Web Processing - Standardised GIS Analyses for Cable Route Planning

SEBASTIAN HEIDEN, Harz University of Applied Sciences, Germany

add as last part

CCS Concepts: • **Computer systems organization** → **Embedded systems**; *Redundancy*; Robotics; • **Networks** → Network reliability.

Additional Key Words and Phrases: datasets, neural networks, gaze detection, text tagging

ACM Reference Format:
Sebastian Heiden. 2022. Web Processing - Standardised GIS Analyses for Cable Route Planning. *J. ACM* 37, 4, Article 111 (August 2022), 3 pages. https://doi.org/XXXXXXX.XXXXXXX

1 INTRODUCTION

Sometimes, finding the shortest path is not sufficient. Additional parameters play also have to be taken into consideration. As the steepness of a road or the soil, play an important role for the building cost of a road or pipeline . For planing the additional routes for a power grid, additional aspects as legal regulations and acceptance by the local population have to be taken in consideration. Also technical aspects, as the effects on the grid stability might be further points to consider.[8]

source

what is the least cost path

2 METHODS

We retrieve a set of different spacial data-sets from public sources as a basis to create the cost raster. Field of study are the counties of Cuxhaven and Osterholz in the state of Lower Saxony, Germany. Areas protected by different European and National conservation laws are provided by the German Environment Agency as Web Feature Service (wfs) [1]. The nation wide land coverage (ATKIS) with a scale of 1:250000 are provided by the Federal Agency for Cartography and Geodesy[3]. The nation wide power grid (tags: 'power': line) has been retrieved via OpenStreetMap.[7] Local data as houses at Level of Detail 1 are offered by the State Office for Geoinformation and Land Surveying of Lower Saxony[6]. In addition local planning geodata for the land usage are taken from from 'Metropolplaner' (Planing data Lower Saxony & Bremen)[5]

PyWPS[2] is used to offer the least cost path algorithm as a Web Processing Service (wps). The for the initial implementation of the least cost path algorithm the implementation for the QGIS-Plugin 'Least Cost Path'[4] has been taken into account.

The different layers from the different entities are optionally filtered, buffered and than converted into rasters. Filtering the layers of the files for special attributes enables to further differentiate further. For examples makes it possible to differentiate between heath and uncultivated land. Adding a buffer can be used either used to convert a line objects as power grids and streets into a polygon with the correct physical width, or to add minimum distance from an existing of planed area to the new power grid. Each of theses rasterized layers are given a weight, or cost that expresses the cost of using land covered by this layer. The costs of all layers of all layers is aggregated with the maximum function. Thus, an area covered by multiple layers is uniformly used with the highest costs. For every area in the study area. that is not covered by any layer, is given the default cost. The costs has been grouped into different levels (see table 1) starting from preferential areas with very low costs, via no restrictions, which is the default, used when no other layers are covering the local area, to restricted, strongly restricted and prohibited areas with high costs. These higher costs resemble the degree how much a local area should be avoided, while routing the path. The ratio of the higher costs to the lower costs directly translates into the additional diversion in pixels the algorithm is willing to go, for avoiding an area of high costs. Thus, as prohibited areas describe a legal obligation, not to use these areas or only to the utmost minimum, the weight that resembles the costs for these types of areas, has to be especially high.

all touched

Table 1. Used levels of costs, the applied numerical equivalent and example layer this cost have been used for.

Cost Level	Cost	Example
Prohibited	500	National Parks, Buildings
strongly Restricted	10	Bird Reserve
Restricted	5	Industrial Areas
No Restriction	0.5	Default
Preferential	0.1	Power Grid, Motorway Buffers

The completed list of layers and the processing applied to them, can be found in Supplement S1.

create the Supplement from the processing rules

3 RESULTS

In this chapter we want to show the different cost rasters, that were created from the very same set of layers, but computed for different resolutions. From this different rasters the cost paths are calculated and compared. In the last step the rasters with lower resolution were used to calculate in a way, that they shall result in similar paths as if the paths were computed from a high resolution raster.

3.1 Cost Rasters

3.2 Least Cost Paths

3.3 Faster Processing of the Cost Path Algorithm

The paths between the all_touched False runs is less distinct. The mean average distance between the 100 m resolution run and the 5 m resolution run is 257.97 m.

Check why values are so different for

Author's address: Sebastian Heiden, u38439@hs-harz.de, Harz University of Applied Sciences, Friedrichstrasse 57-59, Wernigerode, Saxony-Anhalt, Germany, 38855.

0004-5411/2022/8-ART111 $15.00
https://doi.org/XXXXXXX.XXXXXXX

Table 2. Least cost paths for the different resolutions of the rasters.

resolution /m	$length_{alltouchedfalse}/m$	$length_{alltouchedtrue}/m$	mean minimum distance /m
5	76136.27	78002.00	126.04
10	75430.10	77936.57	277.92
50	76135.02	70619,95	1140.01
100	76283.80	74120.73	1946.41

Table 3. Ratio Category values of each least cost path.

resolution /m	all touched	$r_{Preferential}\%$	$r_{NoRestriction}\%$	$r_{Restricted}\%$	$r_{stronglyRestricted}\%$	$r_{Prohibited}\%$
5	False	4.29	59.01	8.88	0.73	27.08
5	True	17.38	67.25	1.17	0.97	13.23
10	False	17.90	68.73	0.92	0.80	11.64
10	True	17.37	66.42	1.47	1.38	13.36
50	False	18.73	67.87	0.87	0.68	11.85
50	True	8.58	74.95	3.95	4.08	8.45
100	False	18.48	69.82	1.31	0.90	9.52
100	True	6.16	71.74	5.75	9.69	7.04

3.4 Faster Processing of the Cost Path Algorithm

4 DISCUSSION

discuss aggregation with max vs sum

5 RELATED WORKS

6 CONCLUSION

ACKNOWLEDGMENTS

...

REFERENCES

[1] 2015. Schutzgebiete in Deutschland. https://geodienste.bfn.de/schutzgebiete?lang=de

[2] 2016. Welcome to the PyWPS 4.3.dev0 documentation! — PyWPS 4.3.dev0 documentation. https://pywps.readthedocs.io/en/latest/index.html

[3] 2021. Digitales Landschaftsmodell 1:250 000 (Ebenen). https://gdz.bkg.bund.de/index.php/default/open-data/digitales-landschaftsmodell-1-250-000-ebenen-dlm250-ebenen.html

[4] 2022. LeastCostPath/dijkstra_algorithm.py at master · Gooong/LeastCostPath. https://github.com/Gooong/LeastCostPath

[5] 2022. Metropolplaner. https://metropolplaner.de/metropolplaner/

[6] 2022. OpenGeoData.NI. https://opengeodata.lgln.niedersachsen.de/#lod1

[7] Geoff Boeing. 2017. OSMnx: New methods for acquiring, constructing, analyzing, and visualizing complex street networks. *Computers, Environment and Urban Systems* 65 (Sept. 2017), 126–139. https://doi.org/10.1016/j.compenvurbsys.2017.05.004

[8] Benjamin Schäfer, Thiemo Pesch, Debsankha Manik, Julian Gollenstede, Guosong Lin, Hans-Peter Beck, Dirk Witthaut, and Marc Timme. 2022. Understanding Braess' Paradox in power grids. *Nature Communications* 13, 1 (Sept. 2022), 5396. https://doi.org/10.1038/s41467-022-32917-6 Number: 1 Publisher: Nature Publishing Group.

A RESEARCH METHODS

A.1 Part One

A.2 Part Two

B ONLINE RESOURCES

Received 20 February 2007; revised 12 March 2009; accepted 5 June 2009