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GazePlotter – tool for eye movement sequences visualization

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Abstract:

Eye-tracking is becoming widely used in cartography to study user visual behaviour while reading maps (Krassanakis & Cybulski, 2021). In these studies, focusing on the cognitive or perceptual aspects of human vision, cartographers benefit from the knowledge and experimental techniques adopted from cognitive scientists, neuroscientists, or psychologists. Krassanakis and Cybulski (2019) reviewed the state of the art concerning eye-tracking in cartography. They divided eye movement research into several categories – user studies focused on design principles, studies comparing 2D and 3D, studies comparing map users (experts, novices), and studies presenting eye-tracking analysis tools and methods delivered by cartographic community. A considerable number of these tools that have been created by cartographers exist (Doležalová & Popelka, 2016; Göbel et al., 2019; Herman et al., 2017; Kiefer & Giannopoulos, 2012; Krassanakis et al., 2014; Sultan et al., 2022). Cartographers are working with visual representations of (spatial) data on daily basis, so their contribution to the field of eye-tracking data visualization is logical.

One of the most common ways to analyse eye movement data (in cartography) is by using Areas of Interest. Cartographers might be interested in what parts of a map attract the gaze most effectively and in what order. Besides a statistical analysis of eye movement metrics related to these AOIs, the order of visited AOIs might be analysed and visualised. The most effective way to visualize such data is a Sequence chart, also known as a Scarf plot. A sequence chart visualization is a graphical representation of the sequence of eye movements recorded in the pre-defined Areas of Interest in which a user's eyes move while looking at a stimulus. The chart typically consists of horizontal lines representing the gaze data of individual participants. The dependencies of the eye movements to the individual areas of interest are shown in colour. This visualization method was available in SMI BeGaze. However, this software is no longer available. As far as we know, the only other tool for sequence charts is SEQIT (Wu & Munzner, 2015). However, it is not possible to analyse own data.

Considering the absence of an available tool for sequence chart visualization, we are presenting GazePlotter, a user-friendly web-based ready-to-use application designed to facilitate the visualisation and analysis of eye-tracking data. It allows researchers to effortlessly upload and integrate data from eye-tracking software platforms like SMI, Tobii, OGAMA, and GazePoint Analysis, eliminating the need for time-consuming manual data transformation or programming tasks.

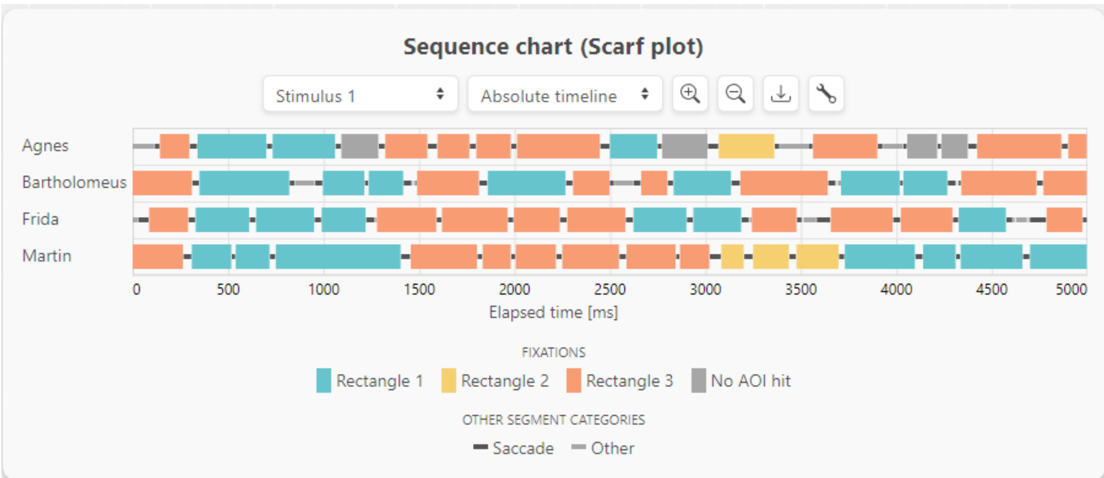

Figure 1. The environment of the GazePlotter on the example of sample data.

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GazePlotter provides interactive sequence charts to visualise and analyse eye-tracking data. These charts allow users to track and understand the focus of participant gaze by distinguishing between individual eye fixations in provided areas of interest. In addition, the sequence charts allow for the display of other eye-tracking sequences, like saccades or blinks, depending on the input data. Researchers can customise the visual representation of each segment, including features such as colour and size, and can easily export the resulting visualisation as a vector or raster graphic. Visualized data might be easily converted into format readable by ScanGraph tool (Doležalová & Popelka, 2016).

Users can run GazePlotter on any device in a modern web browser, regardless of their operating system. In addition, the app can be downloaded and used offline, providing even greater flexibility and convenience for researchers. Its thick-client, serverless design also enhances the security and confidentiality of sensitive eye-tracking data, as it is not transmitted or stored through a centralised system and is kept only on the researcher's device.

Writing the app in TypeScript, a strongly typed superset of JavaScript, allowed us to leverage modern programming practices and design patterns, resulting in a well-structured, maintainable, and easy-to-understand codebase. As an open-source project distributed under the GNU GPL, the source code is available for modification by users, fostering collaboration and the potential for the development of new features.

There are numerous opportunities for further extending the app's capabilities. For example, expanding the range of eye-tracking visualisations beyond interactive sequence charts and introducing interactive scan paths could provide researchers with deeper insights into their data. Additionally, integration with other eye-trackers or eye-tracking tools, such as ET2Spatial (Sultan et al., 2022) could simplify the analysis process even further.

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