International Cartographic Association
Association Cartographique Internationale

Automation of the visualisation of eye-tracking data with animated heatmaps

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Keywords: eye-tracking, heatmap, animation, automation, geoexploration

Abstract:

Eye movement analysis has become more and more common in cartographic research as it enables researchers to collect and analyse data about the gaze of the map users. Eye tracking makes it possible to measure gaze variables that reflect map users' gaze behaviours and their understanding of maps and geospatial data. Therefore, eye tracking can lead toward better knowledge on human visuospatial cognition, and provide interfaces that adapt to the user's behaviour.

To analyse datasets collected by eye-tracking, one must rely on suitable data visualisations. One of the most widely used eye-tracking data visualisations is heatmap representation (Raschke et al., 2014). It is a density map of fixations and has an advantage of being an easy-to-understand visualisation of gaze behaviour on an image. It is convenient for visual assessment of gaze patterns although must be complemented by fixation and saccade related metrics to avoid misleading interpretations. Heatmap representation, which has typically been a static representation, shows how gaze is distributed over the stimuli or areas of interest, without showing any information about the order of looking. This way, it provides complementary information to what one can visualise with scan-path plots, for instance.

Goal of this study is to extend this commonly used eye-tracking data representation by combining the density analysis and the information related to the order of looking using automatised animation. Animated heatmaps can help gaining more insight on the user's choices and preferences (e.g., Tobii, 2009). We tried this representation in the context of an eye-tracking experiment about comprehending spatial data that is in large amounts, unstructured and unlabeled, in other words, resembling a vector spaghetti (see Keskin and Kettunen, 2021). The eye-tracking experiment involved 36 participants who were asked to look at 23 pseudo map series and memorise each of them as much as possible. The data is collected within the TUGEVA project and details of the experiment will be published elsewhere.

Animation of the visualisation of the data collected during the experiment consisted of two major steps followed by a step of improvement of the resulting visualisation. First, we used an interactive approach through the GIMP software to experiment with several criteria such as the number of frames, frame duration and frame transparency. This software was associated with the MATLAB software toolbox called LandRate (also compatible with Octave; Krassanakis et al., 2018) which has a function that generates the colours of the heatmaps from a set of data. The second step was the automation of the animation using the Python language. The written script enables the generation of animated heatmaps by choosing the number of participants, stimuli, conditions and the frame duration. The generated animations are saved in the GIF format in the end of the steps presented in the Figure 1.

In the domain of eye-tracking data visualisation, the created animated heatmap gives an aggregated view of how someone looks at an image over time, and thus shows additional information to a regular static heatmap. The goal of this study was to transform a static visualisation into a dynamic one through animation and to automate the whole process for making it suitable to process large volumes of data. Besides, using heatmaps and especially animated heatmaps makes it easier to make decisions and convey outcomes with a broader and eventually non-expert audience. One of the main concerns of heatmap animation is to keep in mind that they remain as heatmaps. Therefore, the animation must not be interpreted as gaze path plots even though there is some interpretable chronological information between the frames of animation.

Abstracts of the International Cartographic Association, 6, 104, 2023.
31st International Cartographic Conference (ICC 2023), 13–18 August 2023, Cape Town, South Africa.
https://doi.org/10.5194/ica-abs-6-104-2023

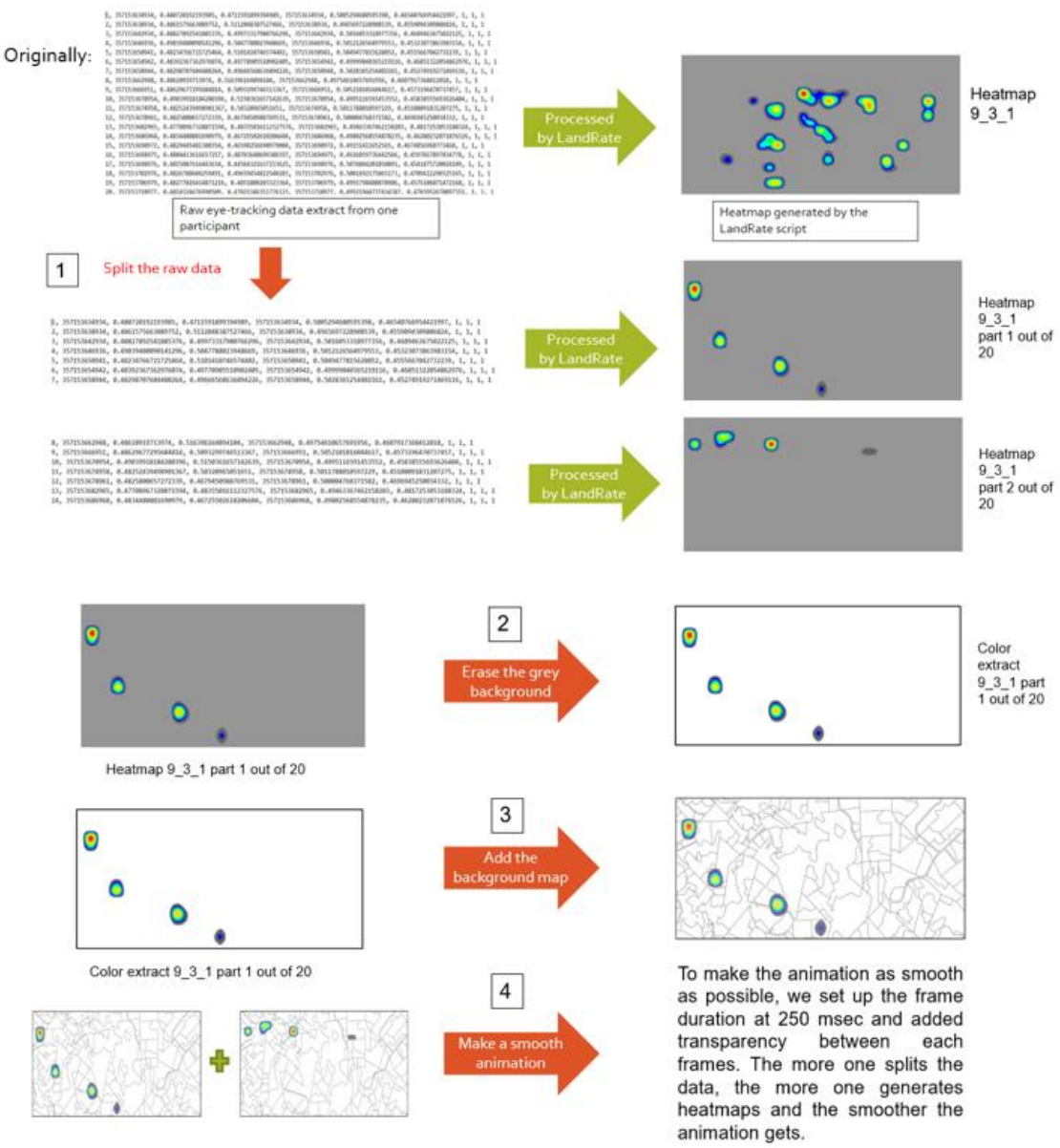

Figure 1. Steps of the heatmap animation process in GIMP.

Acknowledgements

This study was conducted in the TUGEVA project funded by the Finnish Scientific Advisory Board for Defence (MATINE). The first author participated in the project through an international mobility internship funded by Erasmus+.

References

Keskin, M. and Kettunen, P., 2021. Designing AI-assisted interactive map displays to explore spatial information. *Abstracts of the ICA*, Volume 3, 148. https://doi.org/10.5194/ica-abs-3-148-2021

Krassanakis, V., Misthos, L. M. and Menegaki, M., 2018. LandRate toolbox: An adaptable tool for eye movement analysis and landscape rating. In: *Eye Tracking for Spatial Research, Proceedings of the 3rd International Workshop*. ETH Zurich. https://doi.org/10.3929/ethz-b-000222256

Raschke, M., Blascheck, T. and Burch, M., 2014. Visual Analysis of Eye Tracking Data. In: W. Huang (Ed.), *Handbook of Human Centric Visualization*, Springer, New York, NY, USA. https://doi.org/10.1007/978-1-4614-7485-2_15

Tobii, 2009. Tobii Studio 1.5, Animated regular heat map feature. Available: https://www.youtube.com/watch?v=OSMnyN_ioJU