EuroCarto2024 Workshop

Online User Experiments:
Seeing What Map Users See without Seeing Them

Date & Location: 8 September 2023 Sunday, 13:00-17:00, TU Wien.
Karlsplatz 13, 1040, Wien, Room: AE U1-1

Organizers: Merve Keskin, Paris Lodron University of Salzburg (PLUS); **Vassilios Krassanakis**, University of West Attica (UNIWA); **Arzu Çöltekin**, University of Applied Sciences and Arts Northwestern Switzerland (FHNW)

All information can also be found at https://eurocarto2024.org/workshop-programme/ #onlineuserexperiments

Program

13:00-13:05: Welcome speech from the workshop organizers

13:05-13:40: Keynote by Prof.Dr. Ioannis Giannopoulos* titled ***Reality as a Basemap:*** *Geographic-Aware Augmented Reality and Geovisualizations*

> This keynote will explore Ioannis' latest research and visions in Geographic-Aware Augmented Reality (GeoAR) by introducing the innovative capabilities of their GeoAR technology, which allows geovisualizations to be precisely positioned at specific geographic coordinates. As this technology offers unprecedented opportunities for interacting with geovisualizations directly within their real-world context, he will discuss how research in this field can profit from the technological advancements in eye tracking and artificial intelligence.

13:40-15:25: Presentations (**12 min** talk + **3 min** Q&A)

Online surveys/questionnaires

13:40-13:55 - Can Blurred Maps with BubbleView Mitigate Mental Shortcuts?, Nianhua Liu, *Technical University of Munich*

13:55-14:10 - A web-based questionnaire for investigating user perception of pictorial symbols for points of interest, Eirini Nektaria Konstantinou, Andriani Skopeliti, Byron Nakos, *National Technical University of Athens*

Own user experiment tool

14:10-14:25 - Adapting to the mobile majority: A new approach to interactive map usability assessment, Stanislav Popelka, Michaela Vojtechovska, Ondrej Ruzicka, Marketa Beitlova, Zdenek Stachon, *Palacký University Olomouc*

14:25-14:40 - User Interactions with 3D Interactive Geovisualizations: A Six-Year Experiences with User Logging in Web Browser, Lukáš Herman, Dajana Snopková, *Masaryk University*

Comparative and webcam eye tracking studies

14:40-14:55 - Quantifying map user response differences between gaze and cursor activity during searching cartographic point symbols, Argyro Vlachou, Dimitrios Liaskos, Vassilios Krassanakis, *University of West Attica (UNIWA)*

14:55-15:10 - Studying visual quality of rendered graphics in a webcam eye tracking experiment, Arzu Çöltekin, Leticia Fernández Moguel, Cédric Merz, Madhumitha Murali, Alexander, Schneiter, Louis Baumgartner, *University of Applied Sciences and Arts Northwestern Switzerland (FHNW)*

15:10-15:25 - Revealing Uncertainties in Noise Models: Visual Detection Using Online Webcam Eye-Tracking and Mobile Eye-Tracker, Zulfa Nur'aini 'Afifah, *University of Augsburg*

15:25-15:45 - Small break

15:45-16:25 - Hands-on webcam eye tracking exercise using realeye.io by Zulfa Afifah, Merve Keskin, Arzu Çöltekin

16:25-17:00 - Open discussion & interaction (via *miroboard* for online participants)

17:00-18:30 - Informal gathering (*tentative*) after 17:00 until the opening ceremony of EuroCarto2024

****About Prof.Dr. Ioannis Giannopoulos***. He has been a Full Professor of Geoinformation at TU Wien since 2018. Before joining TU Wien, he was a Postdoctoral Researcher and Lecturer at ETH Zurich (Swiss Federal Institute of Technology). In 2015, he earned his doctoral degree at ETH Zurich, where his dissertation was recognized with the prestigious ETH Culmann Award for outstanding work. His research interests span Human-Computer Interaction (HCI) and Geographic Information Science, with a focus on Spatial HCI, Urban Computing, Mobility, Location-Based Services (LBS), GeoAI, Mobile and Remote Eye Tracking, Pedestrian Navigation, and Visualizations and Interaction in Virtual and Mixed Environments.

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Can Blurred Maps with BubbleView Mitigate Mental Shortcuts?

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Keywords: blurred map, mental shortcut, user interface, cognitive mechanisms

Abstract:

Mental shortcuts, or heuristics, simplify complex decision-making processes by relying on patterns, stereotypes, or rules of thumb (Kahneman, 2011). While these shortcuts reduce cognitive load and save time, they can lead to errors or biases when based on incorrect assumptions. Maps are powerful tools for communicating complex information and persuading readers (Deitrick & Edsall, 2009). However, this power can be misused, triggering mental shortcuts and bolstering misinformation. Even credible maps from peer-reviewed articles or government-produced science can exploit the "appeal to authority," using confirmation bias to convey misinformation when taken out of context (Fish & Kreitzberg, 2023).

Research on how different map user interfaces can mitigate mental shortcuts is limited. BubbleView, an attention-capturing methodology, simulates eye focus using mouse clicks to reveal areas of interest in blurred images (Newman et al., 2020). It has been shown to approximate eye fixations and rank the importance of image and design elements (Kim et al., 2017).

We propose a user study to compare attention, memory, and cognitive mechanisms between normal view (Figure 1) and bubble view (Figure 2). Participants will interact with both type of maps at the same amount, with their eye movements tracked. After interacting with each post, participants will complete benchmark tasks to assess the trustworthiness and recall of map elements. User performance and satisfaction with the interactive design will be evaluated through a post-questionnaire.

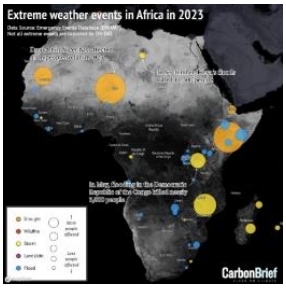

Figure 1. Example or normal map.

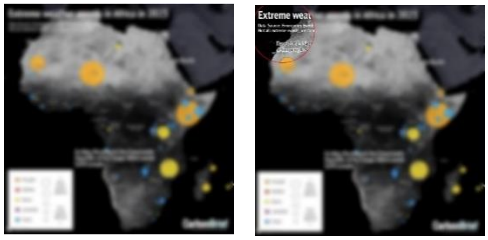

Figure 2. Example of blurred map with bubble view.

This experiment aims to evaluate the effect of forced interaction with map content through the use of blurred maps with BubbleView. While this interface may potentially compromise user experience, it is hypothesized that it will prevent mental shortcuts and mitigate the misuse of maps for disseminating misinformation.

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A web-based questionnaire for investigating user perception of point symbols for points of interest.

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Keywords: cartographic symbolization; online tourist map; point symbols design, cartographic research

Abstract:

Nowadays tourist maps are one of the most popular and familiar type of maps worldwide. As the available data, technological innovations, and human demands are increasing rapidly, it is essential to improve maps that are used for travel purposes in order to succeed better information transmission and communication between the map and the user.

This article aims to investigate the symbolization utilized in online tourist and general-purpose maps through practical research. Specifically, the purpose is to explore and analyze user preferences and perceptions regarding point symbols on tourist maps. The point symbols under consideration in the research are the pictographic symbols, which are preferred by most map designers due to their potential for delivering complex messages efficiently.

According to J. Korpi (2015), pictographic symbols are generally categorized in terms of their visual abstractness and the relation between the symbol and the referent. The three categories upon which this research is based are as follows: arbitrary convention, visual similarity, and semantic association. In representation through visual similarity, the referent is represented by depicting its visual characteristics, for example, a symbol depicting an elephant in a map of a zoo pointing out the location of the elephants in the zoo. In arbitrary convention, the symbol is attached to the referent by a convention, for example, the Red Cross standing for health services. In representation through semantic association, the connection between the referent and the symbol is "mediated" by depicting concepts that are semantically close to the referent, for example, a coffee cup standing for a cafeteria (Nakamura & Zeng-Treitler 2012).

These three types formed the basis on which the research and the selection of point symbols in tourist maps were built for the subsequent stage of their evaluation through practical research. Specifically, a questionnaire was created with the aim of an initial experimental approach to the design of point symbols in a tourist map. Therefore, 21 different pictograms were selected for 7 different symbols (3 unique pictograms for each symbol). These symbols were chosen to be universally understandable and are as follows: Airport, Church, Restaurant, Hotel, Museum, Hospital, and Parking. If they were to be categorized based on general content categories, these would be: accommodation, healthcare, gastronomy, transportation, culture, religion, and services (Konstantinou et al., 2022).

This questionnaire is divided into seven main parts. The first part concerns the social characteristics of the participant, and the remaining five parts relate to point symbolization. In more detail, in the second part, a point symbol is presented, and the participant is asked to provide their opinion on what is depicted. The third part focuses on variables that characterize a symbol. These variables are explained in detail in the cognitive scheme for the interpretation of cartographic symbols (MacEachren, 1995; Kuveždić Divjak et al., 2020). A characteristic example is drawing conclusions on whether it is better to use a symbol background and a symbol frame or not. This part depicts all point symbols on a white background, in contrast to the fourth part, which uses the same questions but depicts them on maps. The reason for this is to investigate whether the presence of a map background affects how the participant perceives the same symbol. In the fifth part, there is a clear reference to the grouping of symbols through the variable of their color. For example, can a specific color in the background of the symbol indicate a clearer categorization than the same color in the frame of the symbol? In the sixth part, the participant is given three symbol options and asked to choose the symbol they believe best fits the respective point of interest (e.g., airport). In the last part, the participant is finally asked to rate each symbol separately for its intended use through a rating scale. Figure 1 provides an example of the questionnaire related to symbolization:

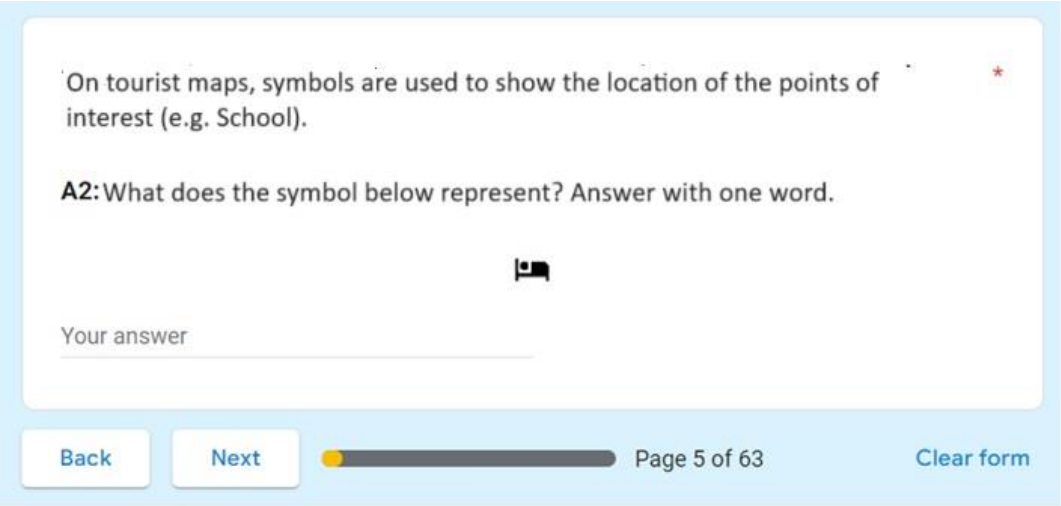

Figure 1. Example of the questionnaire related to the point symbolization

The way in which the questions are presented is not random, as one of this survey's purposes is to ensure that the participant is not predisposed and that the answers are as spontaneous as possible. First, the participant is asked to say what they believe a symbol depicts, and then they are asked to evaluate it based on the survey's interpretation. The questionnaire was initially administered to university students to conduct a preliminary evaluation. The ultimate goal of this research is to draw conclusions that will benefit the design of point symbols on tourist maps.

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Adapting to the mobile majority: A new approach to interactive map usability assessment

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Keywords: interactive maps, user interaction logging, mobile devices

Abstract:

This submission explores the challenges faced by social scientists and data journalists in visualizing spatial information through interactive maps. Employing a qualitative research methodology, we conducted interviews with professionals from both fields to understand their experiences and identify barriers to the effective use of interactive maps for disseminating spatial data. One of the primary challenges identified is the prevalent use of mobile devices for map consumption, with over 70% of users accessing maps through such platforms. This mobile dominance introduces significant difficulties in map evaluation, for which we usually employ eye movement analysis. The use of eye-tracking for mobile usage is complicated and ineffective. In response to these challenges, our research team is in the process of developing a tool designed to log user interactions with maps, particularly when displayed on mobile devices. This tool aims to provide insights into user engagement and map readability, offering a novel approach to evaluate interactive maps in the context of mobile usage. As the development progresses, we anticipate presenting a prototype of this tool at the workshop. Our research highlights the necessity of adapting visualization and evaluation techniques to meet the changing landscapes of digital technology and mobile consumption, ensuring that spatial information remains accessible and comprehensible across various platforms.

Acknowledgements

The submission was prepared with the support of the project “Identification of barriers in the process of communication of spatial socio-demographic information” (23-06187S) of the Czech Science Foundation.

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User Interactions with 3D Interactive Geovisualizations: A Six-Year Experiences with User Logging in Web Browser

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Keywords: 3D geovisualization, 3DmoveR, asynchronous remote testing, usability testing, user logging

Abstract:

This paper summarizes experience with user testing of 3D geovisualizations outside controlled conditions using user logging approaches. The first such user study was performed in 2018 when it was a pilot test of the 3DmoveR (3D Movement and Interaction Recorder) tool, which has been improved to work in various software and hardware configurations (Juřík et al., 2018). 3DmoveR is based on open web technologies such as PHP, JavaScript, and the Three.js library (Herman, 2019). In 2021, the data from respondents working with 3D city models were recorded from 110 participants, and 76 of them were correct (Herman, 2021). Subsequently, the 3DmoveR was modified to display spherical images using the A-Frame framework. This modification was used in research on spatial navigation and decision-making during evacuation from the building. Two hundred seventy-three respondents entered the test, while 211 completed all tasks and the evaluation questionnaire (Snopková et al., 2023; Snopková & Herman, 2023).

In all cases, the use of the tool was influenced by both technological and non-technological aspects. Some technological variables can be monitored: operating system, web browser, colour depth, screen and window size or 3D scene loading time. Others can be set or disabled, such as keyboard button functionality. The future deployment of the tool is closely related to the development of various web technologies, from 3D graphics to eye tracking. Technology enabling the creation of virtual environments, i.e. WebVR, is also currently being developed. From the non-technological aspects, it is worth noting that the return of tests recorded is in the range of 69 to 77%. Ethical issues will be discussed as well.

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Quantifying map user response differences between gaze and cursor activity during searching cartographic point symbols

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Keywords: eye tracking, mouse tracking, comparison metrics, lab-based and online user studies

Abstract:

The examination of both perceptual and cognitive issues related to map reading requires the performance of experimental procedures that aim to measure map user response under free viewing or task-oriented conditions. Map user reaction can be modeled by considering data collected utilizing several experimental techniques (e.g., reaction time and response accuracy measurements). However, it is of great importance to explore experimental frameworks that can be executed remotely. The present study aims to present a work in progress that aims to compare gaze and cursor activity during the execution of a typical map reading task. In more detail, we implement a lab-based experiment which concurrently captures both eye and (computer) mouse movements while searching for specific point symbols on cartographic backgrounds. The experiment is based on the use of the visual stimuli and point target symbols presented by Pappa & Krassanakis (2022). The aforementioned study was implemented utilizing remote (online) mouse tracking techniques. In the framework of the current work, the overarching goal is to explore quantitative measures that are able to describe individual and/or aggregated visual search behavioral differences. Considering the aggregated statistical grayscale heatmaps produced by both experimental studies, we plan to use the Jaccard index, the Dice coefficient and the BF score in order to perform comparisons between gaze and cursor activity, as well as between the mouse movement data produced under both conditions (lab-based and online). In addition, we will compute the GraphGazeD (Liaskos & Krassanakis, 2024) metric towards describing existing visual perception differences. The process of data analysis will be fully automatized using Python programming language and MATLAB software.

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Studying visual quality of rendered graphics in a webcam eye tracking experiment

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Keywords: visual quality, 3D graphics, webcam eye tracking

Abstract:

It is well known that human visual system captures remarkably higher levels of detail in the central visual field than in the periphery (Feinberg 1949; Loschky et al., 2017). Based on this principle, foveated visualizations have been proposed in computer graphics (Guenter et al., 2012) geospatial sciences (e.g., Çöltekin 2005) and other domains (e.g., Krajancich et al., 2023). We examined the feasibility of an online study to capture the differences in human judgement of visual quality in central vs. peripheral vision. Stimuli of varying levels of detail were placed in various systematically selected positions in the visual field. Participants (n=58) were shown pairs of images that gradually differ in visual quality and judged if two objects were same or different. We measured overt and covert attention. In the covert condition, participants were instructed to keep their eyes fixated in the center while comparing quality of objects in their peripheral vision. Eye tracking allowed automating when and where to show these objects and examining if participants kept to the instructions. Our preliminary findings confirm that subtle differences are easier to detect in overt condition, and gradually gets worse away from the center in the covert condition, suggesting that current webcam eye tracking solutions allow implicit control in such experiments.

The study has interdisciplinary relevance where large datasets are rendered for transmission and adaptive visualizations are an option (Duchowski & Çöltekin, 2007), such as information / scientific visualization, 3D graphics, remote sensing and cartography.

Acknowledgements (optional)

This project has been partially supported by Innosuisse (40467.1 IP-ICT).

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Revealing Uncertainties in Noise Models: Visual Detection Using Online Webcam Eye-Tracking and Mobile Eye-Tracker

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Keywords: Uncertainties, noise model, noise modelling, mobile eye-tracking, online webcam eye-tracking

Abstract:

The European Union has introduced the Common Noise Assessment Methods in Europe (CNOSSOS-EU) as a method for assessing noise from various sources, such as roadways, railways, industrial sources, and aircraft (Kephalopoulos et al., 2012). The implementation of CNOSSOS-EU in modelling road traffic noise has been used to estimate population exposure in Ireland (Faulkner and Murphy, 2022).

Spatial modelling can contain uncertainties from various sources. This preliminary study generated noise models for Munich and Jakarta. However, they are still not representative since noise emissions were only considered from road traffic. Additionally, noise levels vary throughout the day, evening, and night. Nonetheless, the noise model is a static visualisation that can only show the average noise level over 24 hours. Based on these examples of uncertainties, the main aim of this study is to reveal these uncertainties arising from the noise models visually.

One study has demonstrated that eye-tracking can significantly aid in evaluating map design and exploring the cognitive processes of map users (Keskin and Kettunen, 2023). Moreover, eye tracking is extensively used to measure cognitive processes and visual attention for various spatiotemporal tasks involving maps and geo visualisations (Peter Kiefer and Duchowski, 2017). Hence, this study will also compare the use of a mobile eye-tracker from PupilLab and an online webcam eye-tracker by RealEye for evaluating noise models.

The between-subjects design user experiments will involve a minimum of thirty people from diverse educational backgrounds. The participants will be divided into two groups. The first group will use a mobile eye tracker, and the other will use an online webcam eye tracker. We will utilise multiple-choice questions to investigate how participants identify noisy areas and recognise uncertainties within the noise model. Additionally, we aim to understand how they make decisions based solely on the model. The analysis will employ metrics such as fixation, gaze, and mouse clicks to evaluate the effectiveness of both eye-tracking methods.

The mobile eye-tracking records the fixation and gaze, and then we can do more processing on the cloud (see figure 1). Meanwhile, the online webcam eye-tracking also shows mouse click, the attention and the emotions of the user, as shown in the figure 2 below:

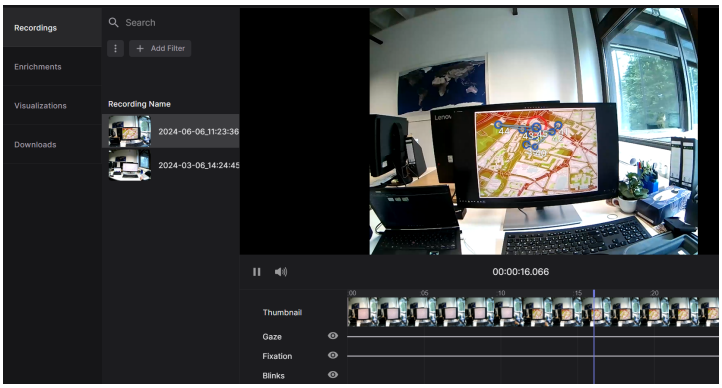

Figure 1. Mobile eye-tracker result on the cloud

Figure 2. Online webcam eye-tracker result

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