Isoscope - Visualizing temporal mobility variance with isochrone maps

Flavio Gortana* FH Potsdam
Sebastian Kaim† FH Potsdam
Martin von Lupin‡ FH Potsdam
Till Nagel§ Interaction Design Lab, FH Potsdam

ABSTRACT

Isochrone maps are an established method to depict areas of equal travel time, and have been used in transportation planning since the early 20th century. In recent years, interactive isochrone maps allowed users to select areas of interest, or explore temporal mobility patterns for different modes of transport. However, conventional isochrone maps depict one traffic situation at a time.

Our visualization approach unifies isochrone maps with time-varying travel data, and instead of showing multiple isolines for different travel times, we show multiple isolines for different times of day in order to reveal time-dependent spatial travel variance. In this paper, we present Isoscope, a web application that provides an interactive map for casual exploration of urban mobility patterns. Through its aesthetic visual form and its simple interface we strive to support people investigating travel time in their own city. We will describe our design goals, elaborate on the design and implementation of our prototype, and discuss limitations and future extensions of the system.

Index Terms: H.5.m [Information Interfaces and Presentation]: Miscellaneous—; I.3.6 [Computer Graphics]: Methodology and Techniques—Graphics data structures and data types

1 INTRODUCTION

Getting around is an essential part of people's behavior in a city. We drive to the supermarket, take the bike to the gym, or walk to the nearest coffee shop. With Isoscope, we wanted to investigate these situations, particularly when our mobility is compromised during traffic jams or other limiting driving conditions. We were interested in finding out how those restrictions impact our journeys through the city.

Various systems have been developed and used to visualize mobility data, and to reveal time-varying patterns. However, these either are complex visual analytic tools for urban planners or transportation experts, or only depict one traffic situation at a time, and show travel times independent of temporal traffic variations.

Isoscope uses 24 layered shapes, one for every hour of the day, to show the area around a chosen location reachable within a chosen travel time. With Isoscope, people can see and compare the influence of traffic conditions on their mobility. Thus, people not only can explore how the physical structure of the city with different road characteristics (e.g. one way streets or highways), and barriers such as rivers affect our travels, but how traffic varies over time, how daily rush hour slows down commute, or how dwelling areas might be less affected than arterial roads.

2 RELATED WORK

Isochrone maps (greek: *iso* = equal, *chronos* = time) show isolines on a map, connecting points that have the same travel time from a specified location, i.e. which can be reached within the specified time or less. For ground travel, they are typically following transportation routes such as roadways, or foot paths.

Isochrone maps for travel time have been displayed as subgraph in a road network [2], or as isolines [6]. The most common isochrone maps use multiple isolines to show travel time for different time spans (however without showing temporal variations).

In recent years, interactive travel maps have been created to explore urban transportation. Mapnificent [5] visualizes reachability by public transport in a given time. It uses time-table data to compute reachable area, and displays them as uncovered bubble shapes, while the rest of the map is grayed out. Public Transit Travel Time [7] uses heat maps to show transit travel times. In contrast to idealistic time table data, Isoscope incorporates actual road traffic data collected from sensors. And while both maps are available in major cities, due to our use of a traffic API with global range, Isoscope is applicable worldwide. The most important distinction, though, is that Isoscope is capable of revealing deviations in the reachable area due to changes in traffic conditions.

*e-mail: flaviogortana@gmail.com
†e-mail: sebastian.kaim@googlemail.com
‡e-mail: kontakt@martinvonlupin.de
§e-mail: nagel@fh-potsdam.de

Figure 1: User interface with a) search bar, b) the main map with an Isoscope in Berlin, c) the 24 hours time selector, and d) additional buttons to select week day, travel time, and transport mode.

3 ISOSCOPE - THE PROTOTYPE

The prototype (http://www.flaviogortana.com/isoscope/) allows people to see how far they can travel from any given spot, for the specified travel time, the time of day, and the day of the week. The fluidity and playfulness of the interface aim to encourage users examining variations in travel time.

Isoscope is a web-based application written in JavaScript. The interactive map is implemented using the Leaflet library [4] while the map tiles are provided by HERE [3]. We tried to reduce the visual complexity of the map in order to enable persons to focus on the visualized data. We used a gray-color style and selected most important geographic features in order to help users navigate and orient themselves. The isochrones are rendered in SVG using the data visualization framework d3 [1].

The traffic information is a formulation of aggregated data collected by HERE from a variety of sources: anonymized probes of mobile, personal & vehicular navigation devices, a network of traffic sensors, and from 3rd party data providers.

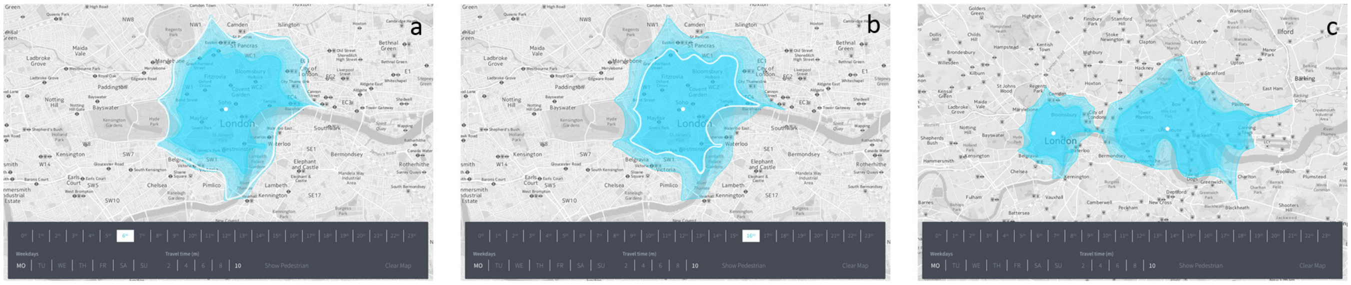

Figure 2: Comparing early morning (a) and the evening rush hour (b) in central London, and different areas with each other (c).

3.1 User Interface

The most prominent part of the interface contains the map (see Fig 1). Users can search for places by entering free-form text. We look this up in a gazetteer, and automatically pan to the location. At the bottom, an auxiliary control is displayed where users can set time parameters that affect the visualization. The most influencing parameter is the travel time that can be set from 2 to 10 minutes in 2-minutes intervals. Users can also select a day of the week, and an hour of the day. An additional layer showing mobility of pedestrians (for the same currently selected data filters) can be switched on and off and is displayed on top of the car visualization in a high contrast color (Fig 1 dark blue area). Since the reachability of pedestrians does not vary much, only one layer with average data is shown. Finally, all selected locations can be erased to start again, and explore a different area.

3.2 Visual style and Organic shape

Displaying the raw data from the API led to an angular polygon, as the calculated reachable nodes are simply connected linearly. Guided by the metaphor of fluidity of urban mobility we used smooth curves to create a visually more appealing shape. The resulting organic form also acts as a subtle cue to users that the displayed information might not be perfectly precise.

We adjusted color and transparency of the polygons in a way to support readability when displayed on a background map. While we considered showing only silhouettes in order to highlight the isolines, the layered lines became cluttered and hard to decipher on a map. We chose translucent shapes with different opacity levels for the layers to assist recognizing the main travel areas, as well as outstretching sections with distinct reachability.

3.3 Walk-Through

First, the user zooms and pans to an area of interest, and clicks on a specific location. Multiple isochrone shapes are displayed, based on the settings of the control (e.g. travel time). When hovering/scrubbing over the timeline the single shape for the selected hour is highlighted (Fig 2a and b). Parameters to explore the location further can be set like the change of the travel time. Switching between days (e.g. weekdays vs weekend) allows comparing the different scopes for rush hours on work days and corresponding times on days with less traffic density. Selecting additional locations on the map lets users compare isochrone shapes of multiple places side by side (Fig 2c).

4 Limitations

While the accuracy of the traffic data was not part of our research, it is an important factor for users of our visualization. User feedback gathered from forums and social networks suggest many were comparing the shown times to their personal experience. We use the HERE Platforms Isoline service, but due to its calculation being based on the current or historical traffic conditions the precision of the result may vary from location to location. We tried to mitigate this perceived discrepancy through the organic visual style.

Currently, travel time can be set to a maximum of 10 minutes, which may be seen as restrictive especially for areas of low population density. This limitation is due to the resource-intensive computation needed by the API to calculate the isoline shapes. In order to give people a good user experience even when allowing user-defined locations, we considered high performance and low response time as more important.

For a holistic representation of mobility, the integration of multiple modes of transportation would be valuable. Then, people could compare car with bike traffic, and see the different sensitivity to disturbances, as for instance a car is hardly able to bypass traffic jams, while a bike is more flexible and can dash through. As a first demonstration, we show pedestrian times in the current prototype.

5 Conclusion & Future Work

In this paper, we introduced a web-based tool to display time-varying mobility data in a unified visualization with the help of layered isochrone maps. In contrast to conventional isochrone maps, our solution allows comparing how travel patterns change over time, and how spatio-temporal variations affect urban mobility.

Feedback from blog and forum comments suggest our tool satisfies diverse use cases. People liked the aesthetics of the visualization, and used the interactive prototype to explore various metropolitan areas.

For the next version, we consider using transitions to smoothen the interaction of scrolling through time. Adding animation would enable a seamless morphing of the outlines and thus could increase the user experience. The possibility to compare cities of different areas more intuitively would be a useful feature. Instead of being dependent on screenshots, the integration of multiple views could be helpful.

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