Map-based Interfaces and Interactions

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Masood Masoodian
masood.masoodian@aalto.fi
School of Arts, Design and Architecture
Aalto University
Espoo, Finland

Saturnino Luz
s.luz@ed.ac.uk
Usher Institute
The University of Edinburgh
Edinburgh, United Kingdom

ABSTRACT

Maps and map-like visualizations are increasingly being used as the basis for many types of interactive tools, services and applications. This workshop brings together researchers and practitioners whose work on such map-based interfaces and interactions is currently dispersed across different publication venues and disciplines. As such, this workshop aims to act as a common space for sharing map-related research expertise and knowledge coming from the fields of visualization, user interface design, interaction design, visual design and cartography.

CCS CONCEPTS

• **Human-centered computing** → **Visualization**; *Human computer interaction (HCI)*; *Interaction design*; • **Applied computing** → **Arts and humanities**;

KEYWORDS

Map visualizations, map-like visualizations, visualizations, interface design, interaction design, visual design, cartography, maps.

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1 INTRODUCTION

"I sense that humans have an urge to map—and that this mapping instinct, like our opposable thumbs, is part of what makes us human... Maps intrigue us, perhaps none more than those that ignore mapping conventions. These are maps that find their essence in some other goal than just taking us from point A to point B." [3]

While wanting to guide someone *"from point A to point B"* may not be the only reason – or the most interesting reason – for creating maps, nevertheless, *"[t]he earliest maps are thought to have been created to help people find their way and to reduce their fear of the unknown"* [9]. Since then, as humans, we have learnt to *"organize information on maps in order to see our knowledge in a new way"*, and *"[a]s a result, maps suggest explanations; and while explanations assure us, they also inspire us to ask more questions, consider other possibilities."* [9].

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Maps do not just represent physical reality, but may also present political, cultural, historical or other information [5]. Maps also have different uses, and as such, they have many common characteristics and differences due to their intended function and audience [5]. However, *"[w]hat is common to all maps, is that they generalize and simplify the things they represent—sometimes severely compromising the reality, or parts of it"* [1]. In fact, the reason that maps function is most likely because they distort reality on purpose *"with just a sufficient level of accuracy for each situation"* [1], rather that even trying to fully represent the reality [2]. Despite this, maps that aim to closely represent some aspect of reality are generally more effective than those that do not at all [7].

Above all, maps in their various forms [6] are ultimately visualizations, and as visualizations, they need to support *"exploring data and seeing data in different ways"* [11]. Yet, unlike most other visualizations, design of maps and map-like visualizations [4] relies not only on the knowledge of the underlying datasets, but also expertise in cartography, visual communication and graphic design.

These days, maps also form the underlying platform for many applications, technologies, tools and services in the form of interactive map [10] visualizations. These can be in the form of, for example, a webmap [11] or a standalone application or tool. Regardless of their form, however, interactive maps enable *"the user to change parameters that drive and control map generation and display during its use"*, thus extending *"users' exploratory capabilities far beyond what is possible with static maps"* [8].

As a result of all these complexities related to the forms, applications, functions, uses, and designs of map visualizations, the research and practice of map visualization design, development and evaluation is currently dispersed across different disciplines and publication venues . This workshop aims to address this challenge by acting as a common space for sharing of map-related research expertise and practices coming from the fields of visualization, user interface design and interaction design, as well as visual communication design and cartography.

2 AIMS AND TOPICS

This workshop aims to act as a venue for sharing of research expertise, practices, learnings, and experiences on a wide range of topics related to map-based visualizations, interfaces and interactions. Some of the key topics covered by this workshop include, but are not limited to, the following:

- theoretical foundations of map design,
- principles and practice of design of maps and map-like visualizations,
- design of map-based user interfaces and interactions,
- applications of map-based visualizations, interfaces and interactions (e.g., applications to epidemiology and healthcare,

climate and environment, sustainability, education, social sciences, etc.), and
- evaluations of map-based visualizations, interfaces and interactions.

3 PARTICIPATION

This workshop aims to encourage active participation of researchers, designers, developers and practitioners from a diverse range of backgrounds concerned, for instance, with the design, development, evaluation and deployment of map-based interactive visualizations, applications, technologies, tools and services.

Prospective workshop participants were invited to submit a position paper describing their contributions to the fields of this workshop and highlight their specific interests in the workshop topics. Numbers permitting, the workshop is also open to other participants without an accepted position paper.

4 ACCEPTED POSITION PAPERS

This workshop includes the following position papers, which cover a diverse range of interesting work related to the aims and topics of the workshop.

(1) **Immersive Maps for Drone Control: A Case for Improving Multi-UAV Ground Control Station Maps with Extended Reality**
Bryson Lawton and Frank Maurer
"Ground control stations typically allow a single human to effectively control several drones simultaneously, the most advanced of which can support the deployment of many tens of independent drones to large-scale, outdoor environments. To best support this, maps are often a central component of their user interfaces in order to best visualize the 3D geospatial data of these drones and how they relate to each other and their operating environment. The capabilities of conventional ground control station software, however, are limited by their traditional 2D screen-based implementation, which negatively impacts the system's scalability, mobility, and how easily users are able to intuitively and accurately understand the three-dimensional nature of these maps and the data visualized on them. This paper presents stereoscopic extended reality technologies as a promising solution to these problems, arguing that by leveraging their strengths not only can one overcome past limitations, but achieve new capabilities simply not possible with prior ground control system methods."

(2) **A Map-based Interactive System for Visualizing Large Networks**
Kathryn Gray, Mingwei Li, Reyan Ahmed, Md. Khaledur Rahman, Ariful Azad, Stephen Kobourov and Katy Börner
"Human subject studies show that map-like visualizations are as good or better than standard node-link representations of networks in terms of task performance, engagement, and memorization and recall of the underlying data. With this in mind, we provide a map-based Interface for large networks where nodes are represented by regions and two regions are adjacent if the corresponding nodes are connected. We create a multi-level tree representation of the input network and use some force-directed methods to generate initial layouts. These layouts are used along with clustering techniques to generate a map that is interactive, always shows real nodes and links instead of showing any meta-nodes or edges from the clustering step, does not contain any node label overlap and link crossing to improve readability. The functional prototype for this map can be found at https://tiga1231.github.io/zmlt/demo/overview.html. We generate map visualizations for four real-world datasets: Last.FM network, Google topics network, tree of life, and math genealogy network."

(3) **Touchscreen Interactions for Spatial Data Visualizations on Multi-touch Spherical Displays: Interaction Design Guidelines**
Nikita Soni, Kathryn A. Stofer and Lisa Anthony
"Beyond flatscreen tabletop displays, multi-touch spherical displays are gaining increased attention, especially to present interactive geospatial data visualizations to facilitate learning in public spaces (e.g., museums). In general, designing an educational interface that is natural and easy to use for learners of diverse age groups and abilities is critical for designing pedagogically effective applications. We discuss interaction design guidelines established in our prior work on presenting geospatial data visualizations on a multi-touch spherical display for museum learning. Two studies were conducted to investigate how users of diverse age groups (i.e., children and adults) naturally interact and collaborate around spherical displays, particularly in the context of spatial data visualizations. This paper discusses a set of 9 interaction design guidelines consolidated from our prior work in one place. These guidelines can be informative in designing more intuitive and pedagogically effective spatial data visualization applications for multi-touch spherical displays in the future."

(4) **Mapping the Colocalisation Network: A Wayfinding Approach to Interacting with Complex Network Diagrams**
Nicola Cerioli, Rupesh Vyas, Mary Patricia Reeve and Masood Masoodian
"Although network visualizations are becoming increasingly common, designing such visualizations can be challenging due to the number of visual elements and non-linear relations that they need to display. The main design challenge faced is finding the right trade-off between providing a sufficient level of information detail while keeping the visual complexity of the visualization as low as possible. One way of overcoming this challenge is to rely on the use of mental models that are familiar to the users of network visualizations. In this paper, we propose the use of a mental interaction model similar to that of map visualizations – generally based on geographical maps – as the basis for visual design of network diagrams. We argue that such a mental model would foster a set of network interaction tasks that can be defined broadly as wayfinding. *We present the process of wayfinding from a semiotic standpoint, and match its main key points to those of interaction tasks with network diagrams. As a case study for this analysis, we also present a prototype network diagram visualization tool, called Colocalization Network Explorer, which we have developed to support the exploration of the relationships between*

various diseases and the portion of the human genome that is potentially involved in their onset. "

(5) **Maps with Meaning**
Alan Dix
"Maps are not mere simulacra of the ground, but imbued with meaning. This is true at a geopolitical scale, but even more so for local community mapping. However, whilst digital mapping has made it easy to embed and customise maps in local websites or printed resources, it also runs the risk of de-humanising these resources, replacing rich meaning with unnecessary precision. This paper explores examples of how meaning can sit alongside the digital in map-based interactions. It then uses this backdrop to consider new challenges to help a living community where their physical village has been all but obliterated."

(6) **Temporal and Spatial Elements in Interactive Epidemiological Maps**
Saturnino Luz and Masood Masoodian
"Maps have played an important role in epidemiology and public health since the beginnings of these disciplines. With the advent of geographical information systems and visualization techniques, interactive maps have become essential tools for the analysis of geographical patterns of disease incidence and prevalence and also for communication of public health knowledge, as dramatically illustrated by the proliferation of web-based maps and disease surveillance 'dashboards' in the ongoing COVID-19 pandemic. While such interactive maps are usually effective in supporting spatial analysis and visualization, support for analysis of temporal aspects has proved more challenging. However, combining these two aspects can be crucial in applications of interactive maps in epidemiology and public health work. We discuss these issues in the context of support for disease surveillance in remote regions, including tools for distributed data collection, simulation and analysis, and support for multidisciplinary collaboration."

5 STRUCTURE

This full-day workshop is structured to be interactive and informal. It combines short presentations of accepted position papers – see previous section – with periods of discussions, aimed at generating ideas for future research directions. The workshop also includes a hands-on activity, during which the participants are invited to sketch designs for a map-based interactive application in small groups. The designs are then shared and discussed in the workshop. The main parts of the workshop are:

- short presentations of the accepted position papers,
- follow-up discussion to guide future development of related research,
- hands-on design activity, facilitated by the organizers, and involving the participants, and
- concluding discussions and planning of future collaborations and outcomes.

Further details on the workshop program are available at the workshop website: http://avcd.aalto.fi/mapii2022/.

6 DISSEMINATION

Beyond sharing the accepted position papers with the participants, the workshop includes a discussion on future publication of the extended versions of the position papers, for instance, in the form of a special issue of a journal or an edited book.

7 ORGANIZERS

Masood Masoodian is a professor of Visual Communication Design in the School of Arts, Design and Architecture at Aalto University, Finland. His research interests include visual design, interaction design and visualization – specializing in visualization of temporal and spatial data in areas such as health, energy, environment and sustainability – using maps as the basis for visualizations and user interactions. He has served as an organizer, programme chair, programme committee member, and reviewer for numerous international conferences and workshops.

Saturnino Luz is a Reader in Medical Informatics at The University of Edinburgh. His research interests include information visualisation and inference in high dimensional data sets, and graphical models. His work on map-based interfaces includes visualization of human and environmental variables for modelling of infectious disease spread, and other applications in health care. He has organized, chaired and participated in the programme committees of several conferences, and served as associate editor in several journals.

8 PROGRAM COMMITTEE

Bridget Kane *(Karstad University, Sweden)*, Saturnino Luz *(The University of Edinburgh, United Kingdom)*, Masood Masoodian *(Aalto University, Finland)*, Shane Sheehan *(The University of Edinburgh, United Kingdom)*, Artemis Skarlatidou *(University College London, United Kingdom)*, Robert Spence *(Imperial College London, United Kingdom)*, Thomas Rist *(Augsburg University of Applied Sciences, Germany)*.

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REFERENCES

[1] Mikko Airikka and Masood Masoodian. 2019. A Survey of the Visual Design of Cartographic and Other Elements of Illustrated Tourist Maps. In *Proceedings of the 23rd International Conference in Information Visualization – Part II (IV 2019)*. IEEE, 7–13. https://doi.org/10.1109/IV-2.2019.00011
[2] Peter Barber (Ed.). 2005. *The Map Book*. Walker Books.
[3] Katharine Harmon. 2003. *You Are Here: Personal Geographies and Other Maps of the Imagination*. Princeton Architectural Press.
[4] Marius Hogräfer, Magnus Heitzler, and Hans-Jörg Schulz. 2020. The State of the Art in Map-Like Visualization. *Computer Graphics Forum* 39, 3 (2020), 647–674. https://doi.org/10.1111/cgf.14031
[5] Juso Koponen and Jonatan Hildén. 2020. *Data Visualization Handbook*. Aalto ARTS Books.
[6] Saturnino Luz and Masood Masoodian. 2014. Readability of a Background Map Layer under a Semi-Transparent Foreground Layer. In *Proceedings of the 2014 International Working Conference on Advanced Visual Interfaces* (Como, Italy) *(AVI '14)*. Association for Computing Machinery, New York, NY, USA, 161–168. https://doi.org/10.1145/2598153.2598174
[7] Alan M MacEachren. 2004. *How Maps Work : Representation, Visualization, and Design*. Guilford Press.

[8] Thomas Rist and Masood Masoodian. 2022. Interactive Map Visualizations for Supporting Environmental Sustainable Development Goals. In *Sense, Feel, Design*, Carmelo Ardito, Rosa Lanzilotti, Alessio Malizia, Marta Larusdottir, Lucio Davide Spano, José Campos, Morten Hertzum, Tilo Mentler, José Abdelnour Nocera, Lara Piccolo, Stefan Sauer, and Gerrit van der Veer (Eds.). Springer International Publishing, Cham, 36–46. https://doi.org/10.1007/978-3-030-98388-8_4

[9] Peter Turchi. 2007. *Maps of The Imagination: The Writer as Cartographer.* Trinity University Press.

[10] Judith A. Tyner. 2014. *Principles of Map Design.* Guilford Press.

[11] Judith A. Tyner. 2014. *The World of Maps: Map Reading and Interpretation for the 21st Century.* Guilford Press.