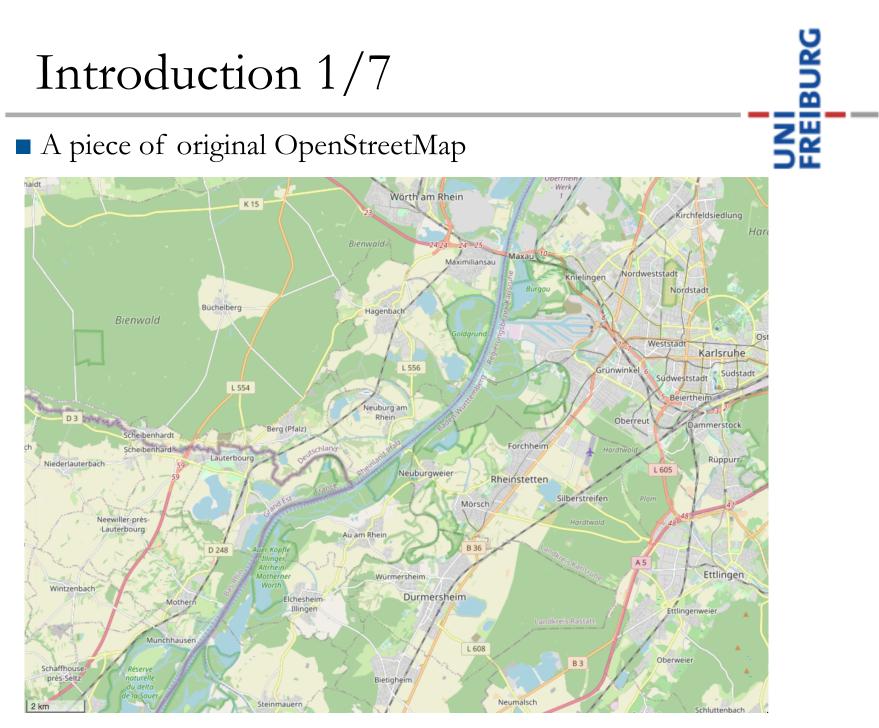
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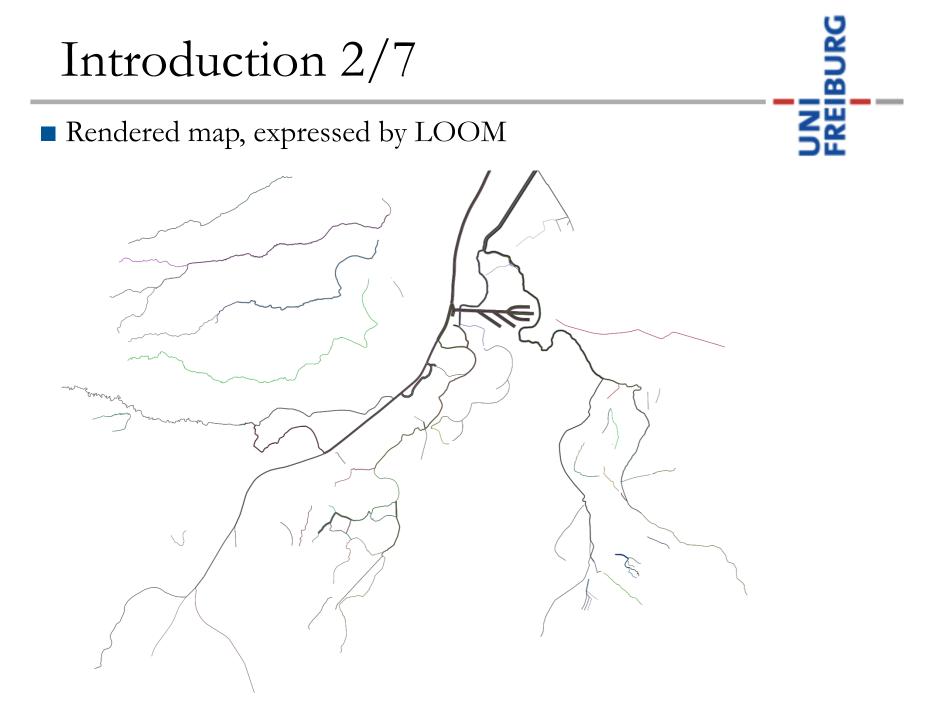
Metro-Map Styled River Maps

Jianlan Shao 23. March 2021

Examiner: Prof. Dr. Hannah Bast Supervisor: Patrick Brosi

> Chair for Algorithms and Data Structures University of Freiburg

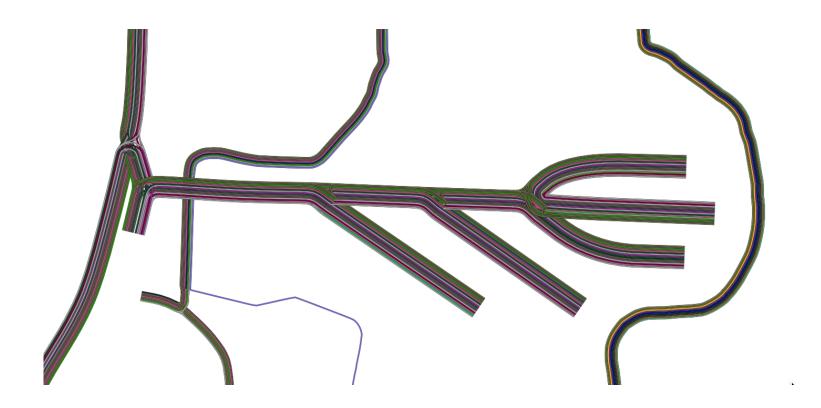


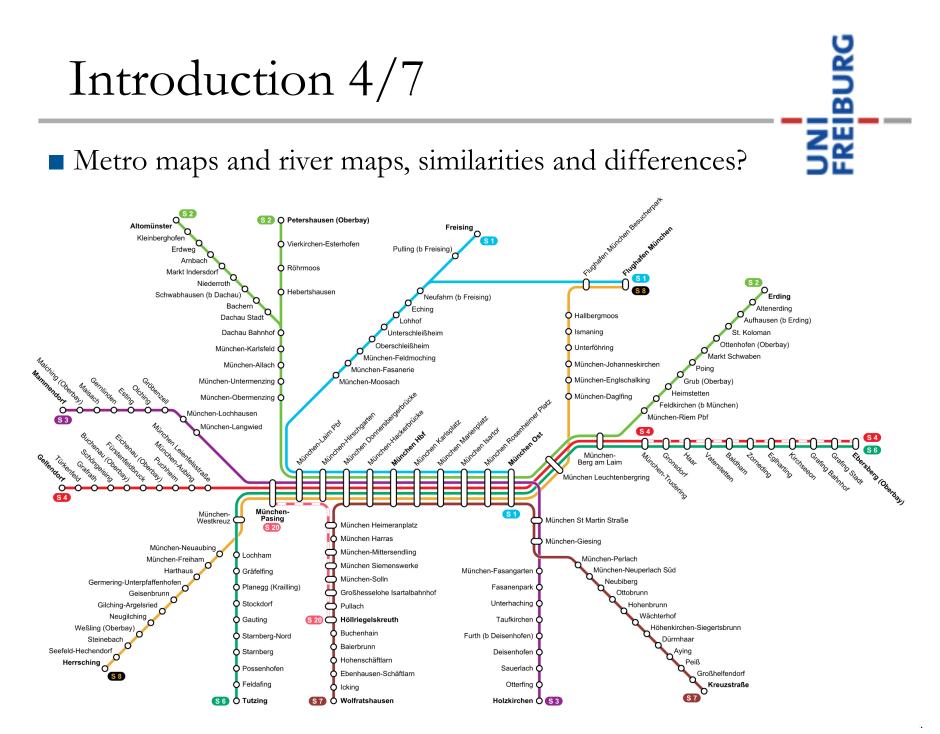




Colors of the tributaries



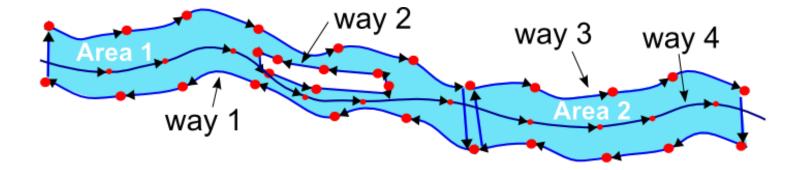




Introduction 5/7

Similarities

- Tributaries gather at the stem
- Geographical width can be ignored



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way 4: waterway=river, "thalweg"
way 1, 2 & 3: waterway=riverbank

Introduction 6/7

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Differences

- Our river maps are geographical accurate
 - \cdot nodes are not equally spaced
 - without "underlying grid"

Introduction 7/7

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■ Output: GeoJSON file, as LOOM expected

```
"coordinates":[
                                                                              27
     "features":[
                                                                                             [945322.1435861, 6358143.7429898],
 2
                                                                              28
                                                                                             [936620.2210671, 6376420.5050057]
                                                                              29
           "geometry":{
                                                                              30
            "coordinates": [945322.1435861, 6358143.7429898],
                                                                                           "type": "LineString"
                                                                              31
            "type": "Point"
                                                                                        },
                                                                              32
                                                                                        "properties":{
          },
                                                                              33
           properties ":{
                                                                                           "color": "a4b020",
                                                                              \mathbf{34}
            "color":"ff0000".
                                                                                          "id": "514832816",
                                                                              35
            "id": "1656844591"
10
                                                                                           "name": "Neckar",
                                                                              36
11
                                                                                          "length": "1.0633858",
                                                                              37
          "type": "Feature"
                                                                                          "from": "1656844591",
12
                                                                              38
13
                                                                                          "to": "507930239",
        },
                                                                              39
                                                                                          "lines":[
14
                                                                              40
           geometry ":{
15
                                                                              41
             "coordinates": [936620.2210671, 6376420.5050057],
                                                                                               "label": "Neckar",
16
                                                                              42
             "type": "Point"
                                                                                               "color": "a4b020",
17
                                                                              43
18
          },
                                                                                               "id": "514832816"
                                                                              44
           'properties ":{
19
                                                                              45
             "color":"ff0000",
\mathbf{20}
                                                                              46
             "id": "507930239"
                                                                                           "type":"river"
\mathbf{21}
                                                                              47
\mathbf{22}
                                                                              48
           "type": "Feature"
                                                                                         "type": "Feature"
23
                                                                              49
\mathbf{24}
        },
                                                                              50
\mathbf{25}
                                                                              51
           "geometry":{
26
                                                                                    'type": "FeatureCollection"
                                                                              52
                                                                              53 }
```

Output file with two nodes and one edge

Data extraction 1/2

- OSM Data Structure
 - Nodes
 - \cdot latitude, longitude, and node id
 - Ways
 - \cdot nodes, referenced by their ids
 - Relations
 - · relationship between nodes, ways, and/or other relations

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- Tags of nodes, ways, and relations
 - \cdot key + value, for example: waterway=canal

Data extraction 2/2

Extracting Procedure

- 1. Filter out the related ways and save
 - \cdot name of the waterway
 - \cdot type of the waterway (river, stream, canal, etc.)
 - \cdot node ids as ordered list
- 2. Find out the needed nodes and save
 - \cdot latitude, longitude

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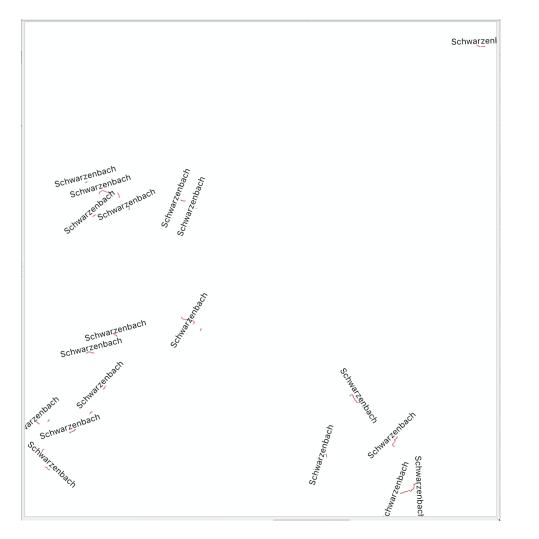
Storage structure 1/3

unordered_maps

- Node map, key: node id
 - set: edges referencing the current node (eInN)
- Edge map, key: edge id
 - \cdot river id
 - set: upstream river ids (rInE)
- River name map (temporary), key: river name
- River map, key: river id
 - set: edges in the current river (eInR)

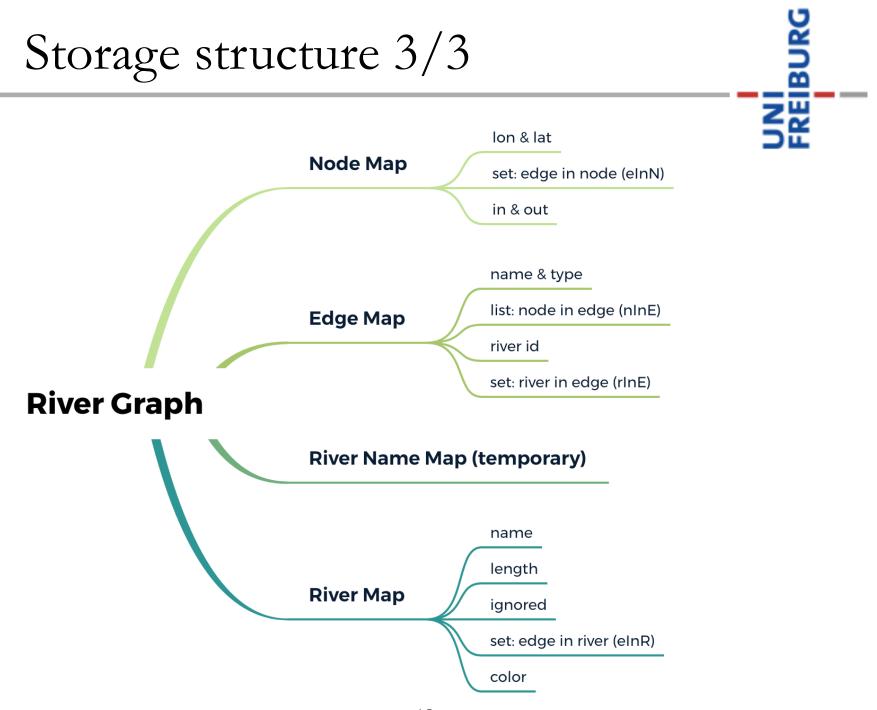
Storage structure 2/3

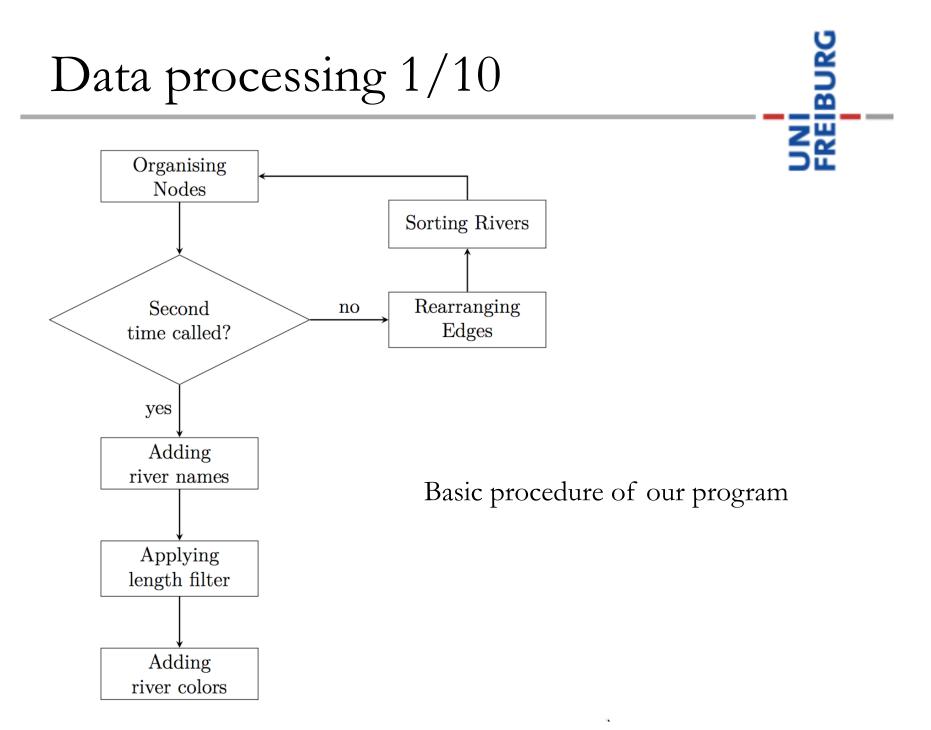
■ Splitting rivers with the same name, why?





"Schwarzenbach" in the black forest





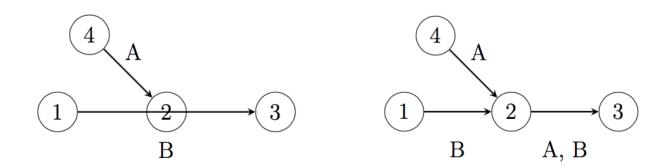
Data processing 2/10

Organising nodes, step 1/6

- Three kinds of special nodes in directed graph point of view
 - · starting points (source of a river)
 - \cdot intersection points
 - \cdot destination points (mouth of a river)
- in and out for these special nodes
 - starting points: in = 0 and $out \ge 1$
 - \cdot intersection points: $in + out \ge 2$
- · destination points: $in \ge 1$ and out = 0

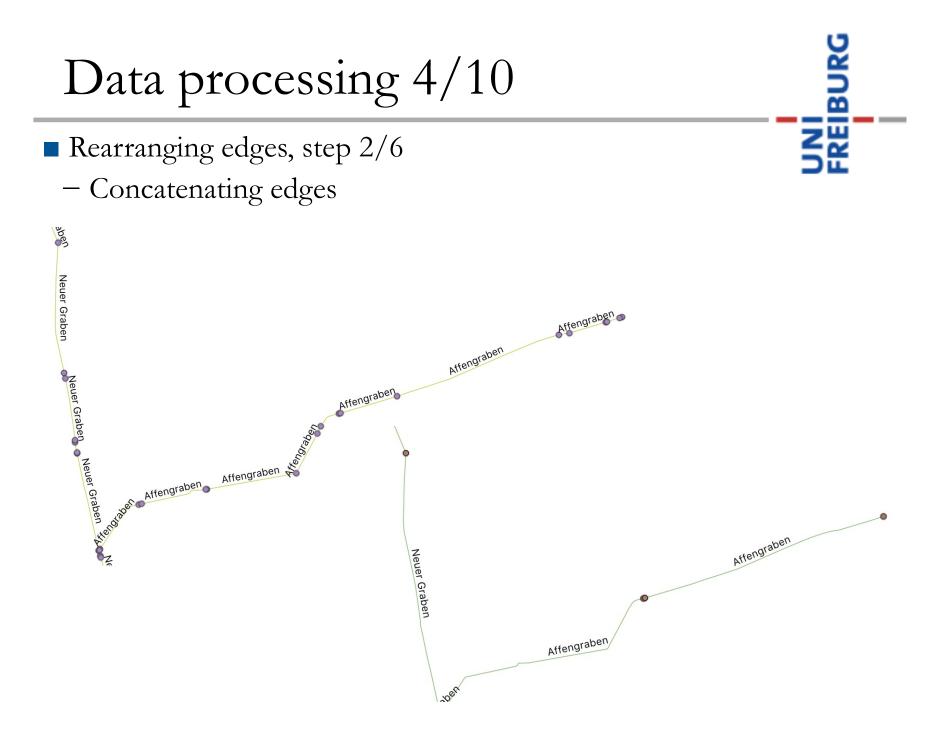
Data processing 3/10

Rearranging edges, step 2/6
 Splitting edges



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Data processing 5/10

■ Sorting rivers, step 3/6

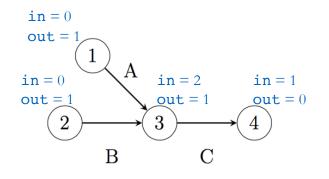
- Add river map (key: river id)
 - \cdot river id is the id of the first explored edge in this river group
- Delete river name map (key: river name)
- Run "organising nodes" again

Data processing 6/10

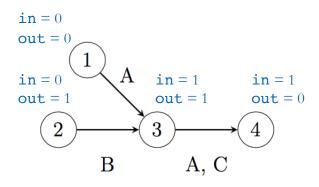
- Adding river names, step 4/6
 - Find all the global river source nodes
 - \cdot in = 0 and out \geq 1
 - \cdot this is our initial explore set
 - Add upstream rivers' names to downstream rivers
 - \cdot for the upstream node: **out** 1
 - \cdot for the downstream node: in 1
 - \cdot if **out** = 0, wipe out from the explore set
 - \cdot if in = 0, add to the explore set
 - \cdot variant of breadth-first search (BFS) algorithm

Data processing 7/10

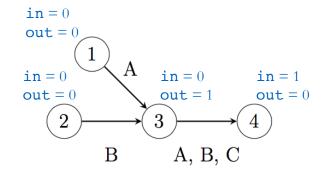




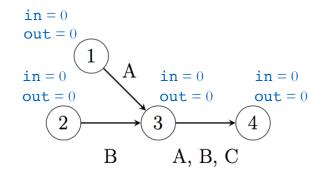
Step 1, Explore set (initial): 1 & 2



Step 2, Explore set: 2



Step 3, Explore set: 3



Step 4, Explore set: empty

Data processing 8/10

- Applying length filter, step 5/6
 - In name adding procedure:
 - · ignored was set to true if river length under the threshold
 - Clean nodes, edges, and rivers respectively
 - \cdot downstream river of an unignored river will not be removed

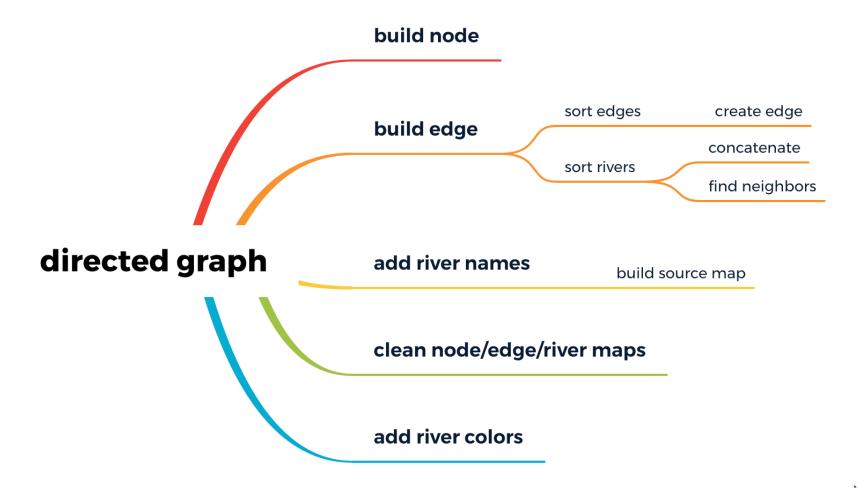
Data processing 9/10

Adding river colors, step 6/6

- HSV (hue, saturation, lightness) model, other than RGB
 - \cdot more intuitive in terms of choosing colors
- For each river, generate a unique color
- Make sure the intersected ones have different colors

Data processing 10/10

Processing procedure from the code point of view



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Evaluation

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Test results

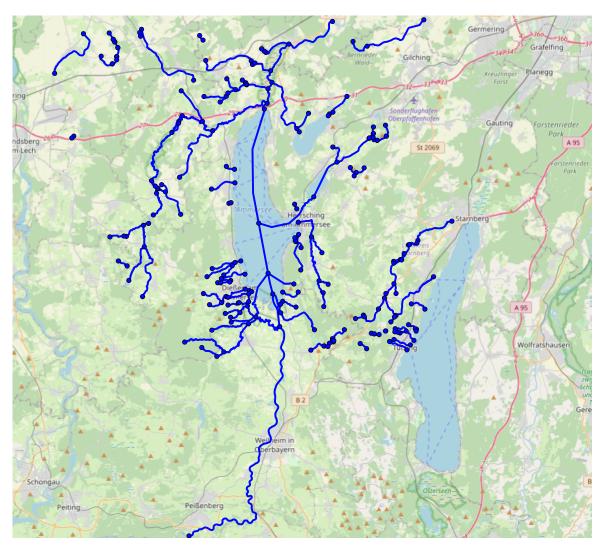
Laptop with Intel Core i7 2,7 GHz (4 Cores) with 16 GB Memory

	Map Size	Amount of points	Amount of lines	Running time in seconds
Hamburg	588 MB	1148	953	19
Freiburg	2.16 GB	7142	6377	72
Bavaria	10.52 GB	26832	23549	362
Germany	56.96 GB	124610	106394	2019

Quasi-linear growth of running time by the size of the data

Possible problems 1/5

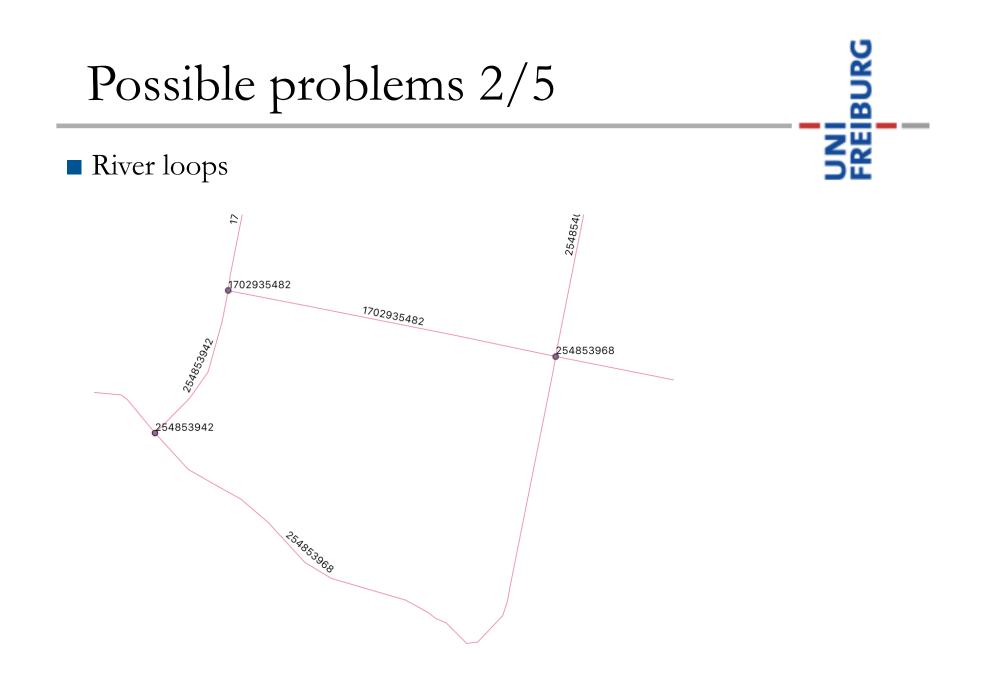
■ Interruption Caused by Lakes

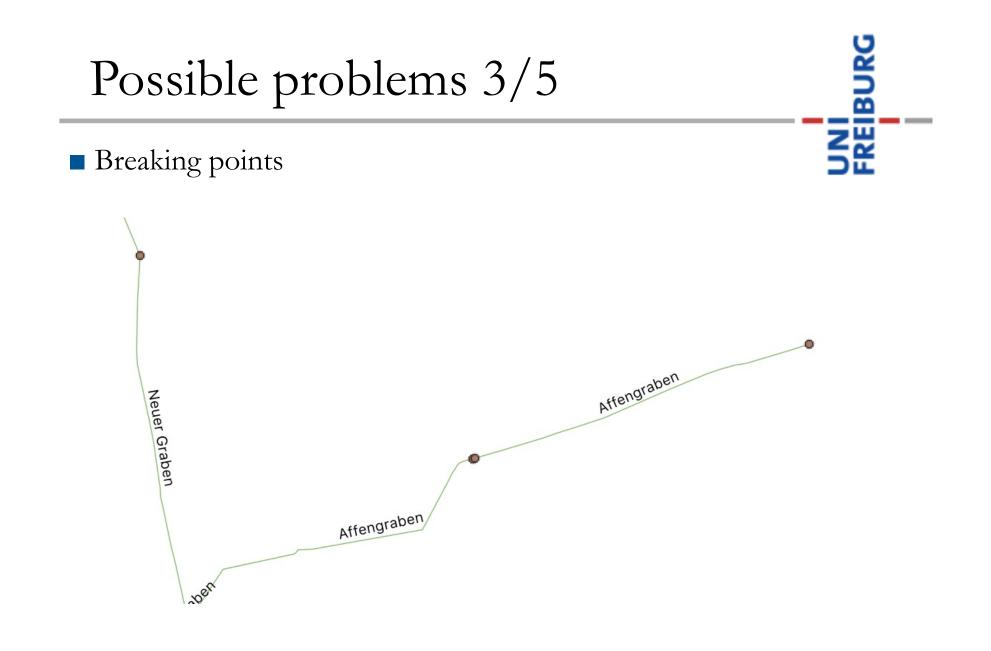


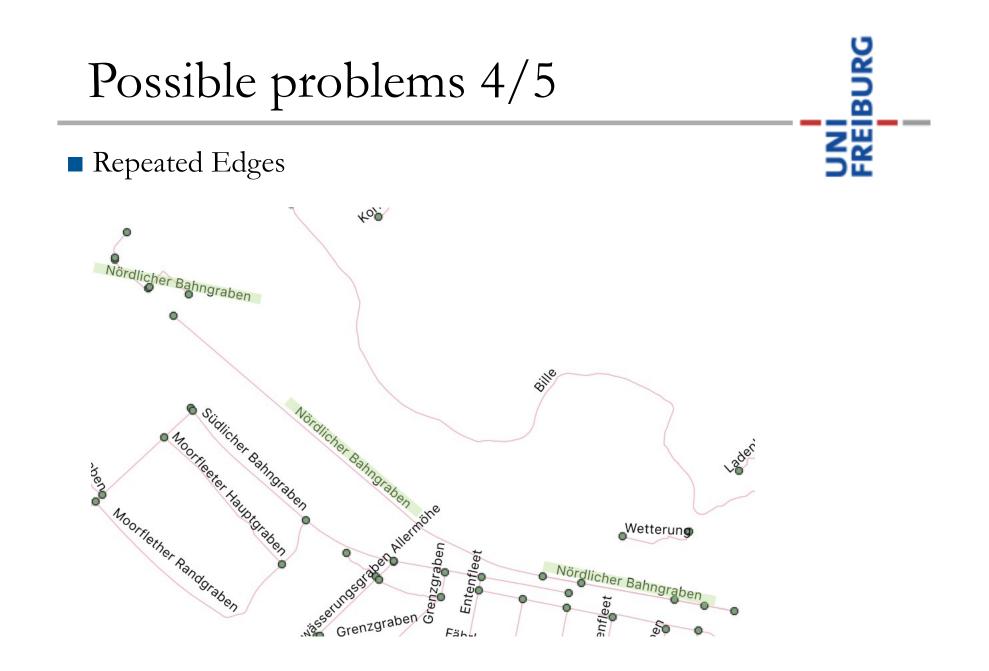
Rivers around Ammersee, Bayern

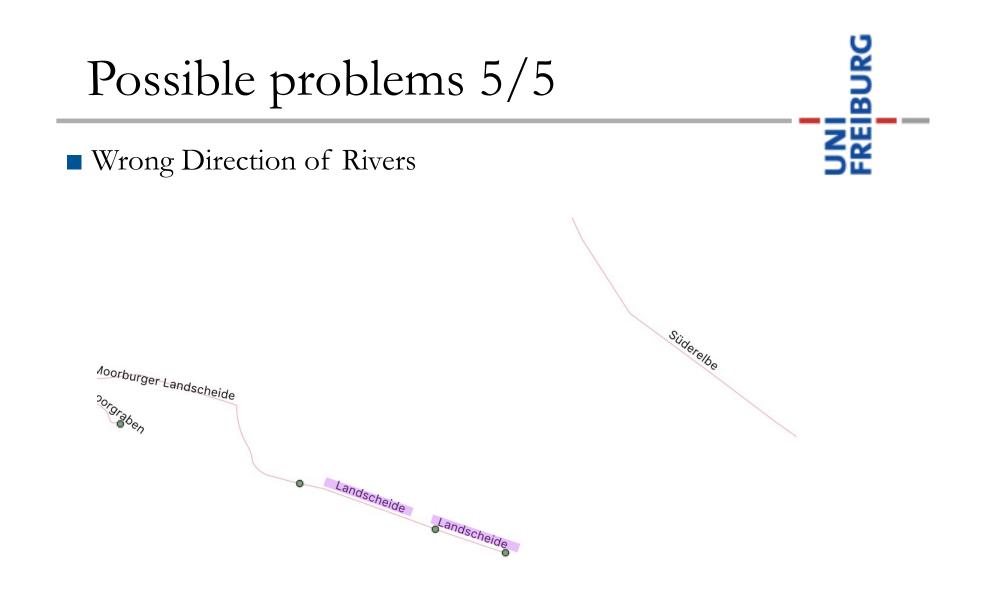
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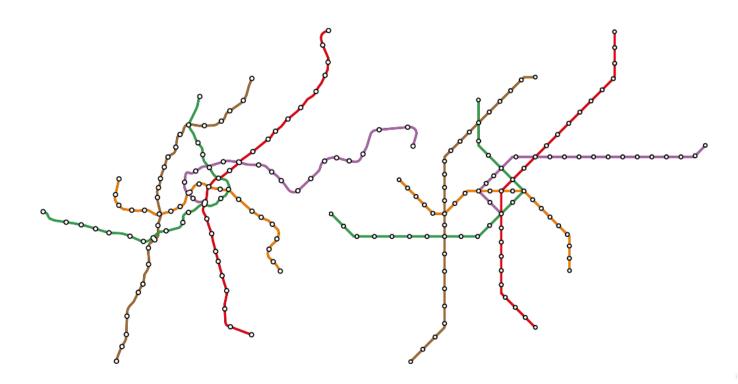




Future work

- Identifying and correcting the above data inconsistencies
- Other creative ideas, e.g. apply the results on octilinear grid graphs?

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References

- Wikipedia
- 1. https://commons.wikimedia.org/wiki/File:Karte_der_S-Bahn_München.svg
- 2. https://en.wikipedia.org/wiki/Thalweg
- OpenStreetMap Wiki
- 1. https://wiki.openstreetmap.org/wiki/Tag:waterway=riverbank
- 2. https://wiki.openstreetmap.org/wiki/Tag:waterway=river
- 3. https://wiki.openstreetmap.org/wiki/Relation
- Literatures

 H. Bast, P. Brosi, and S. Storandt: Metro Maps on Octilinear Grid Graphs. EuroVis *Eurographics Conference on Visualization*, 2020, volume 39, issue 3.
 H. Bast, P. Brosi, and S. Storandt: Efficient Generation of Geographically Accurate Transit Maps. *ACM Trans. Spatial Algorithms Syst.* 5, 4, Article 25 (September 2019), 36 pages. <u>https://doi.org/10.1145/3337790</u> **Bachelor** Thesis

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Thank you for your attention! Questions?