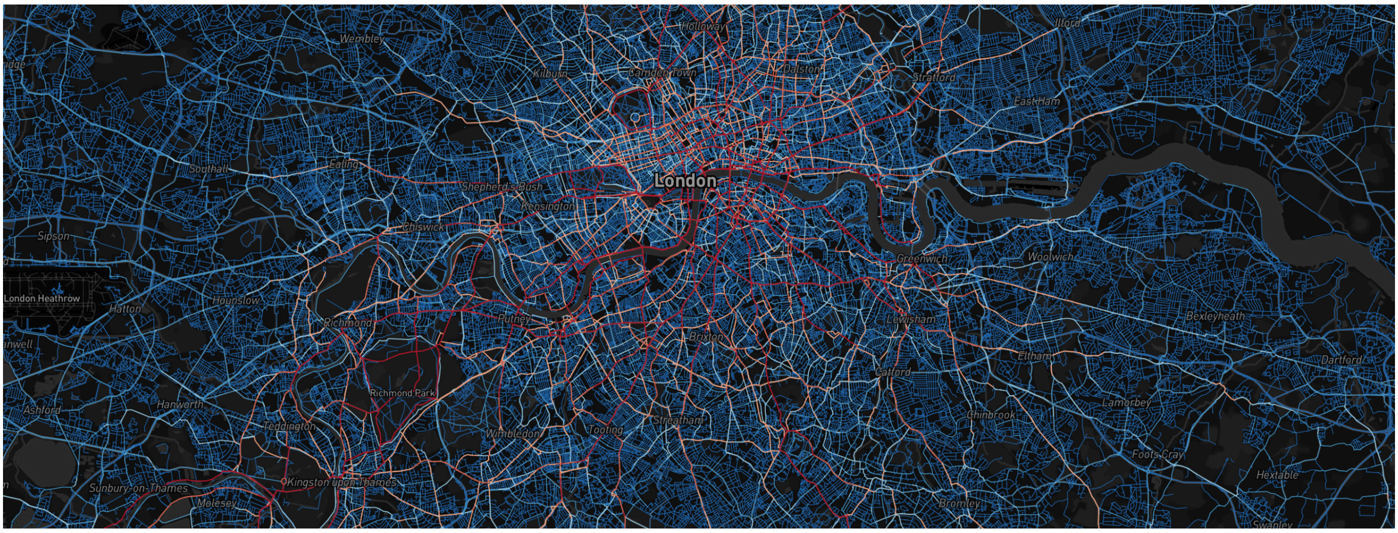

Figure 1: Interactive network flow map depicting patterns in over two million self-tracked bicycle trips across 747,534 street segments in London over a six-month period. Primary bike corridors are highlighted in shades of red. Less traversed streets are denoted in shades of blue.

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CARTOGRAPHY OF THE QUANTIFIED-SELF: MAKING SENSE OF LARGE-SCALE BICYCLING BEHAVIOR PATTERNS IN URBAN PLANNING CONTEXTS

Keywords: movement; bicycling behavior; quantified self (QS); cartographic interface; network flow map; urban planning

1. RESEARCH PURPOSE AND BACKGROUND

The rise in the affordability and use of geo-enabled smartphones and other wearables (e.g., pedometers, smartwatches, wristbands, etc.) has resulted in unprecedented amounts of personal movement data [13]. The large amounts of quantified-self (QS) data being generated in urban environments afford opportunities that extend beyond delivering 'self-knowledge through numbers' to the individual who engages in personal tracking activities. When aggregated and anonymized, this data can be used to, for example, inform city safety [16], routing choices [1], and exposure to air pollution [12]. The civic impact of such data, however, is constrained by the technical skills and resources available to city planners, transportation agencies, and local advocacy groups.

The purpose of this research is to address the question of how to design a cartographic interface to serve as a mediated platform for making large amounts of personal movement data more accessible, usable, and actionable to those tasked with assessing large-scale bicycling behavior patterns in urban centers. The interface discussed in this abstract is specifically focused on utilizing personal movement data contributed voluntarily by a large number of users of Strava, an activity tracking platform and social fitness network. Note that technology development described in this work was carried out while I was employed by Strava Metro, leading interface development. Metro is a small division of Strava that partners with and licenses aggregated and anonymized activity data to a variety of organizations that are taking data-driven approaches to city planning.

2. APPROACH

A two-and-a-half year cartographic design approach was taken to arrive at an effective visualization tool for an urban planning audience. The principles of cartographic representation, as well as interaction science frameworks relevant to data visualization and cartography (e.g., the Information Seeking Mantra [10] and taxonomy of cartographic interaction primitives [9]) provided a conceptual and theoretical foundation for the work. Interface development followed a client-centered design model adapted from Robinson et al. [7] to defining and refining interaction flows based on various stages of system development. Scenario-based design techniques [8], specifically a hypothetical use case scenario and complementing claims analysis, were then employed to evaluate design rationale, provide task-based user documentation, and identify focused opportunities for future user testing.

The resulting interface consists primarily of an interactive flow map that depicts counts of bike trips, commute-designated trips, and bicyclists aggregated to a linear street network (see figure 1). In addition, the interface provides an option to view a non-aggregated, rasterized heatmap of the GPS points that represent the activity traces used in the creation of the other views. An innovative technical framework consisting of map matching [14], spatial data aggregation, vector tiling, and network flow mapping was implemented to render and enable interaction with large geospatial datasets in the browser. The design approach and technical framework resulted in an interface that supports city planning professionals and stakeholders, who possess limited or no expertise in geographic information systems, in easily distinguishing commute from recreation bicycle corridors; identifying candidate areas for fixing or creating new bicycle facilities; and, quantifying ridership before and after infrastructure change.

3. IMPACT AND OPPORTUNITIES

The cartographic interface has been delivered to transportation agencies, local advocacy groups, and researchers across the globe and is being used to make more informed decisions on city planning. For example, Transport for London leverages the dashboard and the underlying data that support it to model network demand and assess the potential for growth in bicycle transport throughout the Capital. In Queensland, the Department of Transport and Main Roads uses the interface to quantify the impact of cycling infrastructure investment. Texas Public Radio published a piece on how the Texas Department of Transportation and local planning organizations were using the interface to better understand how cyclists were moving across the State's network to prioritize where to construct new facilities and bicycle infrastructure [3]. The piece highlighted the significance of the interface for allowing stakeholders to quickly identify patterns in behavior and distill actionable insight.

This work reflects a unique opportunity; in that a novel and impactful cartographic interface was conceptualized and created in an industry setting, while also being grounded in academic rigor. There exist opportunities to extend the framework to support multiple data sources and incorporate dynamic, agent-based modelling visualizations that relay a more complete and representative depiction of how individuals and entities move and interact across a network. Crowdsourced fitness data only represent a subset of the active population and should serve to complement and extend more traditional approaches to active transportation surveillance and analysis [2, 4]. User-generated fitness data, for example, can be correlated with survey and counter data to more effectively model the flow of cyclists across a network [15]. Additionally, supplemental data on crash incidents, roadway characteristics, and environmental factors can be integrated with crowdsourced activity data to help prioritize safety initiatives and inform why some routes are more popular than others [5, 6, 12]. Ubiquitous computing and the onset of Internet of Things (IoT) technologies further create potential for integrating personal movement data into smart city initiatives and urban interaction design. This can result in a more humanized, bottom-up approach to city planning [11].

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