Using web-based technologies to better understand and present temporal variations in access to public services

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Summary

This poster summarises ongoing research into methods of representing geographical data that improve user comprehension of findings from GIS-based analysis. This research focuses on how the latest developments in data analytical and visualisation techniques might be used to enhance user interpretation and understanding of the outputs of GIS-based analyses concerned with investigating access to services. Furthermore, by analysing both traditional and emerging data visualisation techniques, this work aims to highlight how the latest developments might be applied to support end-users when analysing their data. Future research will evaluate potential drivers for the wider adoption of such tools and investigate possible reasons for user apprehension and possible reluctance towards embracing these new approaches.

KEYWORDS: Web-based technologies, open-source, geo-spatial, Web-Mapping API, User Interpretation

1. Introduction

Developments in spatial analytical techniques for exploring geographical access to services have received considerable attention in the academic literature over the last two decades, often driven by a desire to report and address potential inequalities in the provision of public services. However, scant evidence exists for their widespread uptake amongst policymakers, planners, and spatial data managers, despite the increasing availability of tools developed to support their computation (Price et al., 2021; Tsalamanis, 2018). This PhD seeks to explore the potential to further integrate spatial analytical techniques, web mapping APIs, and advanced data visualisation APIs, so as to inspire real-world practitioners to apply and understand the outputs of sophisticated spatial techniques more readily. Our primary aim is to explore, evaluate, and apply in the most effective manner, latest technologies to improve the level of user interaction with underlying data models, and to raise the sophistication of visualisation of their outputs. The poster presentation will provide a summary of preliminary findings of the types of tools available to improve the effectiveness of web-based technologies for policy-focused audiences.

2. Background

Since most mapping techniques are of the conventional format much of the potential productivity in spatial data is lost by it not being analysed to its full potential. By employing modern dynamic mapping techniques, spatial data can be used more productively, exploiting online mapping tools and APIs such as Leaflet and OpenLayers. A benefit of utilizing these mapping tools is they allow integration with various other JavaScript libraries which possess the ability to synchronise both map and chart outputs to allow for a more holistic and comprehensive display of the information. This paired with the ability to amend and interact with live data through the mapping tool shows how applying newer dynamic approaches might improve the analysis of geospatial data.

3. **Methods of visualising geo-spatial data**

A traditional web-mapping technique is the choropleth map, this approach has been used for many years by data analysts to visualise spatially referenced data (Huang, et al., 2020). Choropleth mapping is a technique that allows for clear visualisation of data by showing boundaries of geographical areas in different shades so users can differentiate data based on a shade or colour, this technique is usually paired with a legend to allow for accurate readings, shown in figure 1.

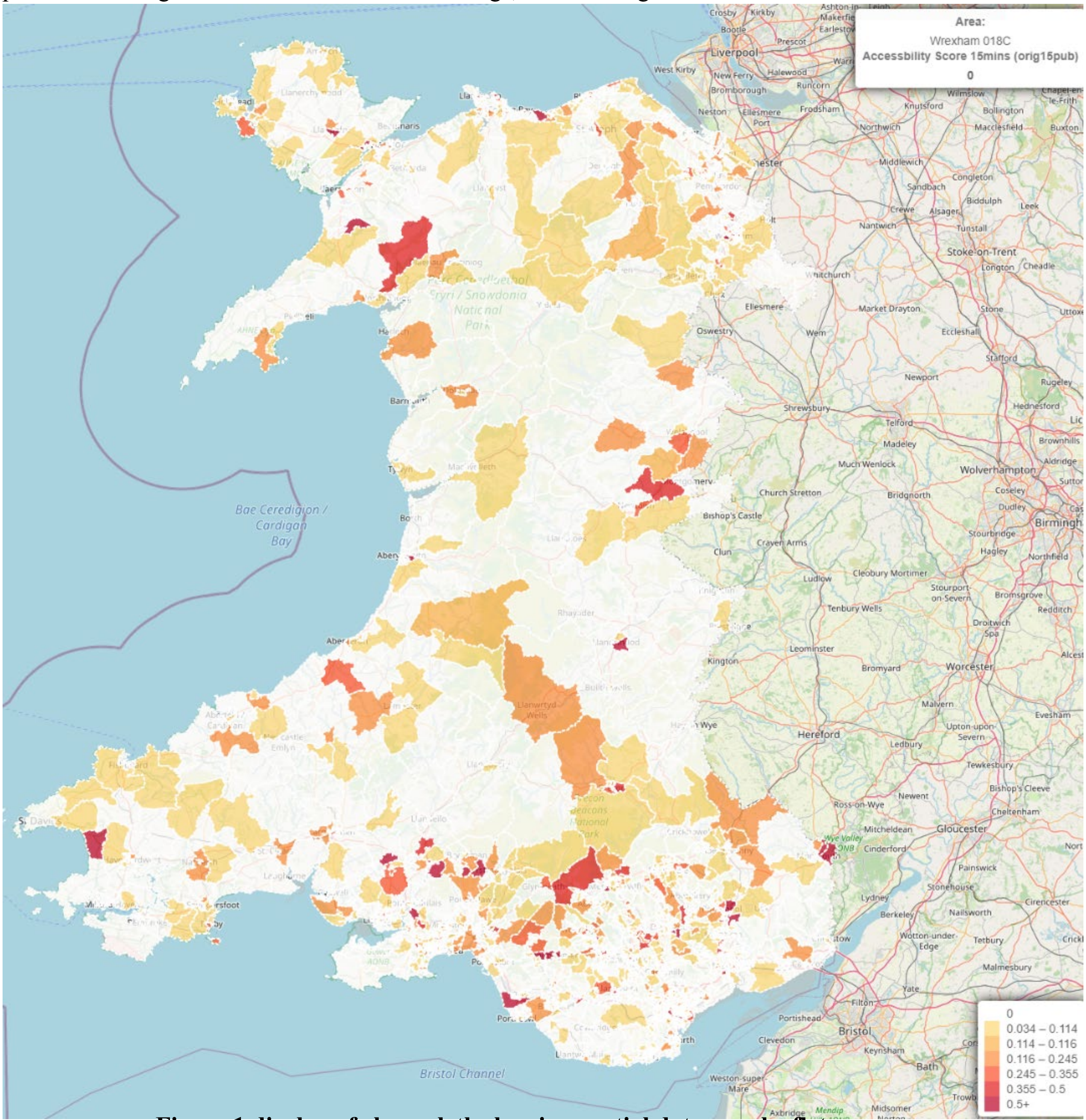

Figure 1 display of choropleth showing spatial data on a leaflet map

Despite this there are well understood limitations of the use of choropleth maps to represent spatial data that can impact on the effectiveness of such techniques in policy arenas. (Requia, et al., 2018). Overall choropleth mapping has advantages for displaying certain attributes; however it still suffers the same fate as other traditional approaches in that the data is static, only allows for certain data to be read and there is limited potential for interaction with the underlying data. Many of the new ways to visualise and manipulate geospatial data are using plugins on web mapping tools. Features such as Google charts and chart.js can be used through web-mapping services like leaflet to display and alter data on the fly. Chart.js is a JavaScript library that can be used with online mapping tools to visualise data in different charts, these are all responsive and customizable (Doshi, et al., 2017). As well as this Chart.js and other manipulation software can link these infographic charts up with the mapping software thus increasing the productivity of the spatial data as users can examine potential data correlation. Unlike the more traditional approaches to visualising spatial data, these web-mapping technologies can help to display data more dynamically and allow users to manipulate and add data in real-time, which in turn allows for greater analysis of current spatial data.

4. Analysis of web-mapping API's supporting modern visualisation techniques

Currently, one of the most popular web-mapping API's is Leaflet, a lightweight mapping package for the visualisation of geospatial data through browser-based web maps (Table 1). This package can be used to apply both modern and traditional cartographic techniques. In a recent report on evolving web-mapping technologies, Leaflet was reported to have the highest positive emotional state in comparison with alternative web-mapping services, suggesting that users were in a positive emotional state for half of the 40 work hours recorded in the report (Roth et al., 2015). In addition, the Leaflet API is a lightweight solution that lends itself to use on mobile phones which may be a further benefit. Access to live and interactive information via mobile platforms might further facilitate policymakers and businesses to analyse data on the fly. Leaflet has well-developed documentation on both its syntax and the core functionality that it offers (Leaflet, 2021).

Another web-mapping API that is well established is OpenLayers. Compared to leaflet OpenLayers sacrifices API size for functionality as its size is considered too large for some users, however, OpenLayers has a lot of added functionality that some users may need. In addition to this OpenLayers has existed a lot longer than Leaflet and revolutionised web-Mapping APIs on its release, for this reason, a lot of users prioritises OpenLayers as they are well-established. Despite this, it is recorded that OpenLayers gives users a lot of negative moods when being used attributed to the user-friendliness of these tools (Figure 2).

Table 1 A comparison of popular web-mapping API's & web-mapping tools

Web-mapping services	Strengths	Limitations	Examples
D3	• Open-source • Supports dynamic projection • Various ways to visualise data	• Slow to load large datasets • Hard to code with a steep learning curve	https://observablehq.com/@d3/gallery
Google Maps API	• A large selection of global data • A street view application • Trusted and recognisable for users	• Added monetary costs • Less personalisation • Unpredictable changes in pricing	https://developers.google.com/maps#tutorials
Leaflet	• Open-source • Lightweight • Well-structured documentation	• Relies upon plugins to add many features • Minimal but unstructured coding	https://leafletjs.com/examples.html

	• Great library of plugins	• The core library only supports GeoJSON	
OpenLayers	• Open-source • Large but well-structured code • Large library with a plethora of features	• Large library size • Small community compared with leaflet • Broken examples	https://openlayers.org/en/latest/examples/
Chart.js	• Open-source • Interactive charts • Offers a plethora of charts	• Slow rendering • Low-quality zoom	https://www.chartjs.org/docs/latest/samples
Highcharts	• Low learning curve • Export chart to an image file • Powerful and responsive	• Expensive	https://www.chartjs.org/docs/latest/samples

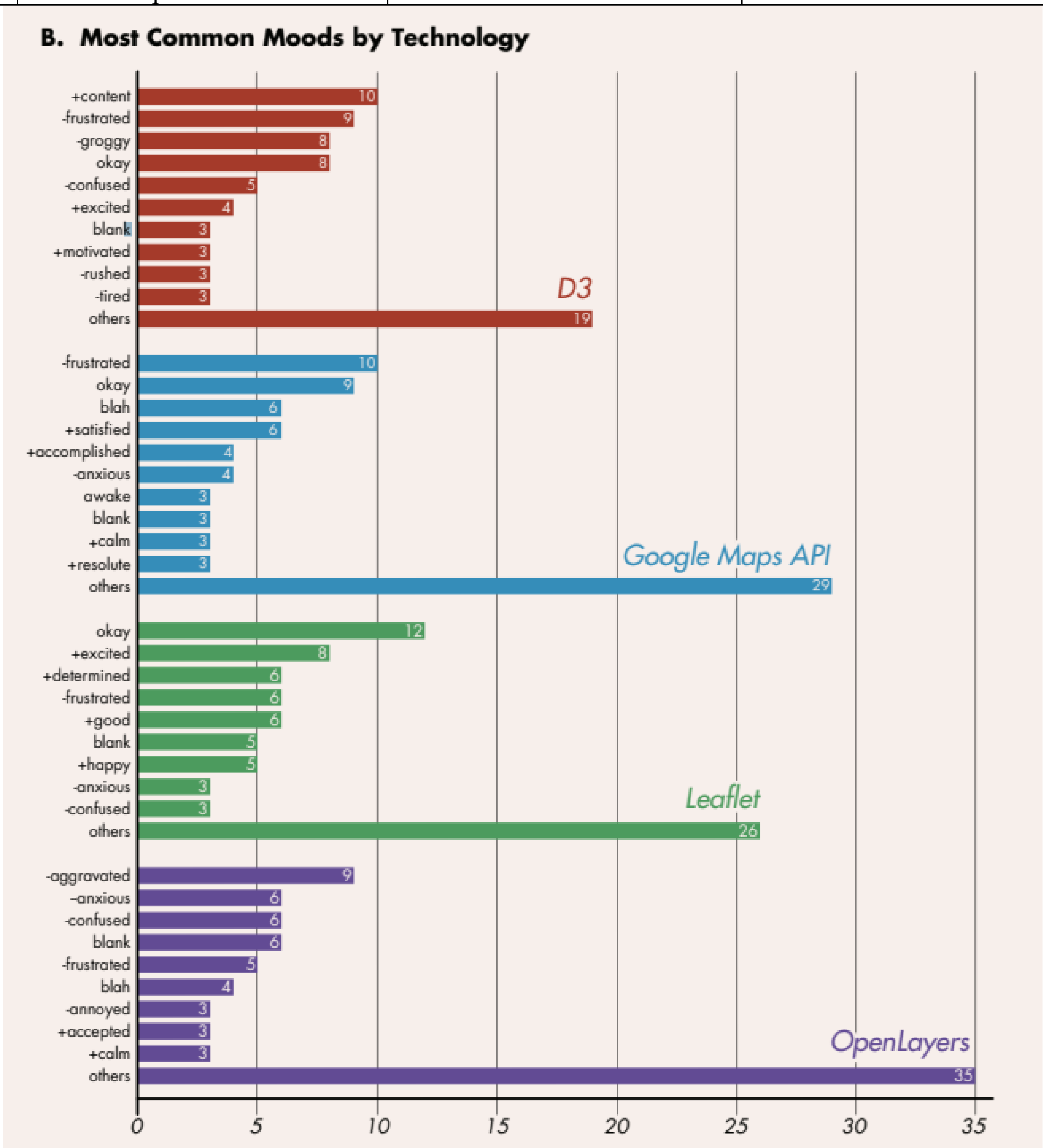

Figure 2 common moods experienced by users when using web-mapping technologies, all moods provided at least three separate times for each technology with a maximum frequency of 80 (Roth et al., 2015).

5. Conclusions and future plans

By using open-source software to visualise and analyse geospatial data, policymakers and businesses will not have to contemplate investing huge amounts into data visualisation and can focus on beneficially using the results as there will be no reliance on proprietary software such as Map box and ArcGIS. Furthermore, it's clear that Leaflet's reputation is well-founded as it allows for various web mapping techniques while being open-source and not sacrificing usability, whereas OpenLayers may be powerful and well established but as figure 2 shows it makes its users aggravated and anxious.

The poster will include a wider review of these web-based technologies in the analysis and visualisation of spatial data illustrated with real world examples drawn from a recent project concerned with applying potential accessibility models. This is part of a PhD study concerned with analysing open-source web mapping techniques, utilising them in a way that allows users to better understand the information with the potential to make live changes to data in order to interactively view the implications of a wide range of policy scenarios. This research will highlight the capabilities of Web-GIS in spatial and geographical analysis, especially in those instances where people are more likely to be working remotely. The ultimate aim is to demonstrate how interactive web mapping could be a step forward for these organisations that enable them to obtain the maximum benefit from the analysis of spatial data.

6. Biographies

Liam Webb is a first-year PhD Student based in the Faculty of Computing, Engineering and Science, at the University of South Wales. His PhD is concerned with using web-based technologies to enhance the visualisation of spatial data

Mitchel Langford is an Associate Professor at the Faculty of Computing, Engineering and Science, University of South Wales, and a co-Director of the Wales Institute of Social and Economic Research, Data and Methods (WISERD). His research interests include dasymetric mapping, accessibility modelling, geo-computation and applied geospatial analysis.

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