Software protocols and a graphical user interface for accessing and analyzing big data from eye tracking experiments

Background

Many studies that are designed to better understand how people work with visualizations, such as maps and map-like tools often also utilize eye tracking. Eye tracking data enables examining where people look and where they do *not* look¸ how long they may have studied a specific feature, in which order they view features on a visuospatial interface, and overall model visual attention. Eye tracking devices produce 'big data', as they record spatial coordinates (x,y) of the gaze, time (t) and pupil size for both eyes e.g., every 20 milliseconds. This data is spatially referenced to the object of interest (e.g., a map, a city model, a route simulated in virtual reality for a drive-through or walk through) and thus we can examine questions of *where/when* and to some degree *why* as eye movements can be an indicator of internal cognitive processes of the viewer. We have data from about a dozen studies that have not only eye movement data but also additional questionnaires that allows us to cross-correlate participant characteristics such as age, expertise, education, spatial abilities, gaming experience etc. with their eye movements. Based on this very rich data, we can conduct analyses to characterize attention, detect behavioral patterns, anomalies, attempt predicting where someone may look next or what they next action might be, and surmise design lessons to improve navigation tools and human navigation experience.

Goals / Methods / Approach

In the context of this master's project, a testbed will be created in which multiple analyses can be conducted on the data from 12 eye tracking experiments with multimedia content. Planned analyses will be both top down (testing hypotheses for cause-effect relationships and correlations) and bottom up (exploratory analyses to identify patterns and anomalies in the data). Some of the hypotheses are perceptually driven, e.g., eye movements may be guided by the saliency of certain visual variables (color, size, shape, location, texture), expertise and age may be factors in the spatio-temporal patterns of eye movements (sequences can be compared based on trajectory analyses), pupil size may reflect cognitive load and correlate with task difficulty, and similar. Establishing answers to such hypotheses using a rich dataset allows for a strong research foundation, and what we learn in these studies will be interesting to interdisciplinary scientific communities such as computer science, psychology, neuroscience, and geography. Besides these hypotheses-driven analyses, we expect exploratory approaches based on a combination of visual analytics and machine learning. In terms of technologies, you can choose what you feel comfortable (R, Python, .js, … a programmable visual analytics environment such as Glue). We anticipate scripting and bulk processing of data in the early stages and then creative technical solutions to deal with 'big data'.

Required skills: Analytical thinking, interest in learning statistical / machine learning approaches to problem solving, programming, visualization and visual analytics, scientific research (conceptual thinking, structuring of ideas)

Others: The project language is English. The project is a spin-off from earlier SNF-funded projects, and may lead to new research grant proposals and publications.

Tasks for the MSE candidate

The project can be implemented in 2 to 3 stages, e.g., ongoing projects P7 (data wrangling, concept building), P8 (visualization and analysis software environment) and P9 (analyses and experiments)

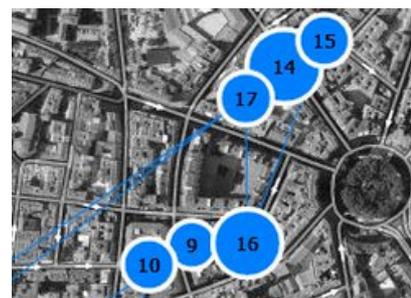|	
Study type:	[x] Full time
	[x] Part time 50%
Project organization:	Single and/or in a project team both possible
Workplace:	Windisch
Advisor:	Prof. Dr. Arzu Çöltekin, arzu.coltekin@fhnw.ch

Image: Eye movements of an individual searching for a specific feature on the map. Heim & Coltekin 2020