Lab Report

Title: Lab 2
Notice: Dr. Bryan Runck
Author: Lucy Sageser
Date: 11/9/2023

Project Repository: *https://github.com/lsageser1/GIS5571/tree/main/lab02*
Google Drive Link:
Time Spent: *40 hours*

Abstract

The focus of this lab was to apply the API calling skills learned in Lab 1 and use them to extract, transform, and perform operations upon raster datasets. Part 1.1 first focused on calling .las data from the MNDNR, convert it into DEM and TIN data, and saves and exports them as pdfs. Part 1.2 involves comparing the way .las data is viewed in 3d vs 2d, and part 1.3 involves using skills from part 1.1 to view data with a temporal element. Part 2 takes all the skills learned in part 1.1 and expands them to finding practical applications for dem and other raster datasets to perform a simple cost-surface analysis.

Problem Statement

Part 1.1: The objective is to build an ETL pipeline that programmatically retrieves an example .las dataset from the source webpage, converts it into two different raster formats, and saves displays of them as pdfs.

Part 1.2: The objective is to visualize the .las dataset retrieved in part 1 in both two and three-dimensional formats, and compare the visualization for both using ArcPro tools.

Part 1.3: The objective is to build an ETL pipeline that programmatically retrieves 30-year precipitation data, converts that data into a spacetime cube, and exports an animation of the time series.

Part 2: The objective is to determine the most optimal path for Dory to walk from her home to a state park based on a certain criteria. In order to do this, an ETL pipeline must be constructed that programmatically retrieves land-use data and elevation data of the general area she is walking in, and create and compare different weighted cost-surface analysis paths using that data to identify her optimal path.

Table 1. Data

#	Requirement	Defined As	(Spatial) Data	Attribute Data	Dataset	Preparation
1	.las to DEM/TIN conversions	LiDAR point cloud data was converted into elevation and TIN raster datasets	LiDAR-derived elevation.	Elevation cell values	https://resources.gisdata.mn.gov/pub/data/elevation/lidar	Data was called using requests.get method. In some cases data needed to be extracted from .laz format. Datasets were converted into other raster formats and in some cases needed to be merged together.
2	Spacetime cube animation	A visualization and animation of continental US precipitation averages over the course of 30 years, showing how that has changed over time.	.bil data of 30-year precipitation averages across continental US	Cells tracked average inches of rainfall over 30yrs	https://prism.oregonstate.edu/normals/	Called using requests.get method. .bil data was converted into a spacetime cube and animated as a time series.
3	Cost-Surface analysis	A start-point and end-point for the character ‘Dory’ was defined, with the goal of identifying the best path for her to walk in terms of most gradual slope and avoiding farmlands and open water.	Land-use data and LiDAR-derived elevation data	Different classifications of land use and elevation cell values	https://resources.gisdata.mn.gov/pub/data/elevation/lidar	land-use data was called from MN DNR and clipped to the relevant extent and converted to raster data. .laz files of the relevant extent were called, programmatically

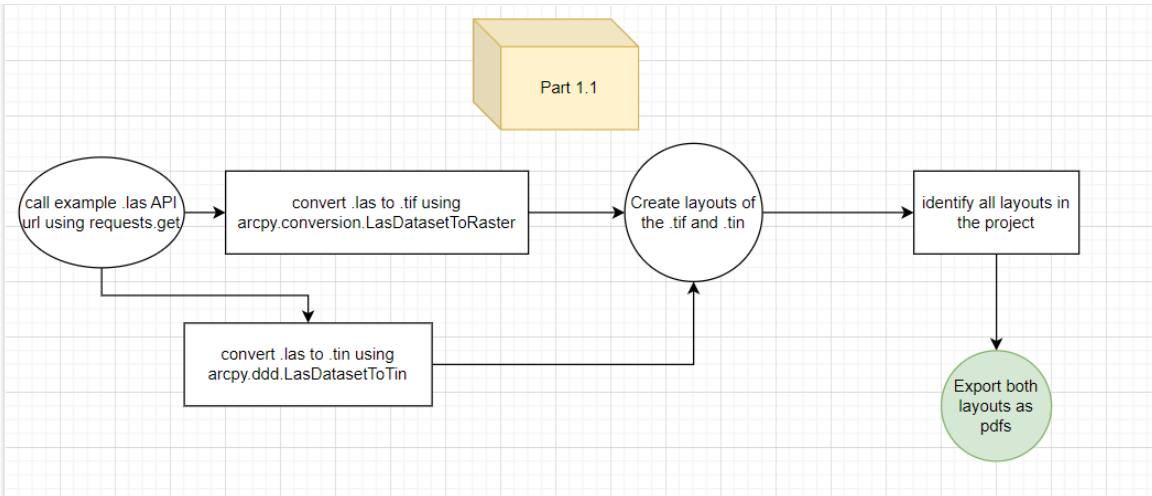
						downloaded, unpacked into .las format, and converted to dem. Point features were created for start and end points, dems were used to calculate slope, and slopes and land-use rasters were weighted to determine best paths.

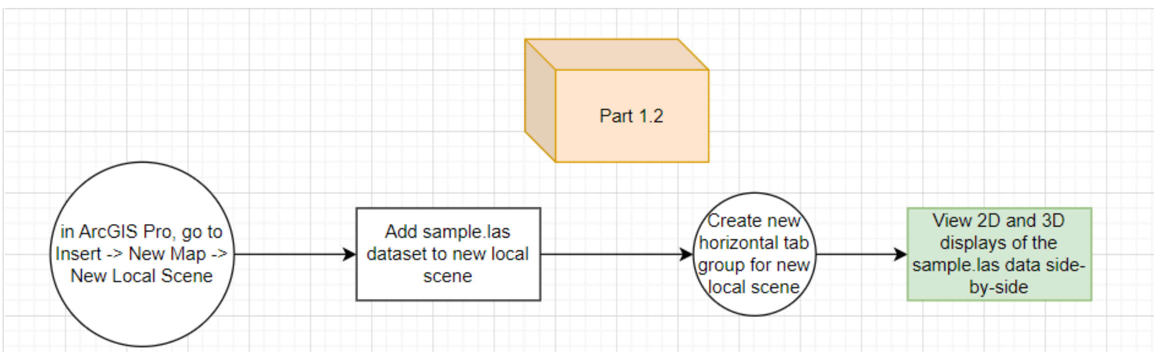
Input Data

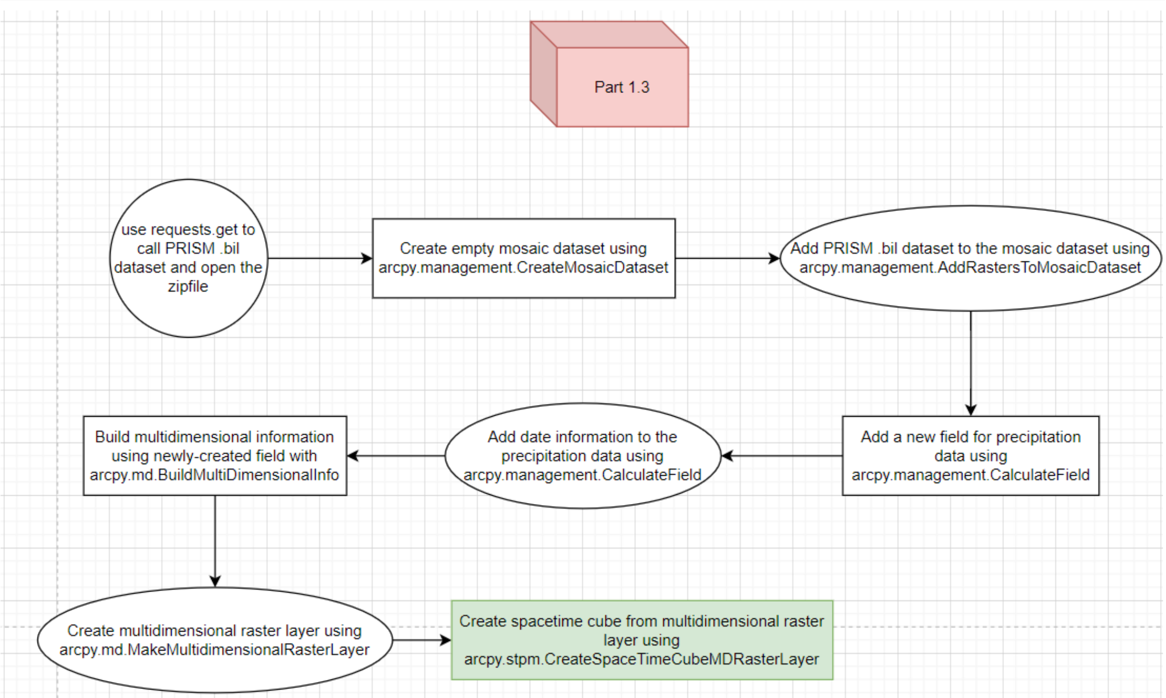
Table 2. All data sources

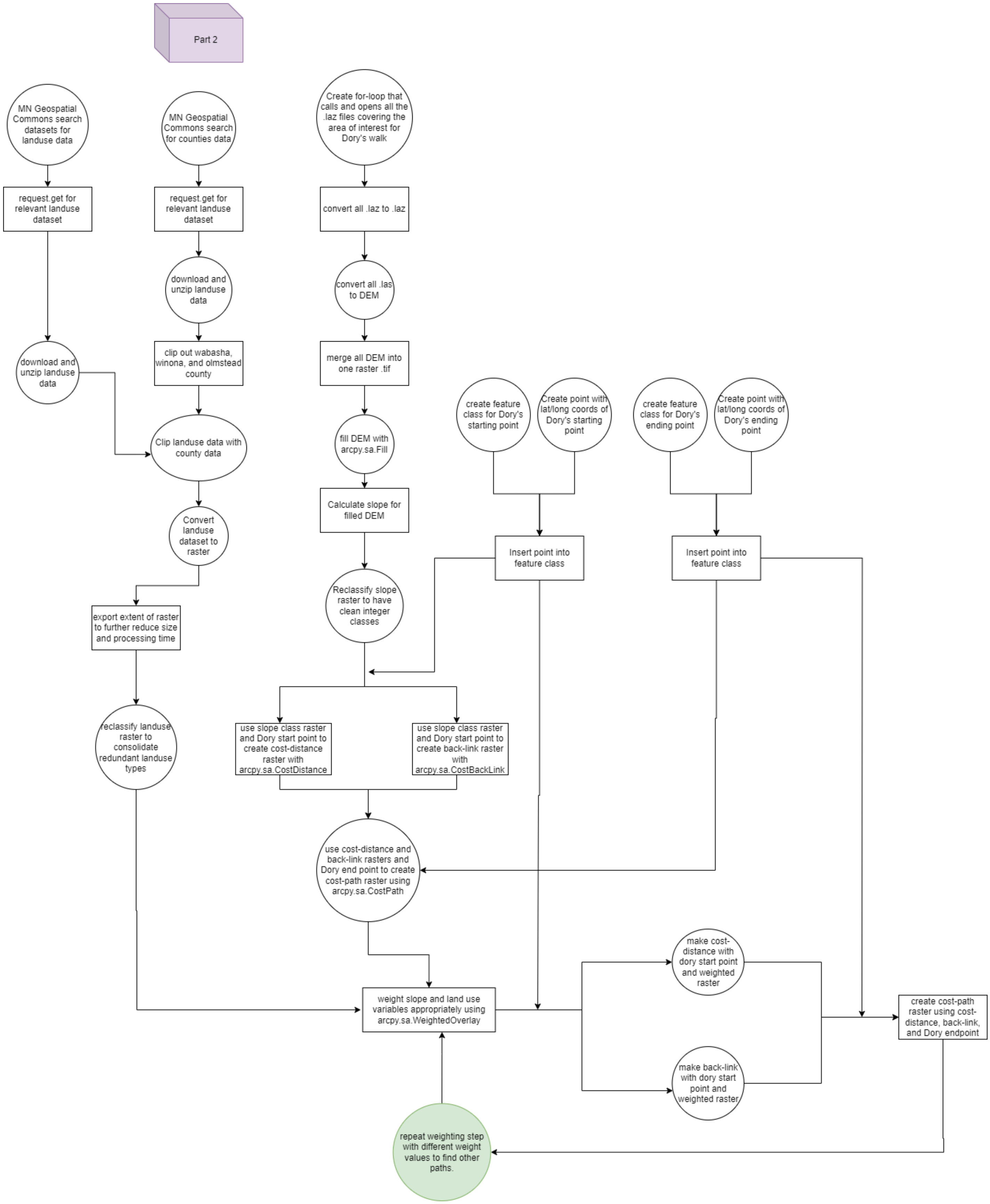
#	Title	Purpose in Analysis	Link to Source
1	MN DNR sample .las	Initial example .las dataset used to convert into DEM and TIN and compare 2d and 3d display.	https://resources.gisdata.mn.gov/pub/data/elevation/lidar/examples/lidar_sample/las/4342-16-03.las
2	PRISM 30-year averages .bil	Used to create and animate temporal space-time cube to show changes in rainfall averages in the continental US over 30 years.	https://prism.oregonstate.edu/normals/
3	MN DNR .laz files for LiDAR point cloud elevation areas of minnesota counties	Used to calculate slope of the area of interest for Dory's walk in part 2.	https://resources.gisdata.mn.gov/pub/data/elevation/lidar/county/
4	Minnesota Land Use	Used to determine the types of land use in the area of interest for Dory's walk in part 2.	https://gisdata.mn.gov/dataset?q=Land+Use%2FCover%2C+Agricultural+and+Transition+Areas%2C+Minnesota%2C+1990
5	Minnesota Counties	Used to narrow down land-use data to speed up processing times	https://gisdata.mn.gov/dataset/bdry-counties-in-minnesota

Methods


Part 1.1
call example .las API url using requests.get
convert .las to .tif using arcpy.conversion.LasDatasetToRaster
Create layouts of the .tif and .tin
identify all layouts in the project
convert .las to .tin using arcpy.ddd.LasDatasetToTin
Export both layouts as pdfs


Part 1.2
in ArcGIS Pro, go to Insert -> New Map -> New Local Scene
Add sample.las dataset to new local scene
Create new horizontal tab group for new local scene
View 2D and 3D displays of the sample.las data side-by-side

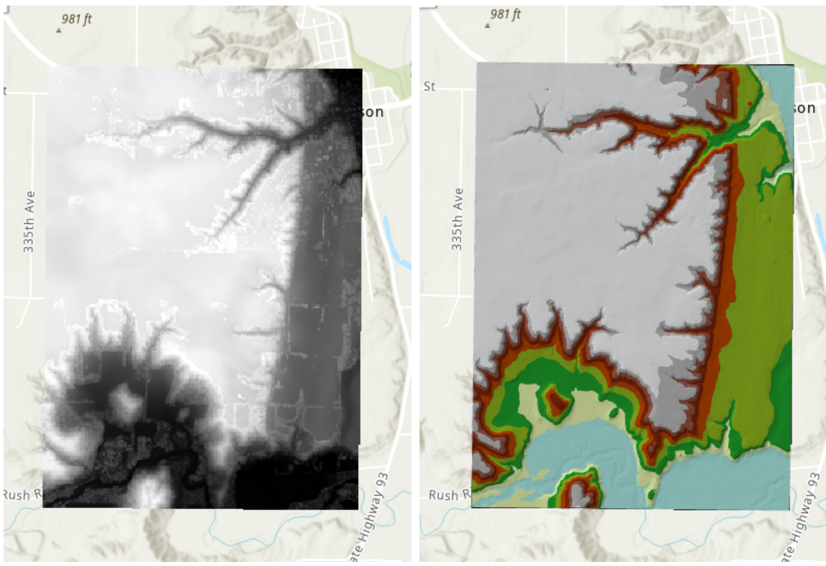

Part 1.3
use requests.get to call PRISM .bil dataset and open the zipfile
Create empty mosaic dataset using arcpy.management.CreateMosaicDataset
Add PRISM .bil dataset to the mosaic dataset using arcpy.management.AddRastersToMosaicDataset
Add a new field for precipitation data using arcpy.management.CalculateField
Add date information to the precipitation data using arcpy.management.CalculateField
Build multidimensional information using newly-created field with arcpy.md.BuildMultiDimensionalInfo
Create multidimensional raster layer using arcpy.md.MakeMultidimensionalRasterLayer
Create spacetime cube from multidimensional raster layer using arcpy.stpm.CreateSpaceTimeCubeMDRasterLayer


Part 2
MN Geospatial Commons search datasets for landuse data
request.get for relevant landuse dataset
download and unzip landuse data
MN Geospatial Commons search for counties data
request.get for relevant landuse dataset
download and unzip landuse data
clip out wabasha, winona, and olmstead county
Clip landuse data with county data
Convert landuse dataset to raster
export extent of raster to further reduce size and processing time
reclassify landuse raster to consolidate redundant landuse types
Create for-loop that calls and opens all the .laz files covering the area of interest for Dory's walk
convert all .laz to .laz
convert all .las to DEM
merge all DEM into one raster .tif
fill DEM with arcpy.sa.Fill
Calculate slope for filled DEM
Reclassify slope raster to have clean integer classes
create feature class for Dory's starting point
Create point with lat/long coords of Dory's starting point
Insert point into feature class
create feature class for Dory's ending point
Create point with lat/long coords of Dory's ending point
Insert point into feature class
use slope class raster and Dory start point to create cost-distance raster with arcpy.sa.CostDistance
use slope class raster and Dory start point to create back-link raster with arcpy.sa.CostBackLink
use cost-distance and back-link rasters and Dory end point to create cost-path raster using arcpy.sa.CostPath
weight slope and land use variables appropriately using arcpy.sa.WeightedOverlay
make cost-distance with dory start point and weighted raster
make back-link with dory start point and weighted raster
create cost-path raster using cost-distance, back-link, and Dory endpoint
repeat weighting step with different weight values to find other paths.

Results

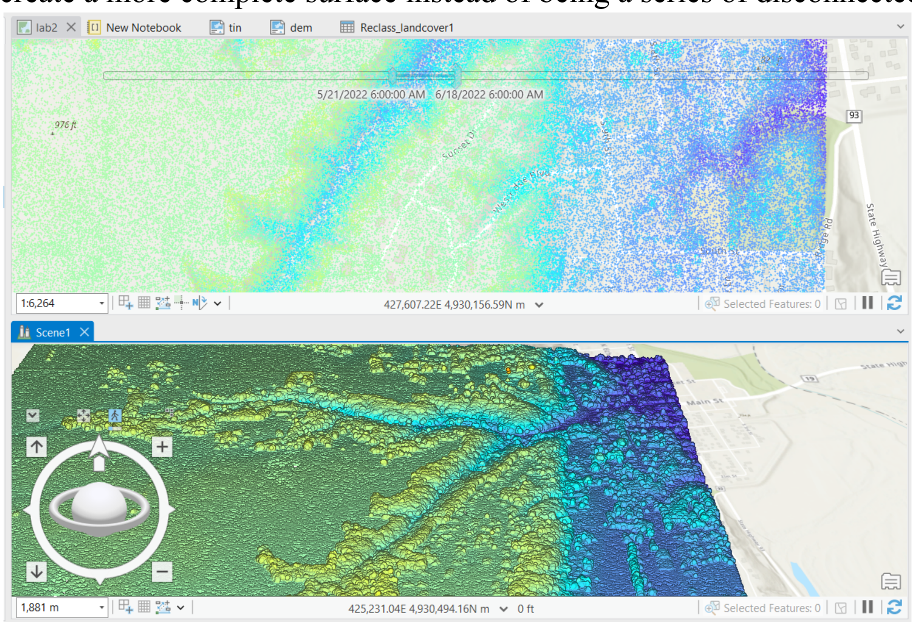
Part 1.1

DEM and .tin successfully created.



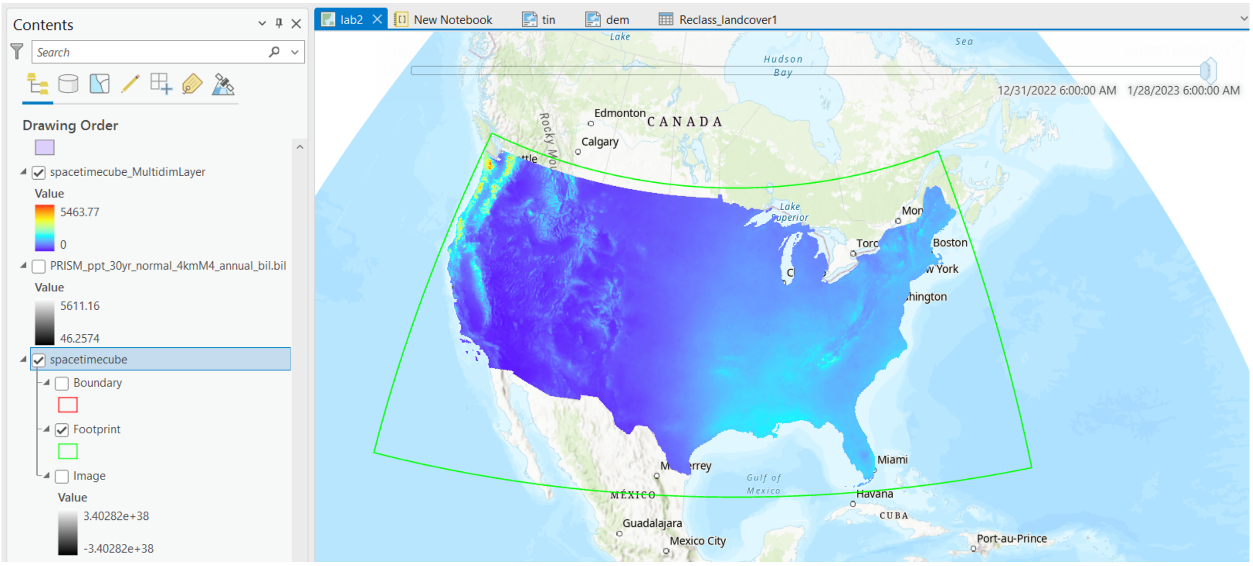
Part 1.2

ArcGIS Pro allows you to create 3D ‘Scenes’ to explore point-cloud .las data, which differs from the 2D display in the map view in that you can pan around in three dimensions and explore the elevation as a shape instead of a shaded relief. The points have a sort of ‘fill’ between them to create a more complete surface instead of being a series of disconnected points.



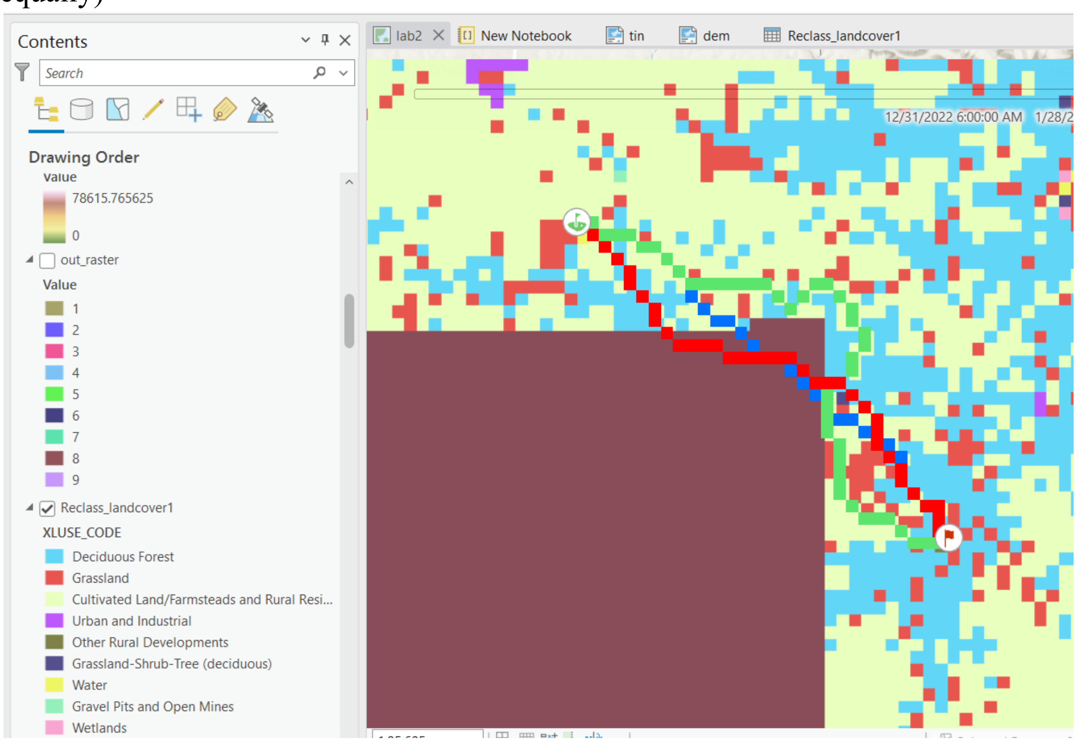
Part 1.3

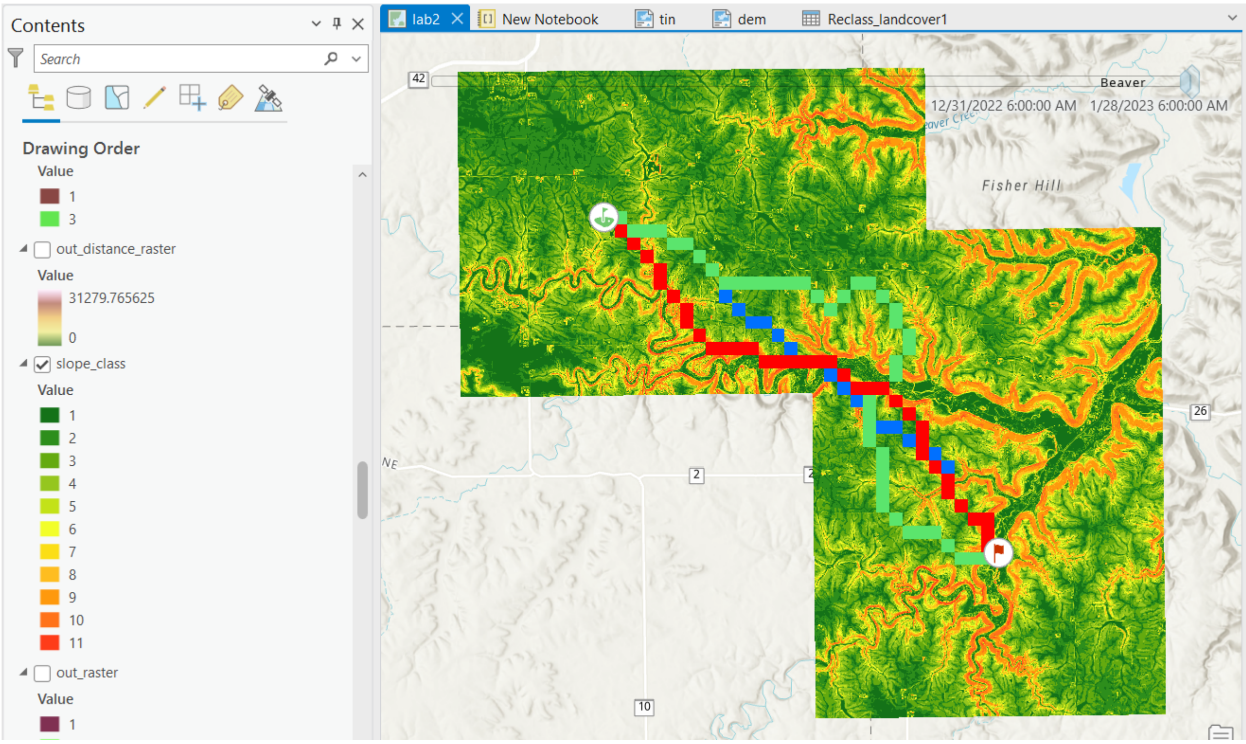
Spacetime cube with animation time series successfully created.



Part 2

3 routes overtop of landuse raster
(red line weighs land use more heavily, green weighs slope more heavily, blue weighs them equally)





Results Verification

For Part 1.1 I know the results are correct because the data all matches visually with one another and with the MN DNR maps and because I am able to successfully find pdfs of the dem and .tin in my output folder.

For Part 1.2 I know the results are correct because the data matches visually in the 2D and 3D displays.

For Part 1.3 I know the results are correct because the animation time lapse plays through and changes visually in a way that is reflected in the attribute tables.

For Part 2 I know the results are correct because my route which weighs slope most heavily snakes strongly along the areas of low slope despite that more-often taking it through more discouraged land-use types like farmland, while the route weighing land use more heavily avoids these areas strongly and sticks closer to the river where land-use is more favorable and similar, despite this resulting in a more sloping path due to the river banks. My compromise route strikes a more average, direct path that lies between the other two routes. Visually, I can conclude that my routes are prioritizing the factors I intended them to.

Discussion and Conclusion

Ultimately, by completing this assignment I feel much more confident about my ability to call raster datasets from different raster sources and then perform operations on them programmatically. Being able to practice using arcpro tools in an arcpy environment has deepened my understanding and ability to apply arcpy documentation to perform practical functions. This lab has built upon the skills from lab 0 and lab 1 and helped me see what it looks like to directly apply map algebra concepts from the lectures in the form of code and examples.

References

"County Boundaries, Minnesota - Minnesota Geospatial Commons." *Mn.gov*, 2021, gisdata.mn.gov/dataset/bdry-counties-in-minnesota.

Explore RS & GIS Tutorials, Channel Name. "Multi Criteria Based Least Cost Path Analysis." *Www.youtube.com*, 25 June 2021, www.youtube.com/watch?v=I3h0nJWFlro. Accessed 10 Nov. 2023.

"Index of /Pub/Data/Elevation/Lidar/County." *Resources.gisdata.mn.gov*, resources.gisdata.mn.gov/pub/data/elevation/lidar/county/. Accessed 10 Nov. 2023.

"Index of /Pub/Data/Elevation/Lidar/Examples/Lidar_sample/Las." *Resources.gisdata.mn.gov*, resources.gisdata.mn.gov/pub/data/elevation/lidar/examples/lidar_sample/las. Accessed 10 Nov. 2023.

Jones, Blake, et al. *Practical Help Completing Lab 2*. The three individuals interviewed were contacted multiple times each to lend expertise and aide in completing this lab.

"PRISM Climate Group, Oregon State U." *Prism.oregonstate.edu*, prism.oregonstate.edu/normals/.

"Resources - Minnesota Geospatial Commons." *Mn.gov*, 2018, gisdata.mn.gov/dataset?q=Land+Use%2FCover%2C+Agricultural+and+Transition+Areas%2C+Minnesota%2C+1990. Accessed 10 Nov. 2023.

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	**28**
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	**100**