ASSESSING CAMPUS TO CITY WALKABILITY USING HEXGRID-BASED NETWORK ANALYSIS

Harrisonburg, VA

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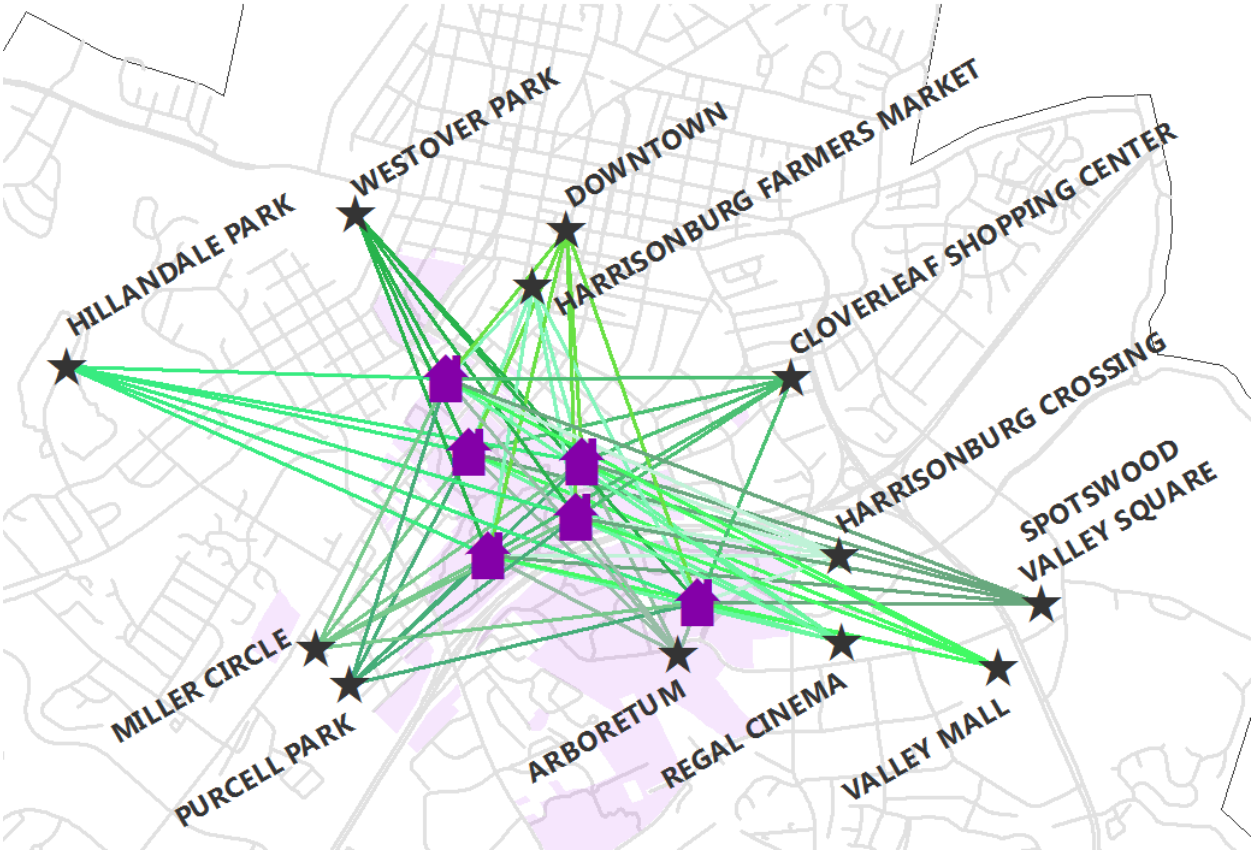
Origin-Destination Cost Matrix Using HexGrid Network Dataset



Introduction

In order to help explore the issue of campus-city integration, this project aims to quantify and assess the walkability from James Madison University campus dorms to major City of Harrisonburg shopping, entertainment and nature attractions as listed on their website.

Network analysis was conducted using a dataset consisting of roads, paths and a city-wide hexagonal grid designed to help mimic normal walking access patterns. An origin-destination cost matrix was built using this network to estimate the time it would take to walk from each campus dorm to each city attraction. Upon route creation, the network was checked against an extensive layer of no-walk zones to increase accuracy. Dorms, attractions and attraction types were then ranked based on average route times.

Methodology

The origin-destination cost matrix analysis was made possible by the creation of an effective network dataset, and made accurate by an extensive line-barrier layer. The network created contains not only the typical roads and paths, but a citywide grid of tiny hexagons which allow for 'offroading' paths that pedestrians would likely take. This free-walk hexagon layer increases realism by allowing the possibility of pedestrian routes that are not limited to pre-defined paths. In order for this hexgrid network to be effective, however, there needs to be an extensive blocking layer. The blocking layer consists of impassable lines to make sure that hexgrid-enabled routes do not go through water, residencies or other impassable features.

Light grey: network dataset | Red: blocking layer | Green: example route

The network built combines the following layers:

- Grid consisting of 30ft-wide hexagons
- Sidewalks
- Streets (excluding interstates and major roads)
- Park trails
- Miscellaneous walking paths

The blocking layer used includes the following layers:

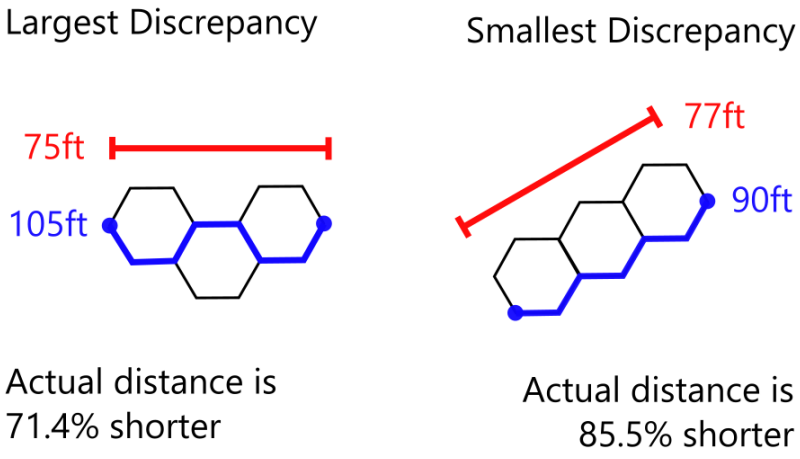
- Buildings
- Land parcels marked residential or industrial
- Streams
    - Line-breaks for bridges included
- I-81 and majority of East Market St. (including guard rails)
    - Line-breaks for crosswalks included
- JMU Barriers (including fences, walls etc.)
- Misc. Harrisonburg barriers (such as park fences)

The network dataset was built and analyzed using ArcGIS 10.3.1, however, the dataset is versioned at 10.1. The hexgrid was created using Tim Whiteaker's Create Hexagon Tessellation tool. This hexgrid and other path layers were combined using the Data Management Feature to Line tool which is capable of merging different layers and rebuilding them as a polyline file with nodes at the appropriate intersections. These intersection nodes are a necessity for a successful network dataset.

The network dataset was created inside a geodatabase feature dataset, as it must. The total combined hexgrid and paths layer was used to generate the network dataset; turns were not modeled nor elevation used. Three attributes were cost-accumulated upon routing: raw distance, adjusted distance and adjusted time. These attributes accumulate as the route extends, allowing total distances and walking times to be calculated for each route.

Because a route that follows the hexgrid will turn more and be longer by default, a multiplier was calculated to account for this discrepancy and make travel times through the hexgrid more accurate:

Comparing Raw Hexgrid Distance to Actual



These percentages were averaged to determine a hexgrid multiplier (0.7849) used to calculate adjusted distance and time accumulations for sections of routes which utilize the hexgrid.

Once the network dataset was generated, an origin-destination cost matrix was created. Six dorm locations were added as origins while twelve Harrisonburg points of interest were loaded as destinations. The blocking layers then added (after a Feature to Line merge) as Line Barriers, and the model was run.

Results

The result of the origin-destination cost matrix ran on the hexgrid-based network dataset was a table of seventy-two routes, one for each dorm to city attraction. The results were organized and ranked by dorm walkability, attraction accessibility, campus accessibility based on attraction type and dorm walkability based on attraction type:

Dorm External Walkability Ranking:

#	Campus Dorm Area	Average walking time to off-campus attractions (minutes)
1	Hillside Area	23.9
2	Village Area	25.0
3	Bluestone Area	26.0
4	Grace Street	27.0
5	Lake Area	27.3
6	Skyline Area	30.6

Attraction Campus Accessibility Ranking:

#	Attraction	Average walking time from campus (minutes)
1	Harrisonburg Farmers Market	17.8
2	Cloverleaf Shopping Center	20.4
3	Downtown	21.3
4	Harrisonburg Crossing	22.0
5	Purcell Park	23.5
6	Miller Circle	25.2
7	Westover Park	26.2
8	Regal Cinema	26.9
9	Arboretum	27.9
10	Valley Mall	33.8
11	Spotswood Valley Square	34.9
12	Hillendale Park	39.6

Attraction Type Accessibility Ranking:

#	Attraction Type	Average walking time from campus (minutes)
1	Food & Entertainment	22.8
2	Shopping	27.8
3	Parks & Nature	29.3

Dorm External Walkability Per Attraction:

Dorm /	**#**	Attraction	Average walking time (mins)
Hillside Area			
	1	Food & Entertainment	20.1
	2	Parks & Nature	26.0
	3	Shopping	35.1
Village Area			
	1	Shopping	19.0
	2	Food & Entertainment	32.6
	3	Parks & Nature	40.1
Bluestone Area			
	1	Food & Entertainment	19.7
	2	Parks & Nature	25.9
	3	Shopping	32.5
Grace Street			
	1	Food & Entertainment	21.4
	2	Shopping	24.9
	3	Parks & Nature	28.6
Lake Area			
	1	Food & Entertainment	19.7
	2	Shopping	24.3
	3	Parks & Nature	27.7
Skyline Area			
	1	Food & Entertainment	23.3
	2	Parks & Nature	27.7
	3	Shopping	30.9

Conclusion

The walking times from campus dorms to major Harrisonburg attractions are generally high. The shortest route time out of all connections was 3.8 minutes from the Skyline Area to the Arboretum, however, the second shortest route was about 10 minutes, and the overall average route time was about 26.6 minutes.

Out of the three attraction types, reaching a Food & Entertainment venue was the overall shortest walk on average. This attraction type remains generally on top when the attraction types are broken down by dorm, however, big differences appear with the other two classes. For example, the Bluestone area has an average of a 25.9 minute walk to parks and nature areas but the Village Area has an average of a 40 minute walk.

The hexgrid-based network dataset did an excellent job of predicting more natural human movement across the city. The dataset did a good job of predicting route times, however, testing should be done to further assess its accuracy.

Data Sources:

- City of Harrisonburg, Virginia
- James Madison University

Technologies:

- ArcGIS 10.3.1
    - Network Analyst
- Whiteaker's Create Hexagon Tessellation tool

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