Visualizing Mobile Network Data

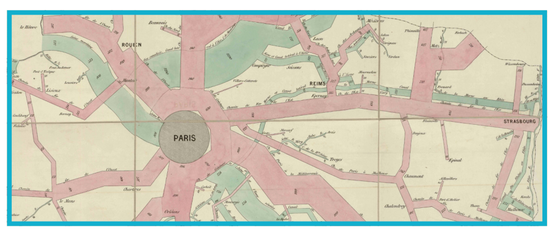
A User-Centred Design Approach Connecting Visual Analytics to Urban Public Transportation Planning

by **LAURA VERENA KLASEN**

Urban regions are becoming increasingly crowded, which places heavy demands on public transportation networks. Movement data stemming from mobile network data is becoming cheap and easy to obtain and much research has been done within the field of Visual Analytics on how to best visualize these data for analytic tasks. Yet, collaboration with the public transportation sector has been lacking [1]. This work addresses that research gap by developing an interactive visualization concept for attributed flow data stemming from mobile network data to be used by professionals in the field of urban public transportation planning.

CONTEXT

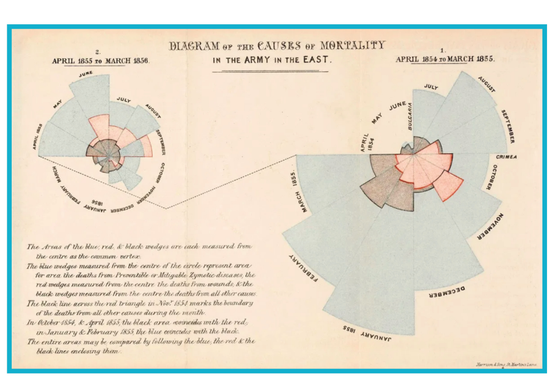
This study was conducted in collaboration with Fraunhofer IAIS, contributing to the xMND-project. This project aims to make mobile network data (MND) usable for public transportation planning by combining it with volunteered tracking data and modelling the mode of transport to trips extracted from the raw data.



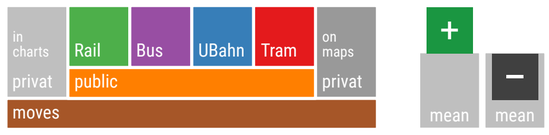
Detail from a series of flow maps by Minard depicting the Circulation of Goods on French Railroads and Waterways between 1850 and 1862. Image taken from https://patrimoine.enpc.fr/document/ENPC01_4_10975, accessed 2020/09/18.

VISUALIZATION CONCEPT

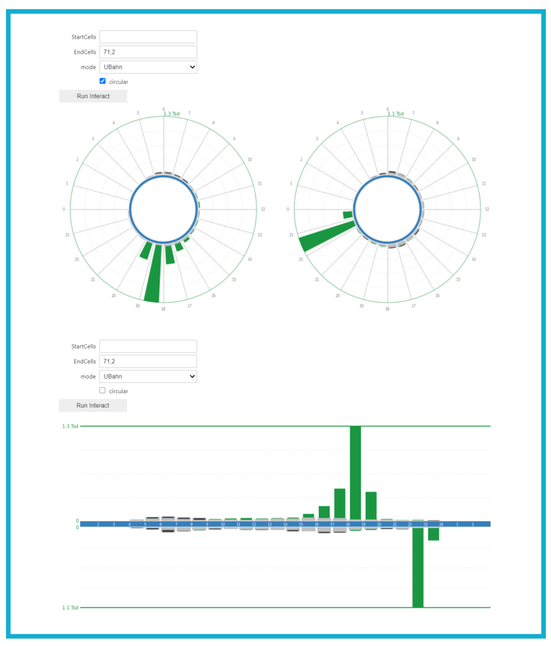
A user-centred design approach [2] was taken, starting with expert user interviews and resulting in the evaluation of a developed prototype. The design of the visualizations is furthermore based on an exploration of the historical development of visualizations of spatiotemporal data [3,4] as well as on recent developments within Visual Analytics [5]. The proposed concept entails a visual interface to the data organised in two parts: A spatial overview for a given period of time and a complementary temporal overview for a chosen spatial situation. Flow maps show movements using lines of varying width and colour. Radial and horizontal bar charts show the development of movement throughout a day. Two datasets containing one week of flows and origin-destination (OD) information respectively were aggregated for synoptic and comparative analysis each, resulting in an analytic scenario in four stages. Colours were used to indicate the assigned mode of transportation and the type of anomaly for comparative views of the data. The interactive visualizations were developed in python using JupyterNotebooks.



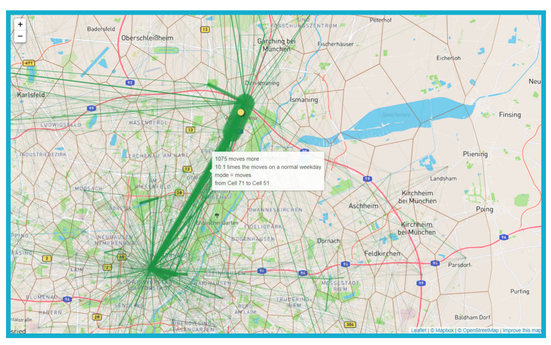
Coxcomb Chart from 1857 by Florence Nightingale showing the Causes of Mortality in the Army during the Crimean War. Image taken from https://www.brainpickings.org/2017/10/09/w-e-b-du-bois-diagrams, accessed 2020/06/18.



The colours used for different modes (left) and to represent anomalies (right). The colours roughly correspond to the official colours used by public transport associations. The colour scheme is based on a Colorbrewer-palette (https://colorbrewer2.org/)



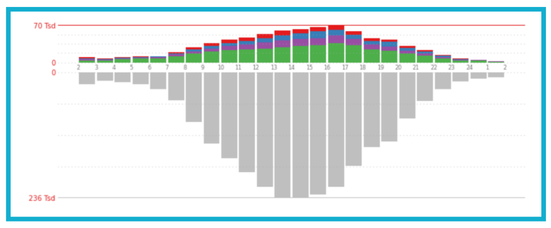
Radial and horizontal bar charts showing anomalies in public underground traffic to (left radial chart, top part of horizontal chart) and from (right radial chart, bottom part of horizontal chart) the mobile network cells associated with Allianz Arena. Light grey bars show average workday values, green and charcoal grey bars show the difference to these on the day a football event took place.



Flow map showing anomalies in OD data on the day a football event took place at Allianz Arena which is located at the yellow dot. Up to ten times as many people travelled along certain routes on that day compared to an average weekday.

USER TEST

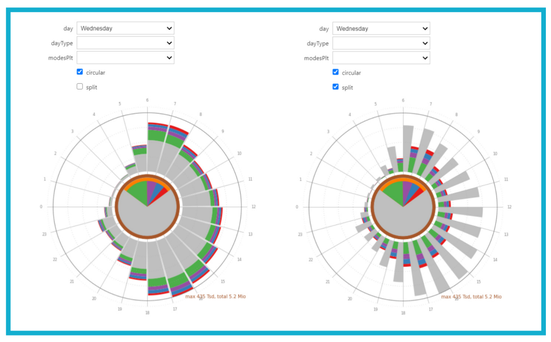
The visualization concept was tested with two small groups of professional public transportation planners who were asked to verbalise their thoughts while interacting with the prototype, fill out a questionnaire and summarise their impressions in a final discussion. The test users appreciated the proposed visualization concept and offered useful feedback.



Horizontal stacked bar chart showing public movement (upwards) and private movement (downwards) in Munich between 2 a.m. on a Sunday and 2 a.m. on a Monday.

CONCLUSION

The results of the user tests show that the incorporation of attributed movement data stemming from mobile network data can help improve several issues of the current framework used for public transportation planning. However, as only the first iteration of a user-centred design cycle could be realised within the given time, several improvements need to be incorporated and evaluated in further cycles in order for a well working product to be developed.



Possible changes in the visualizations based on the results of the user tests: the total number of plotted movements is now indicated by a pie chart in the centre of the plot. A modal split can be chosen, dividing each bar into two slimmer ones.

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YEAR

2020

KEYWORDS

Visual Analytics, Urban Public Transportation Planning, User-Centred Design, Extended Mobile Network Data, Spatio-temporal Data

REFERENCES

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Find all JupyterNotebooks containing the code for the visualizations here: https://github.com/klavere/xMNDvis

This master thesis was created within the Cartography M.Sc. programme – proudly co-funded by the Erasmus+ Programme of the European Union.

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