ViaVelox - A System to Visually Analyze GPS-tracked Bike Rides

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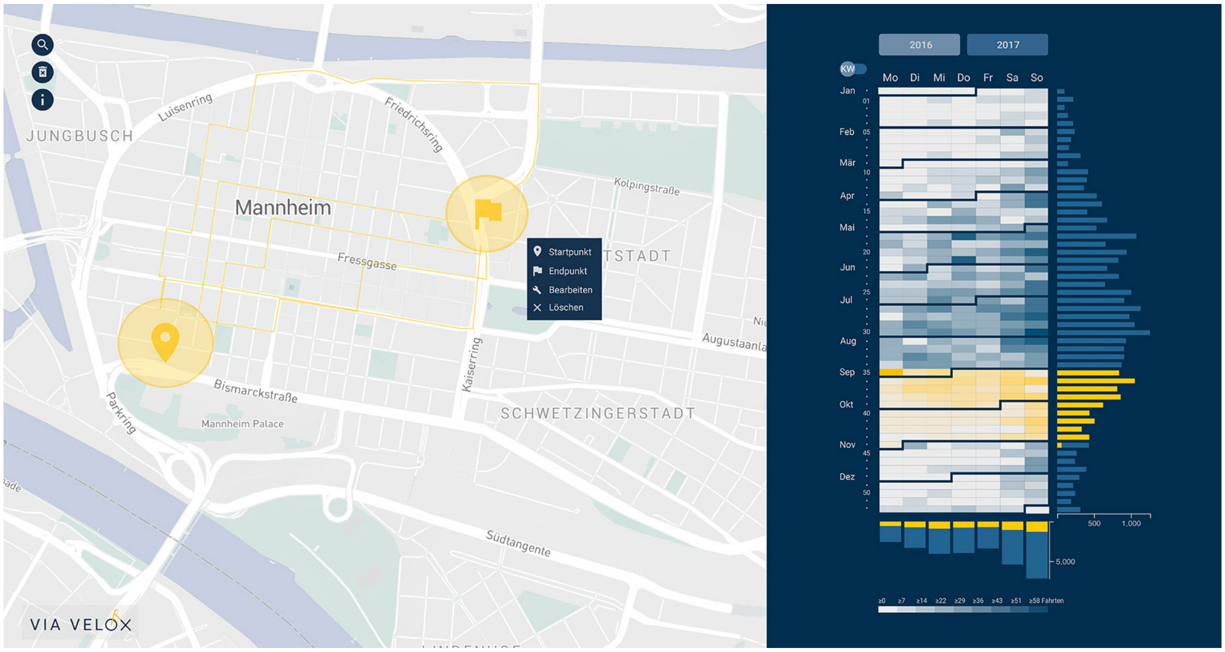

Figure 1: Visualization system with selected rides on the map (left) and filtered days in the frequency matrix (right).

ABSTRACT

This paper presents Via Velox, a system visualizing rides tracked and shared by cyclists through a mobile app. It shows a map and a calendar view side by side, and enables to interactively filter spatial and temporal properties of the rides to allow analyzing bicycle traffic. We explain the functionality of the prototype, and briefly discuss some of the insights people had while using the system at a public exhibition on a bicycle festival.

Keywords: visual analysis, trajectories, urban mobility

1 INTRODUCTION

Mobility behavior of cyclists much more depends on individual characteristics and preference in comparison to users of public transit or motorized private transport. One of the goals of this project was to get a deeper understanding how cyclists move around in their environment. While a multitude of apps allow recording personal bike trip data, these typically are for tracking individual routes, or for measuring fitness goals. Our system gathers a range of volunteered trajectory data, and visualizes them in order to support a better understanding of bicycle mobility patterns and trends.

Via Velox has been developed within a larger student research project together with traffic planners from the region to investigate demand-oriented planning of a cycling network. While a group from a partner university developed the mobile app to track bike rides, this poster presents the visualization system of such tracked data.

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2 RELATED WORK

One of the main goals of interactive geovisualizations is to ease identifying and comparing temporal and spatial patterns, as well as combinations thereof. A wide set of techniques for visualizing movement [1], and more specifically mobility data [3] have been developed. In the context of bicycle mobility, these range from visualizing trajectory data, to origin/destination paths in bike sharing systems [5, 6].

While many combine visualizations of the data's temporal and geo-spatial properties, including flow maps, and space time cube variations [2], others focus on providing sophisticated interaction mechanisms to finely select and filter spatio-temporal data (e.g. [4]).

In our systems for visually analysing dense amounts of bike trajectories, we aimed to make overall patterns easily understandable to the public or more casual users, while offering deeper insights to experts, or other people investing more time to learn the system.

3 VIA VELOX - THE PROTOTYPE

After a design thinking workshop with different stakeholders ranging from transit planners, to cyclists, to designers and developers, we drafted wireframes and developed a series of datavis experiments before deciding on the design of the final prototype.

The functional system provides two coordinated views: A map with bike trajectories, and a frequency matrix with a calendar heatmap and adjacent histograms (Fig. 1).

3.1 Trajectory Map

The map view shows the paths of all bike trips. The trajectories are simplified to a degree where it shrinks the data volume on the client side without reducing the expressiveness of the paths. All paths are shown in blue, and selected paths in yellow.

The interactive map can be zoomed and panned to investigate areas of interest. Analysts can enter place names into the search field, after which the map automatically adapts to show the found place with a zoom level dependent on the hierarchy level of the place (i.e. a small scale for a region, and a large scale for a neighborhood). All bike trajectories starting in, ending in, or passing through the current view are shown. By clicking anywhere on the map, users can select areas to filter bike trips which started or ended there. A translucent yellow circle is displayed whose size encompasses the geographic area to filter. Users can use direct manipulation to update these filters. By dragging the border of the circle, people can change the radius of the circle to highlight more or fewer cycling paths.

Each newly created circle acts as start filter, i.e. bike trips are highlighted which began in that area. Changing an area from start to end filter, or vice versa is possible through a context menu with the current status indicated through a centered icon. Lastly, users can also remove circles via the context menu, or reset all by clicking on the button on the top left menu.

3.2 Calendar heatmap

On the right side, the temporal distribution of bike rides are visualized as a heatmap, with darker cells indicating higher amounts of rides. The calendar shows days of the week on the x-axis, while the y-axis either shows weeks of the year, or the 24 hours of the day. Two marginal histograms on either sides show aggregated frequency of trips for each weekday, as well as for each week, respectively each hour. By summarization, these histograms allow a more direct comparison of trends over the different temporal levels.

Every spatial filtering in the map is mirrored in the calendar view, with all matching trips being displayed over time. Here, the two axes as well as the legend update dynamically.

Users can select time spans via the calendar by clicking on single cells, or by dragging the mouse over the matrix. For instance, they can select Monday through Friday to analyse cycling behavior on business days. Or they can choose specific times of day, to better investigate the emerging patterns at rush hours. Each selected cell is highlighted in yellow, with a matching gradient color schema representing the same amounts of rides per unit.

After selecting specific time ranges, the histograms on each side get updated to highlight the sub-selection, as well. In this way, the highlighted parts of the histogram bars enable comparing the frequency of trips in a selected time range with the overall distribution of all bike trips (see Fig. 1).

4 Feedback

Via Velox[1] was exhibited publicly at a large urban festival (Fig. 2). This bicycle festival celebrated the 200th anniversary of the invention of the bike in Mannheim, and was open to the public. Our goal was to demonstrate Via Velox to interested people, to encourage cyclists to participate in our project by tracking their rides, and to discuss bike related themes with the public. As citizens could test the working visualization prototype, we also gathered first informal feedback.

In the relaxed social setting of a public festival, people were compelled to try out the visualizations in a casual way. One of the goals of our spatio-temporal visualization was to enable people to explore cycling behavior according to their personal interests. We observed many visitors to first pan to local regions, and when asked responded they were looking into their neighborhood, or the routes they are taking.

[1] http://infovis-mannheim.de/viavelox/

Figure 2: Citizens discussing cycling infrastructure in front of our exhibition booth at the bicycle festival in Mannheim.

While the calendar in general mostly was well understood, the histograms needed further explanations. One of the most common patterns in mobility data are daily fluctuations, and specifically in bicycle datasets seasonal fluctuations. Visitors were able to understand such temporal patterns, and identified commuting on working days, or general higher cycling activities in spring and summer time.

Similarly, the spatial filtering mechanism commonly was used only after pointing out that feature. We guided visitors through a scenario which highlighted more complex spatio-temporal patterns such as commuter behavior with cyclists riding to an industrial campus in the morning and from that area in the evening.

5 Conclusion

First feedback from visitors of our exhibition booth let us to believe our visualization system works as intended. The attractive visualizations and simple but powerful interactions make bicycling data accessible and comprehensible. Together, Via Velox makes movement data accessible and comprehensible. While parts of the system have not been self-explanatory for casual users, explaining the views and filters, and demonstrating a scenario helped users to better understand the system. We learnt that Via Velox enables gathering a variety of insights, ranging from seeing which routes are used more frequently, to understanding daily patterns such as morning and evening movement behavior. With this, we hope that our system helps to improve safety on the way to work, school or university, and contributes to a sustainable urban mobility planning.

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References

[1] N. Andrienko and G. Andrienko. Visual analytics of movement: An overview of methods, tools and procedures. *Information Visualization*, 12(1):3–24, 2013.

[2] B. Bach, P. Dragicevic, D. Archambault, C. Hurter, and S. Carpendale. A Review of Temporal Data Visualizations Based on Space-Time Cube Operations. In *Proc. of EuroVis*, 2014.

[3] W. Chen, F. Guo, and F.-Y. Wang. A Survey of Traffic Data Visualization. *IEEE TITS*, 16(6):2970 – 2984, 2015.

[4] N. Ferreira, J. Poco, H. T. Vo, J. Freire, and C. T. Silva. Visual exploration of big spatio-temporal urban data: A study of new york city taxi trips. *IEEE TVCG*, 19(12):2149–2158, Dec 2013.

[5] T. Nagel, C. Pietsch, and M. Dörk. Staged Analysis: From Evocative to Comparative Visualizations of Urban Mobility. In *Proc. of IEEE VISAP*, pp. 23 – 30, 2016.

[6] J. Wood, A. Slingsby, and J. Dykes. Visualizing the Dynamics of London's Bicycle-Hire Scheme. *Cartographica*, 46(4):239 – 251, 2011.