ProtoMatch: A Tool for Manipulating Eye, Mouse, and Keystroke Data

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Human experimentation is a necessity for many disciplines from cognitive science to usability testing. Gigabytes of data are often collected during a typical study. In most cases, especially in complex task environments, it is up to the researcher to develop the data extraction tools necessary to make sense of the data. We have developed ProtoMatch (Myers & Schoelles, 2005) as a general-purpose tool for transforming and extracting logged data into information of interest to cognitive scientists, eliminating the need to rewrite these tools. As log file formats are often not uniform, ProtoMatch provides a form-based interface that enables the parsing of logged data into Object, User, and Event data (Schoelles, Zafrina, & Gray, 2007).

The general framework for how a typical user will interact with ProtoMatch is: reading log files, adjusting the settings, processing data, and outputting results. The description below is intended to give an overview of how the interface to ProtoMatch works, what capabilities it gives the user, and a description of the processing involved.

Reading in the Log File(s). The researcher begins by reading in either a single log file or a whole directory of log files. If a directory is read in, the user can filter the files in the directory by supplying a "qualifying string."

Specifying Tags and Locations in the Log File(s). Depending on the type of log file format, the user can specify through a GUI interface certain aspects of the file's organization such as the tags signifying the various data lines (i.e., Eye Data line, Object Data line, User Action line). The user can also specify the location (column) of each aspect of the data line (note that this is crucial in the Fixed and Variable column format but will not be necessary for the XML Tagged format).

Specifying What to Extract and Defining AOIs. ProtoMatch enables the researcher to segment the data by hierarchical regions or areas of interest.

Hierarchical Regions of Interest. If our recommended data-logging format has been followed, then it is a simple matter for ProtoMatch to deliver to the researcher the data that is aggregated at different levels in the object hierarchy. For example, for a certain question-of-interest, one researcher may want to extract User data on all buttons, all buttons in one window, all radio buttons, or all highlighted radio buttons. Likewise, another researcher may want to extract user interactions between different windows, or between the various objects available within a single window. As a third example, a researcher may want to tabulate when the user is reading any text, or may wish to track which paragraphs are most frequently read or reread.

Areas of Interest (AOI). The researcher will have the option to specify areas of interest (AOIs) defined by the spatial layout of the screen. There are two ways that AOIs can be defined. The user can either read in a Secondary File that defines the AOIs, useful for dynamic task environments, or manually draw the AOIs after loading a static image of the interface.

Segmenting the Data. Flexible analysis of logged data requires that the researcher be able to segment the data so as to best address the questions-of-interest. For example, the researcher may wish to aggregate all cases that begin with a user-initiated action such as a mouse click. Likewise, they may wish to aggregate over all user responses to some system event (e.g., the appearance of a Help message). An example of a query that we pursued, required the extraction of all eye fixations that began 2000 milliseconds before the user clicked on a target item and ended 2000 milliseconds after the system response. This enabled us to understand how attention was allocated with respect to a key event.

Extracting and Outputting the Data. After all of the above settings have been made, ProtoMatch runs through the log file(s) it has read in, combines eye gaze and mouse samples into fixations, and assigns fixations to objects and AOIs. The user can then specify what should be output and how. For example, the user can qualitatively visualize the data or quantitatively output the summary statistics. In addition, exploratory sequential data analysis can be employed (Sanderson & Fisher, 1994).

In conclusion, the flexibility provided by ProtoMatch in aiding the researcher's analysis is limited only by two factors: (a) a properly formatted log file, and (b) the imagination and questions-of-interest generated by the researcher.

References

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