Lab Report (Part 1)

Title: Cost surface for optimal paths
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Date: 12/7/2022
Project Repository: https://github.com/Samikshya036/GIS5571/tree/main/Lab3
Time Spent: 14 hrs

Abstract

A cost raster shows the price associated with traversing each cell within any research extent. In this lab, a cost surface raster is used to find the best route between two points while accounting for subject preferences. All of the input datasets, including the DEM, streams, land cover, and highways, were initially acquired from the MN Geospatial and imported into ArcGIS Pro. The criteria layers are then given identical weights and standardized using the reclassification tool before being overlaid. To find the ideal path between the specified two places, two spatial analyst tools: cost distance and cost path as polyline tool were then applied. Following the use of 2 different weighting approaches—weighted overlay and weighted sum—input datasets were then overlayed. The two predefined places were then connected by at least three ideal routes using the spatial analyst tool Optimal Region Connection.

Problem Statement

To create three optimal paths from where Dory lives to Whitewater State Park by changing how the cost surface is calculated by manipulating different data inputs or weights. Cost surfaces are produced using map algebra and cost modeling. In order to get from her farm location (44.127985, -92.148796) to the North Picnic area (44.049801, -92.050226), Dory needs to choose a path, although she has various preferences.The steep path, farm fields, or water bodies without a bridge are not Dory's preferred routes to go. Map algebra is used to generate the cost surface that represents these preferences. By gradually changing each model weight and rerunning the model, uncertainty analysis can be used to determine how various decisions might affect the map results.

Table 1. Table 1 shows data requirement for the cost surface.

#	Requirement	Defined As	(Spatial) Data	Dataset	Preparation
1	MN Counties	Shapefile of counties in Mn	Vector (Polygon)	Mn GeoSpatial Commons	-
2	Streams	Raw vector input data	Vector	Mn GeoSpatial Commons	Reclassify
3	Road Network	Raw input data (vector)	Raster	Mn GeoSpatial Commons	Reclassify
4	DEM	Raster data for slope determination	Raster	Mn GeoSpatial Commons	Reclassify

5	Starting and ending points	.CSV file of Dory's coordinates	CSV	-	Reclassify
6	Land Cover	Raster data for land use determination	Raster	Mn GeoSpatial Commons	Reclassify

Input Data

The datasets needed to generate the cost surfaces using map algebra and cost modeling are listed below. There are six datasets in total that take into account all of the subject's route preferences as well as the starting and ending locations of the route.

Table 2: Table showing purpose of analysis for input dataset

#	**Title**	**Purpose in Analysis**	**Link to Source**
1	MN Counties	For study extent	MNcounties
2	Streams	This layer will represent all the streams in the study extent.	Stream order
3	Road Network	This layer will represent all the roads that cross the streams in the study extent.	RD network data
4	DEM	This dataset will contain information about the slope in the study area.	MN DEM
5	Starting and ending points	Dory's starting and ending coordinates are stored in a CSV file. final point	-
6	Land Cover	This dataset will show how forests, wetlands, impermeable surfaces, agricultural, and other land and water types cover the study area.	ncld

Methods

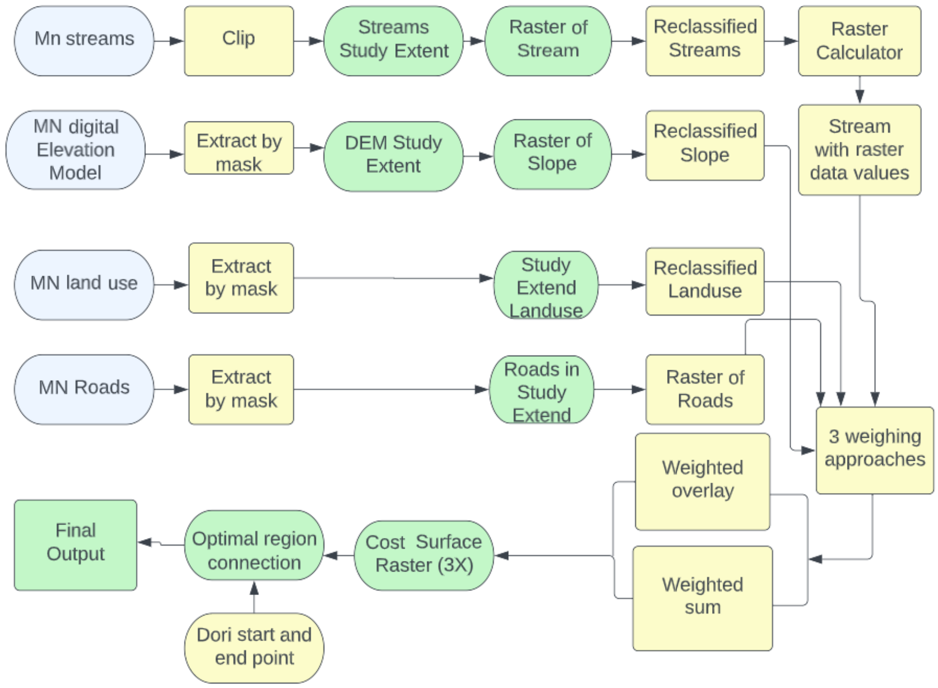


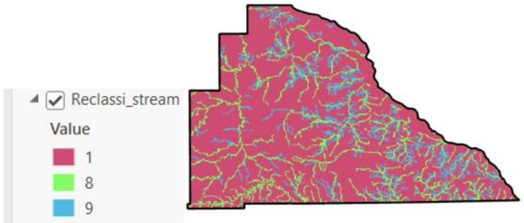
Figure 1. Diagram showing overall methodology

Method steps

Four datasets were used to determine the cost surface path of a bridge and a steep path. All input data were obtained from MN Geospatial and then imported into ArcGIS Pro. Dory's starting and ending points are exclusively in three counties: Winona, Olmstead, and Polk. Using the geo processing tool select, and Wabasha were chosen from the MN county layer as an attribute. The dissolve tool was used to join the three counties and define the study extent. A spatial analyst tool, namely Optimal Region Connection, was used to get the desired optimal paths between the two predefined points. The inputs for the said tool are Dory's starting and destination points and weighted overlays. The data flow diagram summarizes the methods used to complete the task as illustrated in Figure 1.

I used cost distance tool to obtain the cost distance layer and cost direction layer following the weighted overlay analysis. The weighted overlay and Dory's beginning point serve as the tool's inputs. I then used Cost Path as Polyline to determine the best route between the starting and ending places of the Dory (North Picnic area). The overlayed input datasets, after assigning them different weights using two different weighting approaches such as weighted overlay and weighted sum

Results



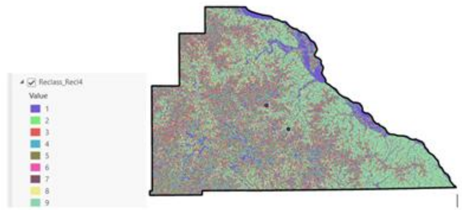


Figure 2: Reclassify Stream

Fig 3: Reclassify Slope

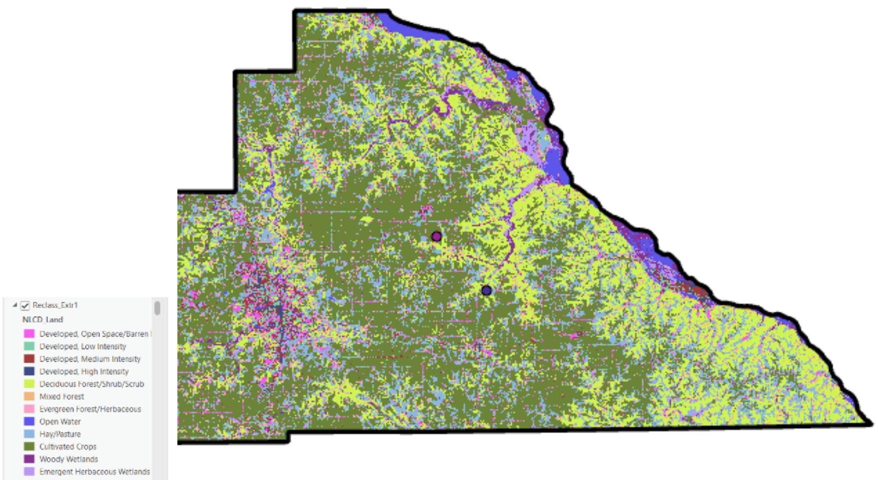


Figure 4: Reclassify Land cover

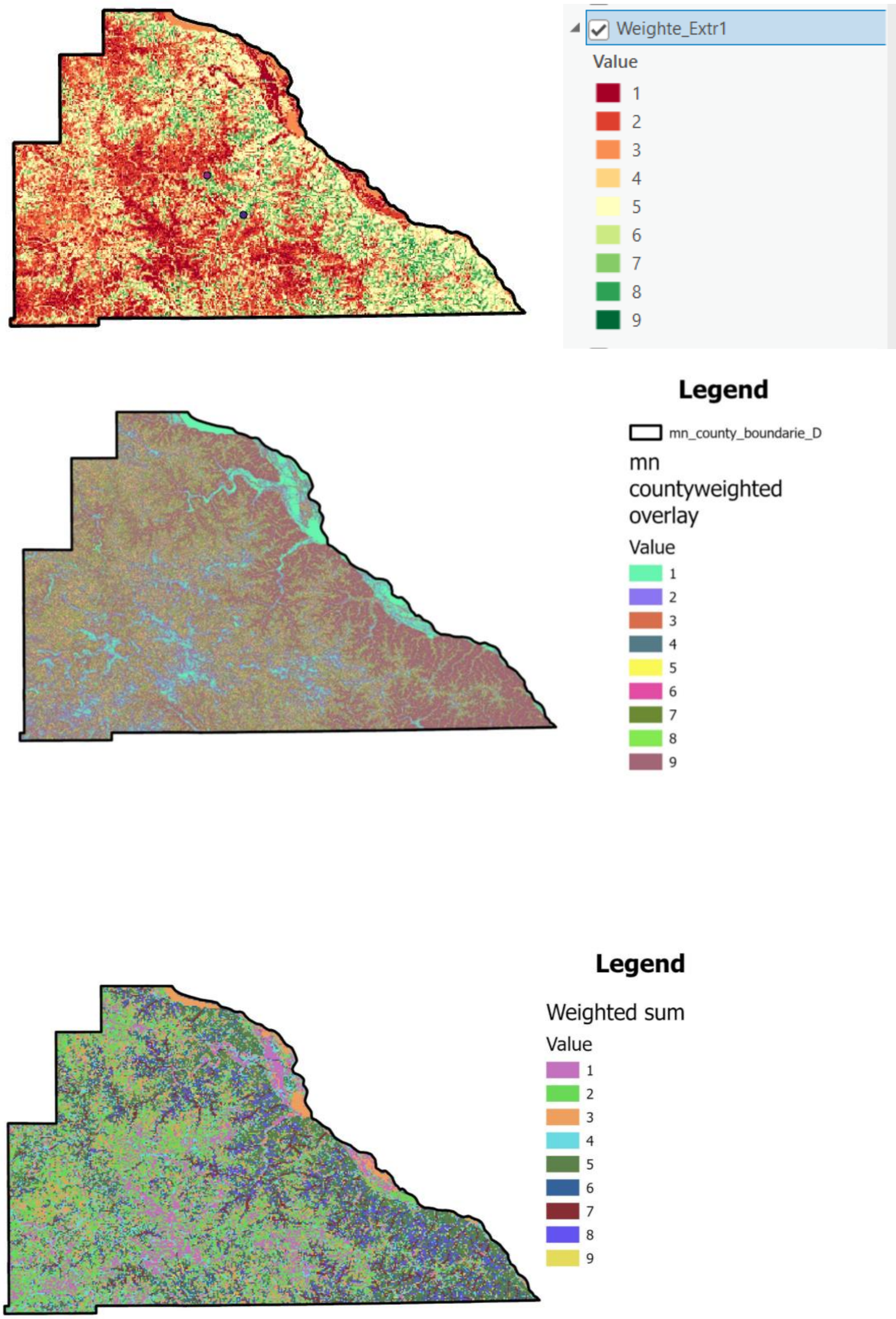


Figure 5: Cost Surface Rasters using weighted overlay and sum methods.

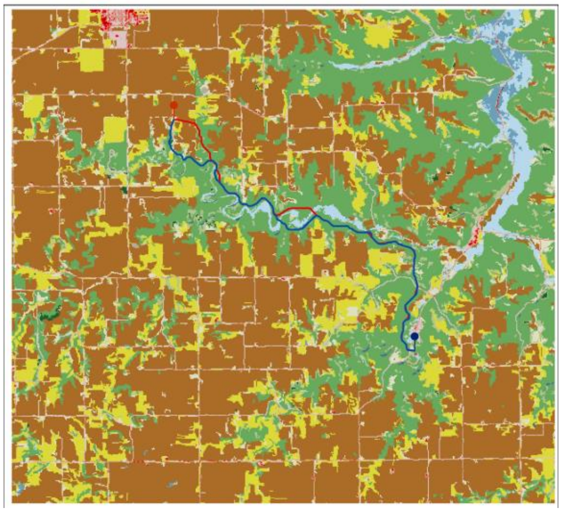
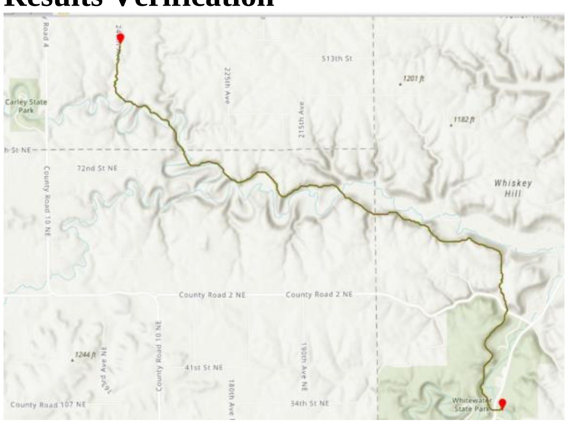


Figure 6: Figure illustrates various weighing strategies, including weighted overlay and weighted sum. Using Optimal Region Connection, the needed optimal pathways are finally depicted in figure. Input datasets were overlayed after being given various weights using two. The findings demonstrate that the best path is only weakly responsive to changes in the weight factors because the three ideal routes remained quite close even though the cost surface models varied in each case.

Results Verification



These outcomes were from code in my Jupyter Notebook, and they were compared with the map outcomes. I can also develop explanations for these results using some critical thought and visual observation. I believe the after adjusting the weights of each criterion and repeatedly running the overlay tools, the results were confirmed. The generated path between the starting and ending places showed virtually little variation It is confirmed visually by tracing the journey in Google Earth and examining the features it has been passing through. In conclusion, Dory's choices are all justified by the best approach.

Discussion and Conclusion

The cost surface models are integrated with the start and end costs in this activity, which expands on Part 2 of Lab 2 using Cost to locate the most efficient path from Dory's house to the North Picnic Area ArcPro's distance and cost path tools. I learned about various techniques for this lab portion, including Optimal Region Connection and Optimal Path as Line, which allows for the visualization of an optimal path between two predetermined places be created. I compared the results of many weighting combinations.

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	**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	**20**
		100	**99**