Lab Report

Title: Lab3 Part 1 (updated for Lab2)
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Project Repository: Link
Time Spent: 8

Abstract

This lab is a continuation of Lab2. This time, we will assist Dory in finding three paths based on various weights.

In Lab2, our task was to build an ETL process to compute a cost surface model with the aim of finding the optimal route for Dory. We needed to consider Dory's preferences and calculate the appropriate weights for the analysis. The data was sourced from Minnesota Geospatial Commons. The instructions provided outline three key aspects that must be considered:

1. Avoidance of farm fields.
2. Avoiding walking through water bodies in the absence of a bridge.
3. Preference for walking on gradual slopes.

To achieve this, we need to identify and acquire relevant datasets such as information on streams, land cover, elevation, and more. Subsequently, we'll need to prepare the downloaded data, which may include tasks like reclassification, clipping, and format conversion. These data preparations are essential for the subsequent analysis.

Once the data is ready, we'll assign appropriate weight values to facilitate the calculation of the cost surface model. This model will help us determine the most suitable route that aligns with Dory's preferences.

Problem Statement

To find the optimal route for Dory from her house (Start) to the North Picnic area (End), we need to create a cost surface model that considers Dory's preferences, which include: (1) avoid farm fields (2) if there is no bridge, not crossing the water body (3) find the most gradual slope path.

Table 1. Required Data

#	Requirement	Defined As	(Spatial) Data	Attribute Data	Dataset	Preparation
1	Minnesota Digital Elevation Model - 30 Meter Resolution	DEM of Minnesota	TIFF	Elevation	Mn GeoSpatial Commons	
2	NLCD 2019 Land Cover, Minnesota	Land cover in Minnesota	TIFF	Land type	Mn GeoSpatial Commons	
3	MnDOT Route Centerlines	the centerlines of all public and some private roads within the state of Minnesota	.shp	Geometry	Mn GeoSpatial Commons	
4	Bridge locations in Minnesota	Point data displayed dataset of in-service bridge locations throughout Minnesota	.shp	Geometry	Mn GeoSpatial Commons	
5	County Boundaries in Minnesota	County Boundaries in Minnesota	.shp	Geometry	Mn GeoSpatial Commons	
6	2012 Assessed Streams	The streams of 2012	.shp	Geometry	Mn GeoSpatial Commons	
7	Start and End points	Coordinates	.shp	Geometry	Provided by instruction	

Input Data

Request the data from Minnesota Geospatial Commons, the datasets listed in Table 2 (data 1 to 6). Afterward, create the start point as instructed in Lab 2. For the endpoint, since only the area is provided, I've generated the endpoint based on the approximately coordinates.

Table 2. Input data

#	Title	Purpose in Analysis	Link to Source
1	Minnesota Digital Elevation Model - 30 Meter Resolution	For calculating slope.	https://gisdata.mn.gov/dataset/elev-30m-digital-elevation-model
2	NLCD 2019 Land Cover, Minnesota	Reclass to find the farm field.	https://gisdata.mn.gov/dataset/biota-landcover-nlcd-mn-2019
3	MnDOT Route Centerlines	To find the optimal route for Dory.	https://gisdata.mn.gov/dataset/trans-roads-centerlines
4	Bridge locations in Minnesota	To find the optimal route for Dory.	https://gisdata.mn.gov/dataset/trans-bridges
5	County Boundaries in Minnesota	To create the study area.	https://gisdata.mn.gov/dataset/bdry-counties-in-minnesota
6	2012 Assessed Streams	To find the optimal route for Dory.	https://gisdata.mn.gov/dataset/env-assessed-streams-2012
7	Start and End points	Use in the cost surface model.	

Methods

After downloading all the required data, I create the study area first (Olmsted, Wabasha, Winona), to be used to clip the data, which can narrow the data size. Then I started to prepare the data.

(1) water stream

First, clip the data to the study area. Next, convert the clipped features to a raster format. Finally, reclassify the water streams.

(2) Land cover

Clip the NLCD_2019_Land_Cover.tif within the study area. Then, reclassify the following land cover categories as indicated:

'Open Water', 'Woody Wetlands', 'Emergent Herbaceous Wetlands' → Reclassify to 10.

'Developed, Open Space', 'Developed, Low Intensity', 'Developed, Medium Intensity', 'Developed, High Intensity' → Reclassify to 2.

'Barren Land' → Reclassify to 5.

'Deciduous Forest', 'Evergreen Forest', 'Mixed Forest', 'Shrub/Scrub', 'Herbaceous' → Reclassify to 7.

'Hay/Pasture', 'Cultivated Crops' → Reclassify to 9.

(3) Slope

Clip the digital_elevation_model_30m within the study area. Then, reclassify the elevation values into the range of 1 to 5.

(4) create start and end points

Start by creating the start point using the provided coordinates (44.127985, -92.148796). Since only the end area was given without specific coordinates, I assumed the endpoint as

(44.05431509462441, -92.04443552409354). Following that, convert both the start and endpoint into raster format.

Finally, commence the creation of the cost surface model. Begin by using the Weighted Overlay tool to assign the appropriate weights to the factors. Following that, utilize the CostDistance and CostPath tools to find the optimal route for Dory.

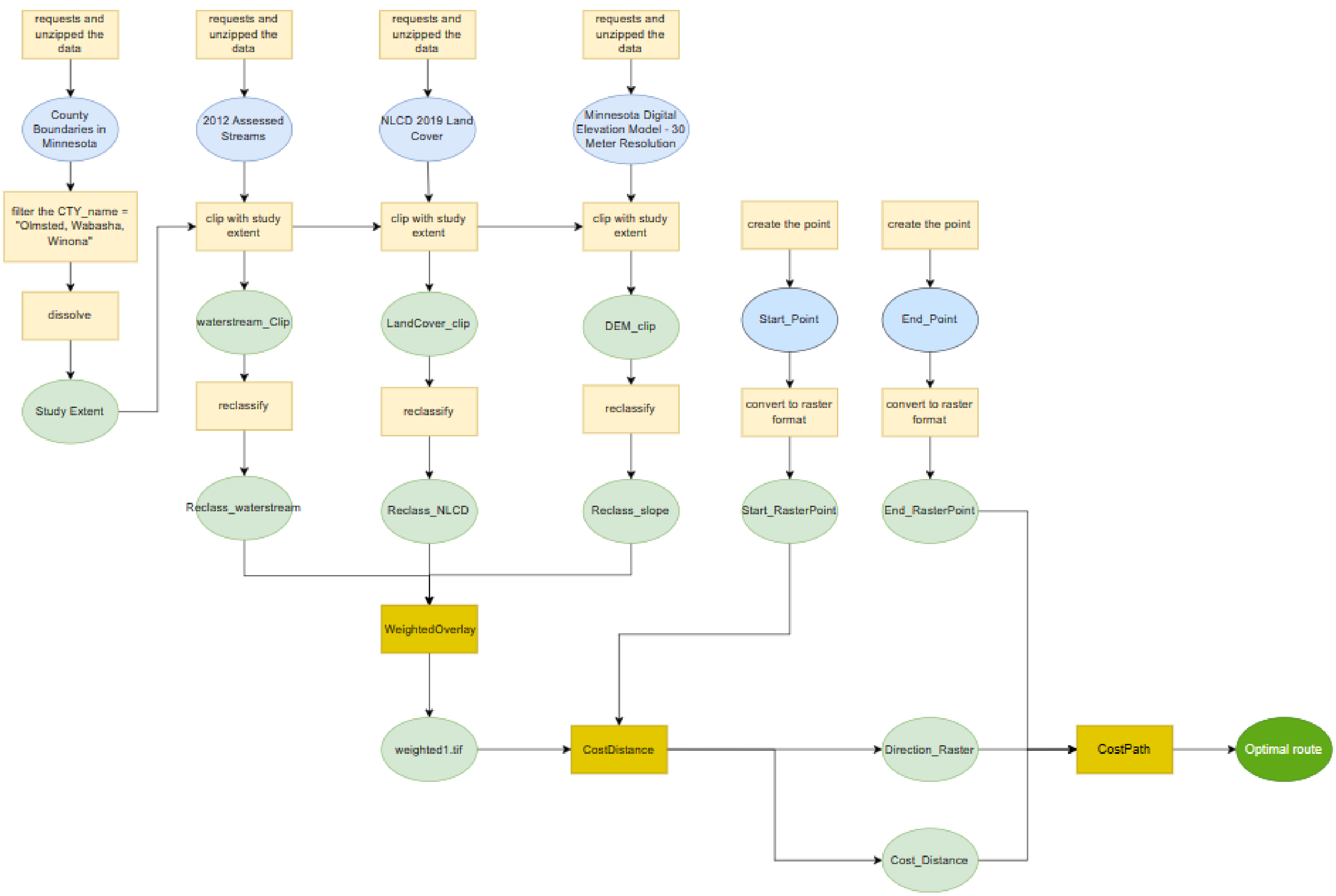

Figure 1. Data flow

Results

Here are the results of the process for constructing the cost surface model to identify the optimal route.

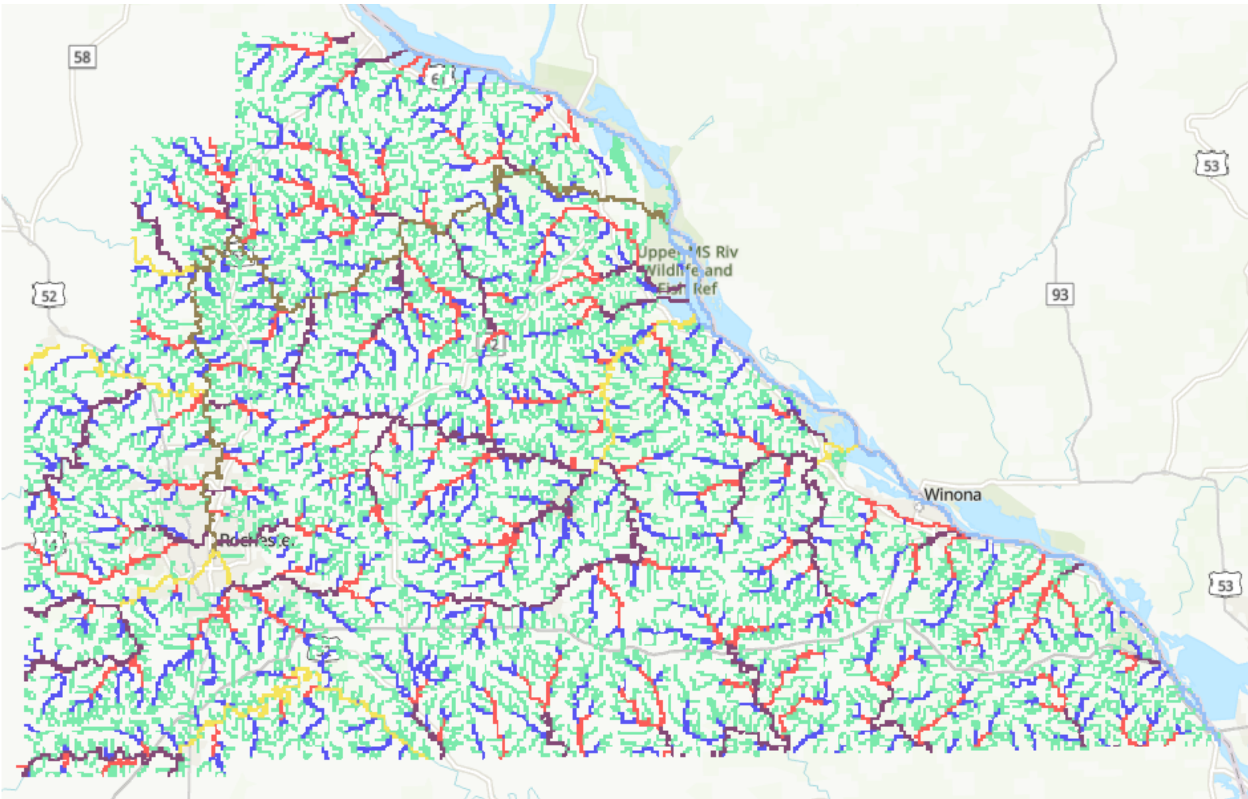

Figure 2. Reclass water stream

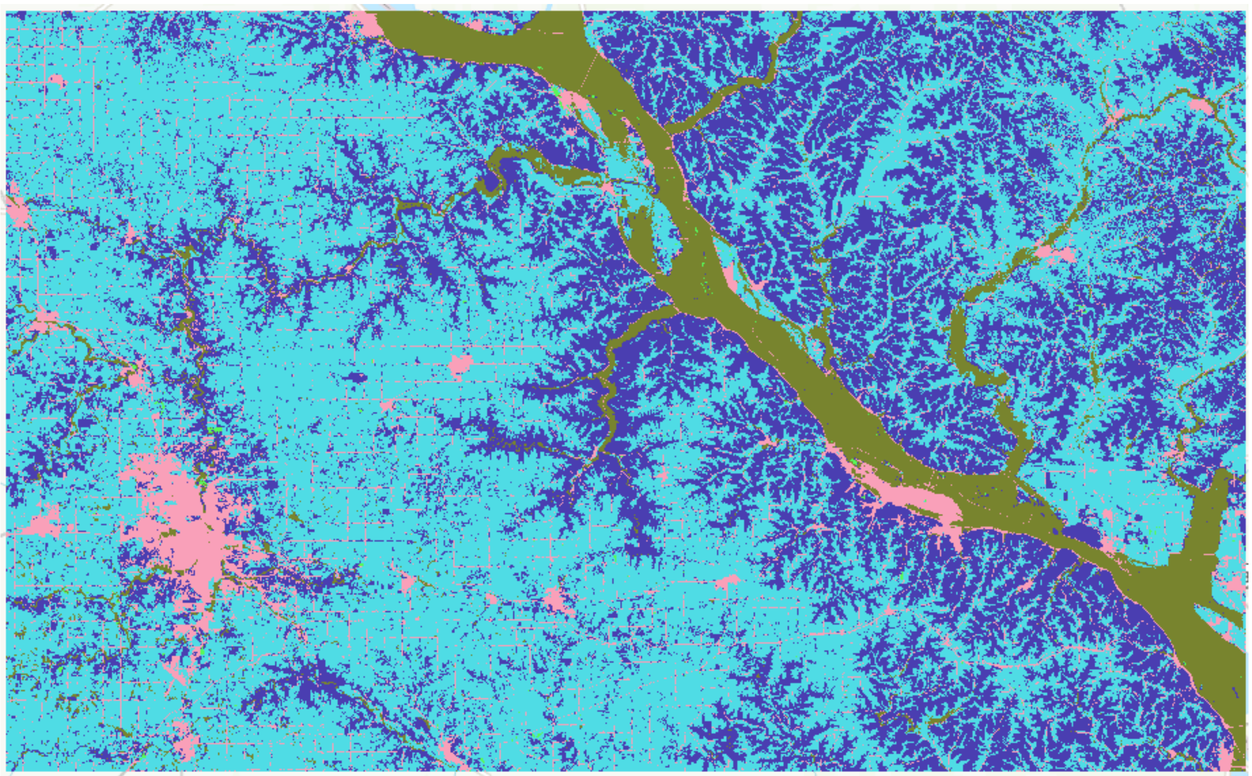

Figure 3. Reclass NLCD

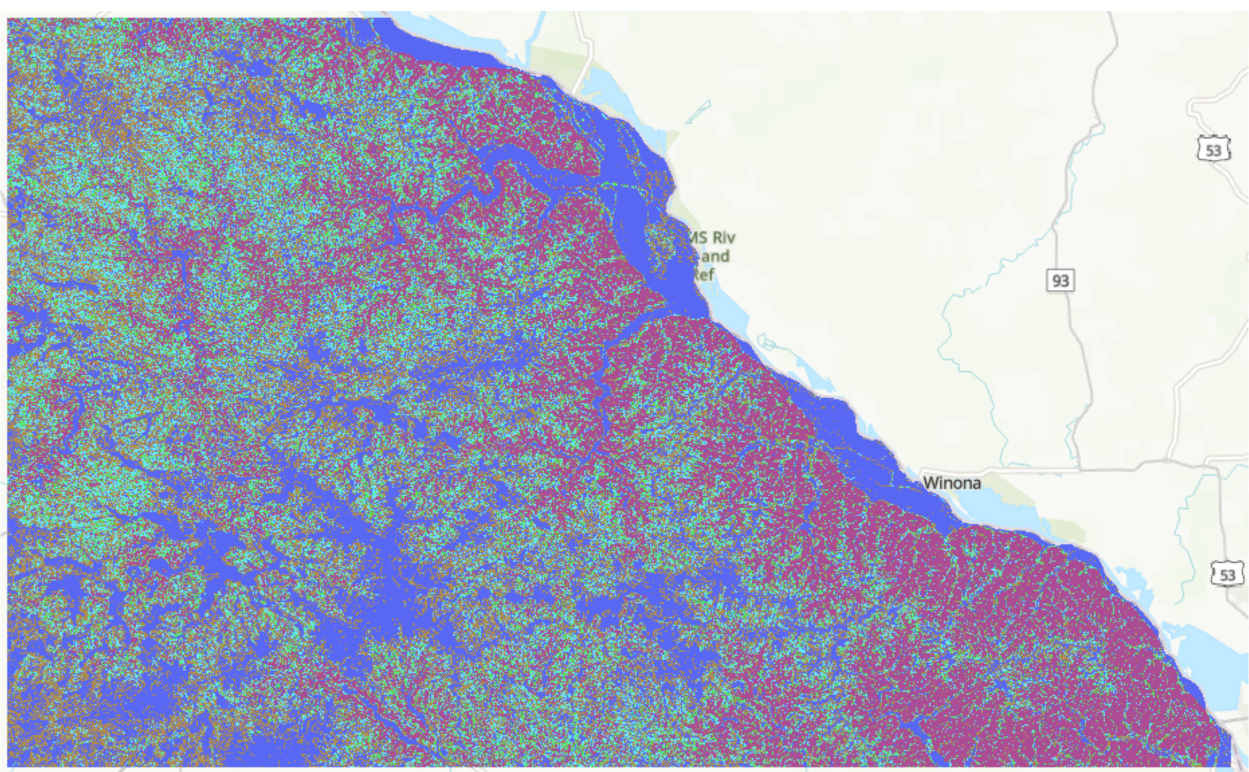

Figure 4. Reclass slope

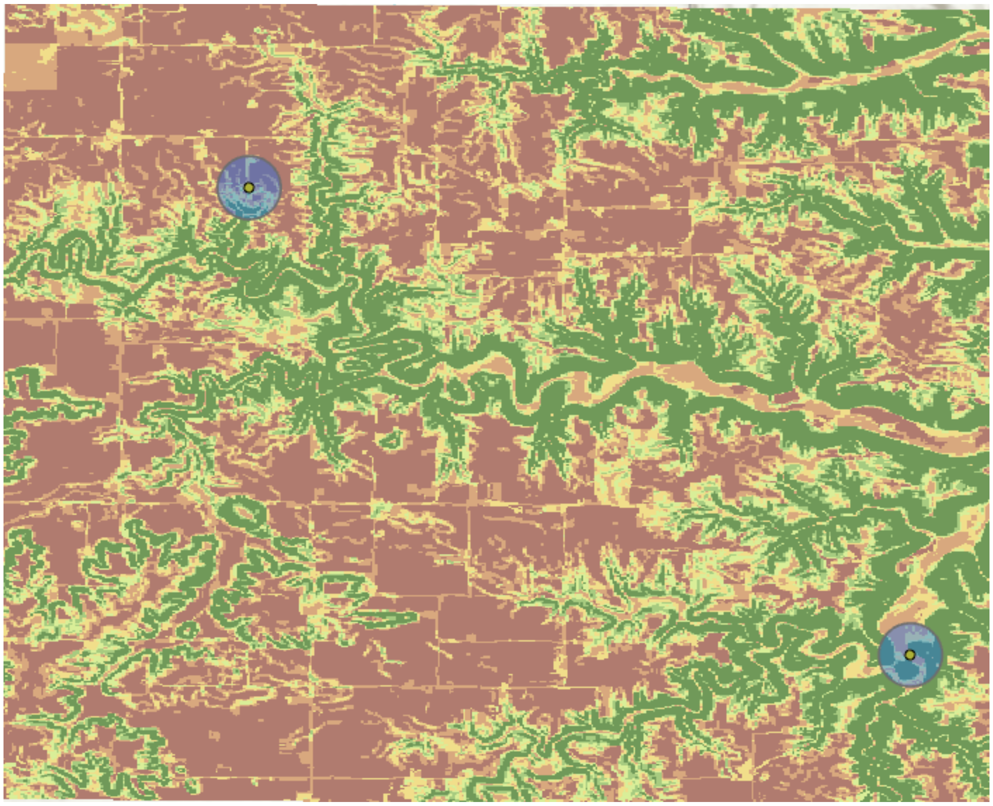

Figure 5. weighted_surface

Figure 6. cost path

Path 1: slope 50% land use 30% water stream 20%
Path 2: slope 80% land use 10% water stream 10%
Path 3: slope 20% land use 65% water stream 15%

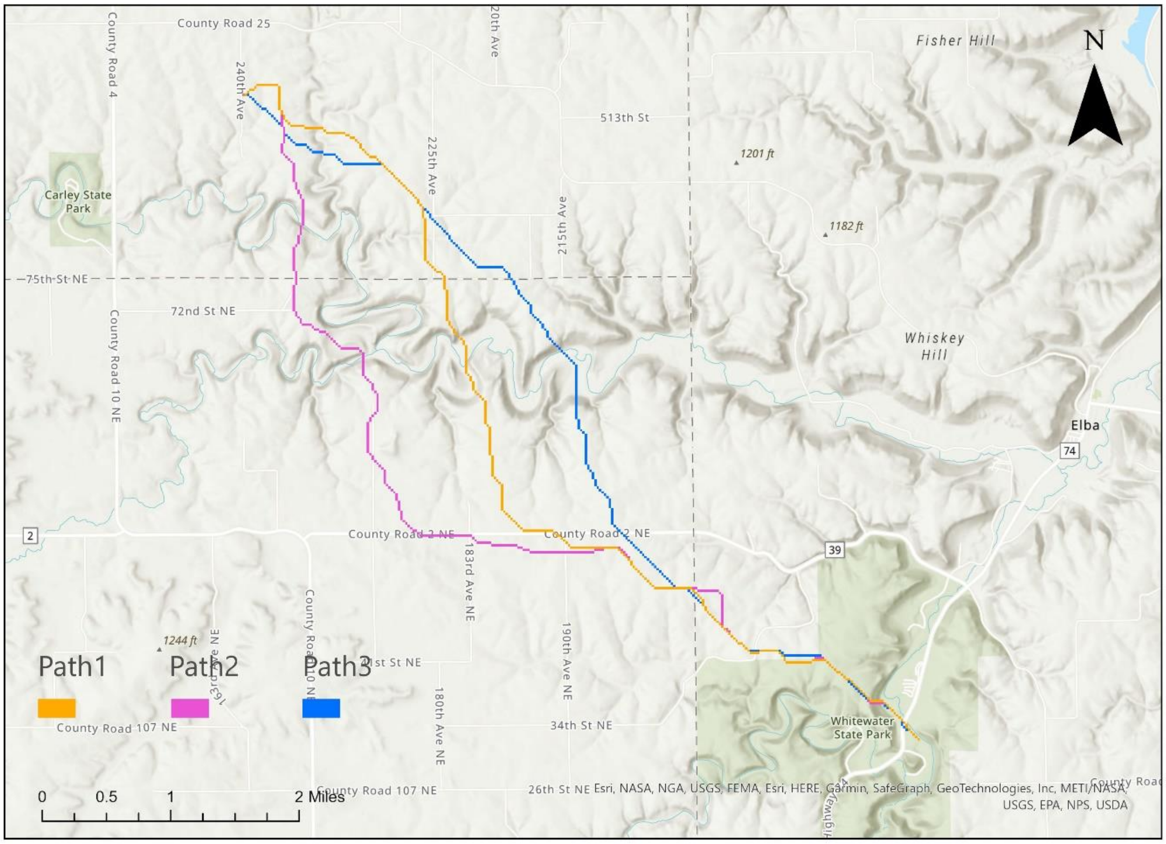

Figure 7. Three paths.

Results Verification

I checked how different weights affected the results and compared them with the routes recommended by Google Maps. Although I noticed differences between the results I obtained and those from Google Maps, I think it's because I only took into account factors like land use, water stream, and slope, without considering the road network.

Discussion and Conclusion

This time was faster as most of the work had been completed in Lab2. In this lab, I experimented with different weights to observe the results. Despite the noticeable differences in the routes I obtained compared to Google Maps, I realize the importance of incorporating road networks into my calculations. Otherwise, the paths I generated may not be suitable for walking. I felt more familiar with utilizing the "cost" functions in this lab, even though I encountered some errors.

References

Creating a cost surface raster—ArcGIS Pro | Documentation. (n.d.). Retrieved November 6, 2022, from https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-analyst/creating-a-cost-surface-raster.htm

Weighted Overlay (Spatial Analyst) —ArcGIS Pro | Documentation. (n.d.). Retrieved November 6, 2022, from https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-analyst/weighted-overlay.htm

Using weighted overlay analysis to identify areas that are natural and accessible. (n.d.). ArcGIS API for Python. Retrieved November 6, 2022, from https://developers.arcgis.com/python/samples/calculating-cost-surfaces-using-weighted-overlay-analysis/

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	26
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**	24	23

	points).		
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	19
		100	96