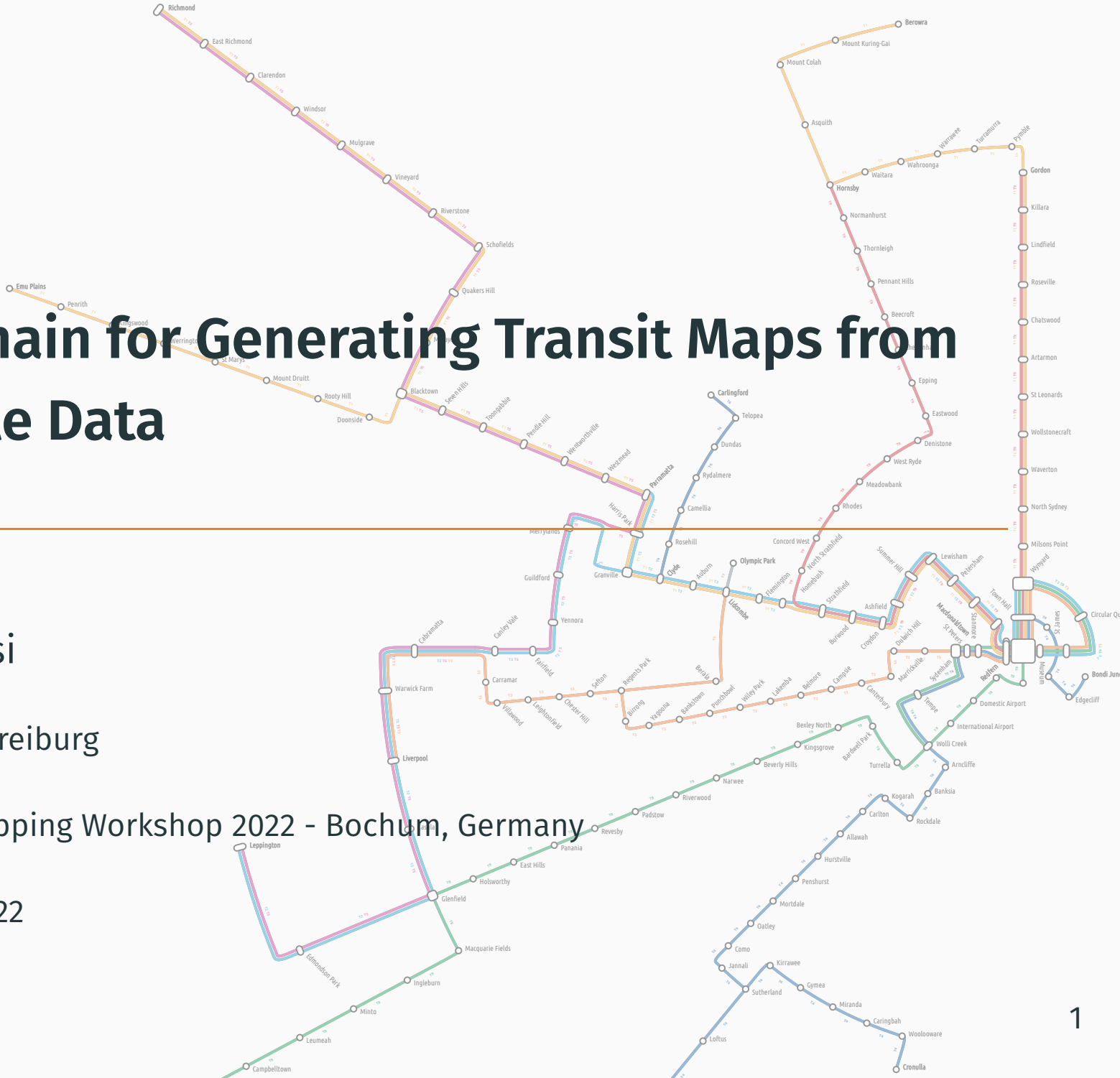
A Toolchain for Generating Transit Maps from Schedule Data



Patrick Brosi

University of Freiburg

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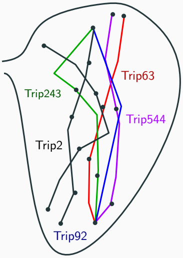
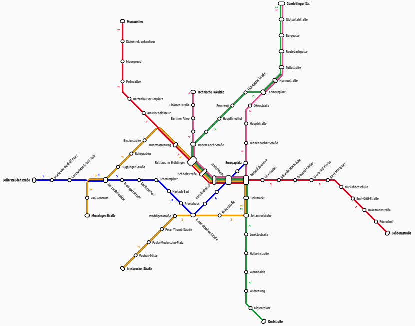
Motivation (1/2)

Goal: given some schedule dataset, render a (schematic?) transit map



"Bag of trips"

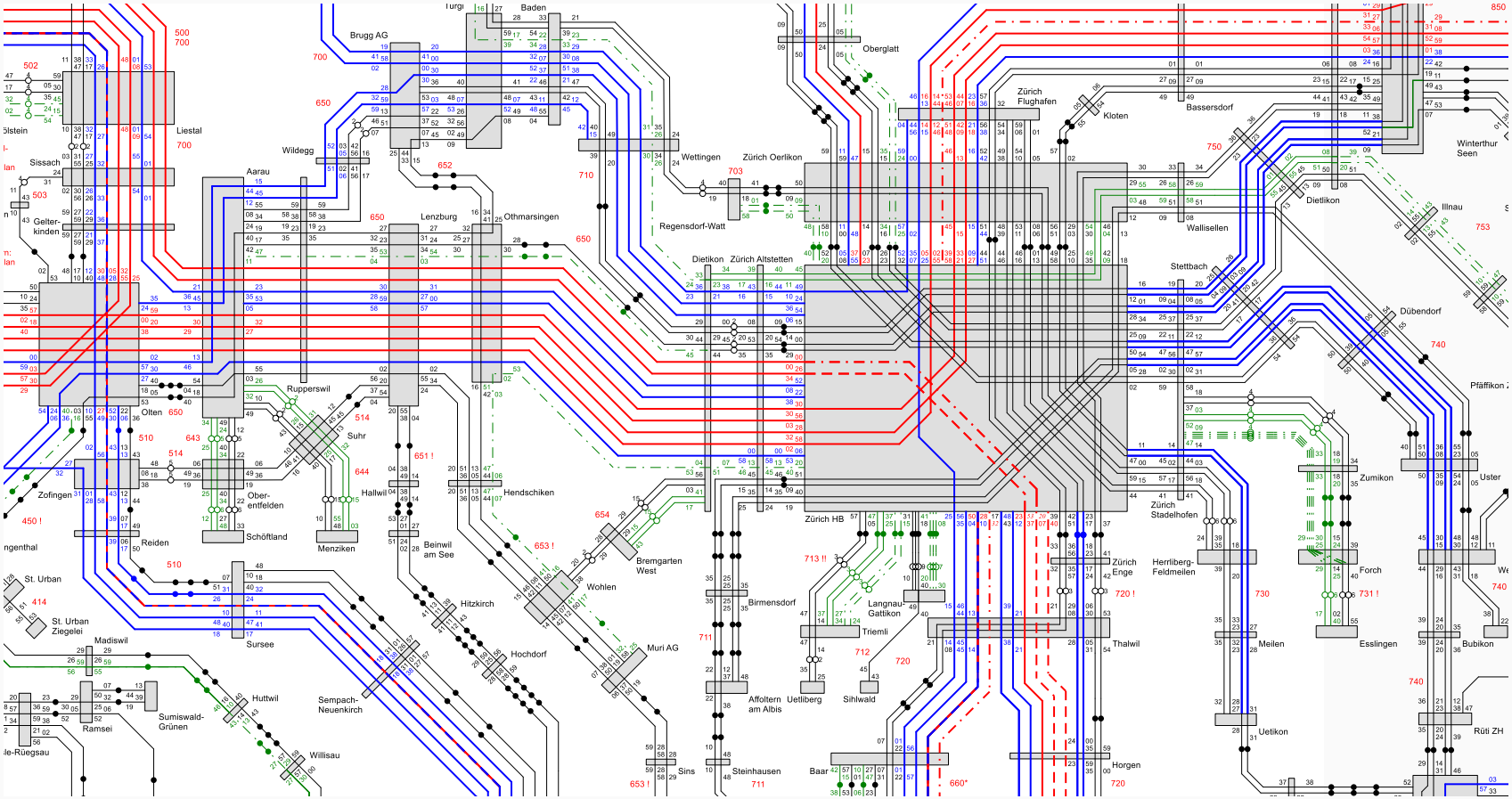
⇒



- **Well researched:** schematization, line-ordering, labeling, esthetic aspects, ...
- **Focus today:** hands-on presentation of a **software suite** to achieve this goal.

Motivation (2/2)

“Just render it automatically”

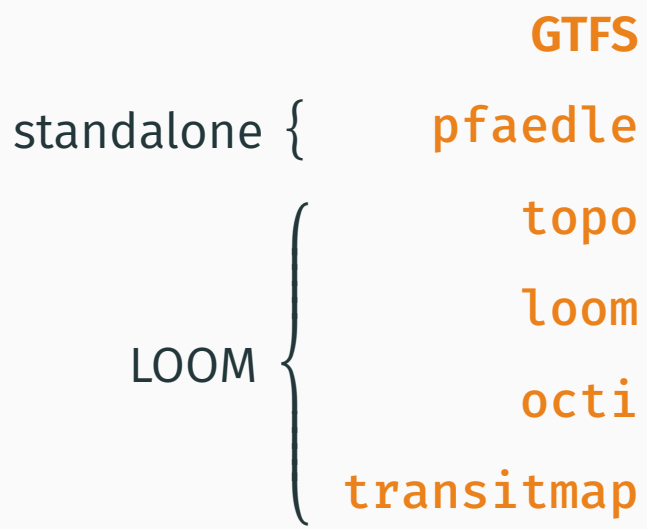


Schedule Data as Input

- Typical input data for research methods: graph embedding of a transit network
- Usually, **this** is what schedule data gives you:

Toolchain Overview

1. Raw schedule data
2. Geographical line courses
3. Overlap-free graph of network
4. Line-Ordering optimization
5. Optional Schematization
6. Rendering



Code: `https://github.com/ad-freiburg/pfaedle`
`https://github.com/ad-freiburg/loom`

`pfaedle` - Generate Geographical Line Courses

Input: GTFS data, OpenStreetMap (OSM) data

Output: GTFS data with geographical line courses

- Map-matching problem
- We use a hidden Markov model based approach[1]

Usage:

```
pfaedle -x freiburg.osm freiburg-gtfs
```

[1] Bast and Brosi, “Sparse map-matching in public transit networks with turn restrictions”.

`topo` - Extract Overlap-Free Line Graph

Input: Line-labeled graph (line graph) of transit network

Output: "Free" line graph without overlaps

- Map-construction problem (typical use case: extract road network from collection of GPS traces)
- We use a constructive approach similar to an approach by Cao and Krumm[2]

Usage:

```
topo < freiburg.raw.json > freiburg.json
```

[2] Cao and Krumm, "From GPS traces to a routable road map".

`loom` - Line-Ordering Optimization

Input: Line graph

Output: Line graph with line label orderings which minimize (weighted) line crossings / separations

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- Combinatorial optimization problem (MLCM), we only allow crossings at nodes (MLNCM)
- Optimization approaches described here[3]

Usage:

```
loom < freiburg.json > freiburg.opt.json
```

[3] Bast, Brosi, and Storandt, “Efficient Generation of Geographically Accurate Transit Maps”.

`octi` - Line Graph Schematization

Input: Line graph

Output: Schematic variant of the line graph

- Uses a grid-based schematization approach, currently supports ortholinear, octilinear, hexalinear, and orthoradial layouts
- Optimization approaches described here[4] and here[5]

Usage:

```
octi < freiburg.opt.json > freiburg.octi.json
```

[4] Bast, Brosi, and Storandt, “Metro Maps on Octilinear Grid Graphs”.

[5] Bast, Brosi, and Storandt, “Metro Maps on Flexible Base Grids”.

`transitmap` - Line Graph Rendering

Input: Line graph

Output: SVG drawing of the line graph

- SVG allows for easy edit, high-quality print, and use in web maps
- Allows easy styling via CSS (which can be included in the GeoJSON file)
- Can also be used in web maps
- Approach: see here[6]

Usage:

```
transitmap < freiburg.octi.json > freiburg.octi.svg
```

[6] Bast, Brosi, and Storandt, "Efficient Generation of Geographically Accurate Transit Maps".

Pipeline Approach

- We took the chain metaphor seriously: LOOM tools can be plugged together via Unix pipes
- Between each step, the tools output and read a GeoJSON graph
- Allows for easy modification / extension

```
gtfs2graph <gtfs> | topo | loom | octi | transitmap > map.svg
```

Who (do we hope) is this for?

1. **Researchers** who want to try their own methods
2. **Map designers** for fast prototyping
3. **Schedule planers** for visualization of schedules

Rough Edges - What doesn't work

1. `pfaedle` only accepts XML OSM files
2. All tools only accept **extracted** GTFS feeds - not ZIPs.
3. Labeling is **preliminary** - for schematic maps, labeling should be part of the schematization
4. Enlargement of high-density areas in schematic maps
5. Schematic maps are based on a heuristic approach, which is a bit unstable - small changes to the input may result in a completely different layout.
6. Very large networks (London, New York) often show constraint violations, ILP approach takes too long (hours)
7. Tariff zones?
8. Holy grail: interactive map editor

Thank you!

http://loom.informatik.uni-freiburg.de

http://octi.informatik.uni-freiburg.de

Activity Ideas

If you are **familar** with installing Unix tools:

1. Go to `http://ad-research.cs.uni-freiburg.de/smw` and follow the instructions, try out some examples
2. Installation can be also be done via Docker for minimal dependencies

If you are **not familiar** with Unix tools:

1. You can browse the render example at `https://octi.cs.uni-freiburg.de/` and `https://loom.cs.uni-freiburg.de/`
2. There you also play around with different layouts or methods
3. There is a JS implementation of the *octi* approach (by Tim Janiak) here: `https://ruhr-uni-bochum.de/schematicmapping/janiak`
4. You can play around with the results of a `pfaedle` run in Germany (and other areas) here: `https://travic.app`

Also feel free to ask me any questions!