIN geovisulzations are just one of many facets to explore data interdimensionaly. Given that Space Time Cubes adds more breadth to the spatial temporal rift in that layering data over a period of time in 2.5 dimensionality and a multiple of variables. The versatility and veracity of data that can be used to approximate indices such as climate, precipitation, temperature or hurricanes is flexible and twofold. Likewise, investigating infrastructure and properties assessments of transportation, buildings, sewers and other ancillary data structures.

References

Buie, L. (2020, February 12). Explore your raster data with Space Time Pattern Mining. ArcGIS Blog; Esri. https://www.esri.com/arcgis-blog/products/arcgis-pro/analytics/explore-your-raster-data-with-space-time-pattern-mining/

Introduction to arcpy.mp. (n.d.). Arcgis.com. Retrieved October 30, 2022, from https://pro.arcgis.com/en/pro-app/latest/arcpy/mapping/introduction-to-arcpy-mp.htm

Self-score

Fill out this rubric for yourself and include it in your lab report. The same rubric will be used to generate a grade in proportion to the points assigned in the syllabus to the assignment.

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	**23**
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	**27**
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	**19**
		100	**97**