International Cartographic Association
Association Cartographique Internationale

Browsing Map Browsers

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Keywords: Map design, Navigation, Interface, Interaction

Abstract:

Map design has undergone significant evolution from the pre-digital era to the present day. Contemporary map design encompasses just-in-time mapping and intuitive interfaces, often on small devices. As a result, issues of multimodal interaction modelling (machine to machine and human to machine interfaces) have become integral to the design of the map.

Nowadays, most maps are pan-scalar maps, i.e. interactive, multi-scale, zoomable maps designed with the assumption that the user will navigate seamlessly and intuitively across many levels of detail to generate contextual understanding with the least cognitive effort (Gruget et al., 2023). They are tailored to accommodate a wide range of tasks and user environments, but this paradigm shift in interaction and map design presents new challenges. First, maps now integrate significantly more data than before. To prevent overwhelming users, efforts on map generalisation aim to suppress and selectively enhance content to minimise navigational trauma. Secondly, additional tasks (routing, landmark selection..) are now mediated through the map. The challenge is in keeping interfaces simple while expanding interaction possibilities (Gedicke and Haunert, 2023).

The evaluation of a map design and its map browser is a multi-variate challenge. The importance of task and context of use is reflected in the continued use of task-based frameworks, offering a structured approach to categorising tasks and defining functionality and modes of interactions (Norman, 1991, Roth, 2013). Harrower and Sheesley (2005), in particular, proposed a distinction between "precise" map navigation tasks and "fuzzy" map navigation tasks. In precise navigation tasks, users possess sufficient information about the desired location to utilise the search bar to input an address or coordinates. Conversely, in fuzzy navigation tasks, users lack locational knowledge and must directly interact with the map. In the context of this paper, our research is focused on effective and efficient interface and map design in support of fuzzy navigation tasks. Nonetheless, it is noteworthy that this task classification may evolve in the future, as search bars make it possible to carry out increasingly complex tasks (Khellaf et al., 2023).

The majority of navigation tasks performed with a map involve multiple zoom and pan interactions. To delve deeper into the analysis of user behaviours in real conditions, we propose a new model that describes the journey of a user who interacts with a map browser (Figure 1). Inspired by the definition of a pan-scalar exploration proposed in (Touya et al., 2023), our model centres around the concept of the "Pan-scalar path". This path represents the trajectory a user follows across map views and scales while completing a task with a map browser.

The observation of users during map interactions has shown that map exploration is composed of two distinct alternating phases: static phases, where the user does not interact with the map browser for a significant period and reads the map displayed on the screen, and transition phases, where the user engages in multiple interactions with the map browser. While the map view (i.e., the displayed map extent) remains unchanged during static phases, it undergoes rapid changes during transition phases. We think that modelling map exploration as a set of multiple phases could help identify patterns more closely linked to the process of comprehension and task execution. Further analysis includes tracking participants' gaze using eye-tracking devices (Wenclik and Touya, 2023).

To better understand the dynamics of user interactions during transition phases, we also conducted an analysis of how user interaction with maps has changed over the past two decades, revisiting the systematic approach proposed by Harrower and Sheesley (2005). Our investigation reveals that traditional buttons enabling sequential zooming or panning within maps have been supplanted by continuous zooming and panning functionalities. This shift has been facilitated by the increasing power of devices on one hand, and the widespread adoption of mice equipped with scroll wheels and touch screens on the other, enabling users to employ natural gestures such as 'dragging' to manipulate the map and scrolling to zoom. Presently, major map browsing platforms including Maps, OSM, BING, MAPBOX, and even QGIS have embraced these new interaction paradigms.

Abstracts of the International Cartographic Association, 7, 130, 2024.
European Cartographic Conference – EuroCarto 2024, 9–11 September 2024, TU Wien, Vienna, Austria.
https://doi.org/10.5194/ica-abs-7-130-2024

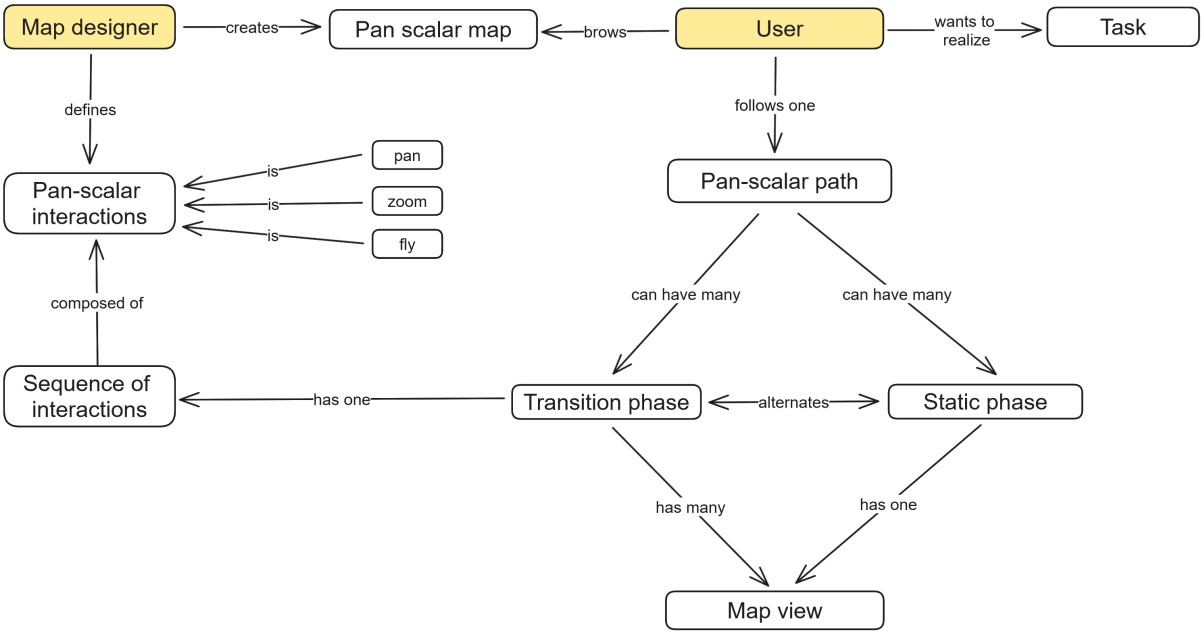

Figure 1. Model of users interactions browsing a pan-scalar map.

In conclusion, we think that the model described in Figure 1 could offer valuable insights into mapping cognition and user behaviours in the consumption of map content. By categorising and describing user behaviours, researchers can better understand the cognitive processes underlying different types of map interactions and tasks. By leveraging unsupervised machine learning, the model enables the classification of navigation archetypes, enhancing experimental design and optimising map browsing interfaces by tailoring interactions for each phase. If the model proves robust, it could be taken into account by designers to develop interactions specific to each phase. For example making some objects persist through a transition phase can reduce navigational trauma, and applying map generalisation techniques to optimise content would be highly relevant in a static phase. Our intention is to evaluate the efficacy of this model – as a way of better designing maps intended for highly dynamic environments.

Acknowledgements

This project has received funding from the European Research Council (ERC) Under the European Union's Horizon 2020 research and innovation programme (grant agreement No. 101003012).

References

Gedicke, S. and Haunert, J.-H., 2023. An Empirical Study on Interfaces for Presenting Large Sets of Point Features in Mobile Maps. *The Cartographic Journal* 0(0), pp. 1–18. Publisher: Taylor & Francis _eprint: https://doi.org/10.1080/00087041.2023.2182354.

Gruget, M., Touya, G. and Muehlenhaus, I., 2023. Missing the city for buildings? A critical review of pan-scalar map generalization and design in contemporary zoomable maps. *International Journal of Cartography* 0(0), pp. 1–31. Publisher: Taylor & Francis _eprint: https://doi.org/10.1080/23729333.2022.2153467.

Harrower, M. and Sheesley, B., 2005. Designing Better Map Interfaces: A Framework for Panning and Zooming. *Transactions in GIS* 9(2), pp. 77–89. _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1467-9671.2005.00207.x.

Khellaf, L., Schlicht, I. B., Bayer, J., Bouwmeester, R., Miraß, T. and Wagner, T., 2023. Spot: A Natural Language Interface for Geospatial Searches in OSM. arXiv:2311.08093 [cs].

Norman, D., 1991. Cognitive Artifacts. In: *Designing interaction: psychology at the human-computer interface*, p. 333. Journal Abbreviation: Designing interaction: psychology at the human-computer interface.

Roth, R. E., 2013. An Empirically-Derived Taxonomy of Interaction Primitives for Interactive Cartography and Geovisualization. *IEEE Transactions on Visualization and Computer Graphics* 19(12), pp. 2356–2365. Conference Name: IEEE Transactions on Visualization and Computer Graphics.

Touya, G., Gruget, M. and Muehlenhaus, I., 2023. Where Am I Now? Modelling Disorientation in Pan-Scalar Maps. *ISPRS International Journal of Geo-Information* 12, pp. 62.

Wenclik, L. and Touya, G., 2023. Where do people look at during multi-scale map tasks? In: P. v. Oosterom, H. Ploeger, A. Mansourian, S. Scheider, R. Lemmens and B. v. Loenen (eds), *AGILE 2023*, Vol. 4, Copernicus Publications, Delft, Netherlands, p. 51.