Processing and Comparing of Sequential Data Using Machine Learning

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Eye-tracking technology is getting more and more attention when evaluating adaptive systems. Current approaches rely upon manually defined areas of interest [1] and optionally also manually designed features [2] fed as an input to some machine learning algorithm. We present a generic way how to learn an efficient abstraction of a user session, which is especially suitable for comparing, clustering and categorizing user sessions.

Our approach is based on unsupervised machine learning, specifically Restricted Boltzmann Machine (RBM) [3], which is presented with fragments of user sessions in form of heat maps capturing spatial (pixel coordinates) and time (pixel intensity) information. RBM is able to find its own features to make efficient session abstraction in the context of other user sessions, which is especially suitable for comparing, clustering and categorizing user eye-tracking sessions.

Our goal is to improve possibilities of automatized evaluation of eye-tracking data sequences by comparing user sessions to each other, comparing user sessions with expected usage of application captured by eye tracker or detecting outliers for closer manual inspection.

In our experiment we had 8 participants with whom we recorded altogether 90 minutes of eye tracking recordings within one of our web applications. By visual comparison of top 12 patterns in sequential eye tracking data (Figure 1) from individual participants one through eight, we made some interesting observations.

One of them is that first six participants began using the application in the same way (fifth pattern, Figure 1). This corresponds to scanning of top and left areas of screen (Figure 2), which contains menus and first few lines of text. This is an expected behavior and our method correctly detects it as a common pattern among these participants.

We verified all these observations by manually looking through the recordings. All of the observations acquired from our abstraction were confirmed by the raw data.

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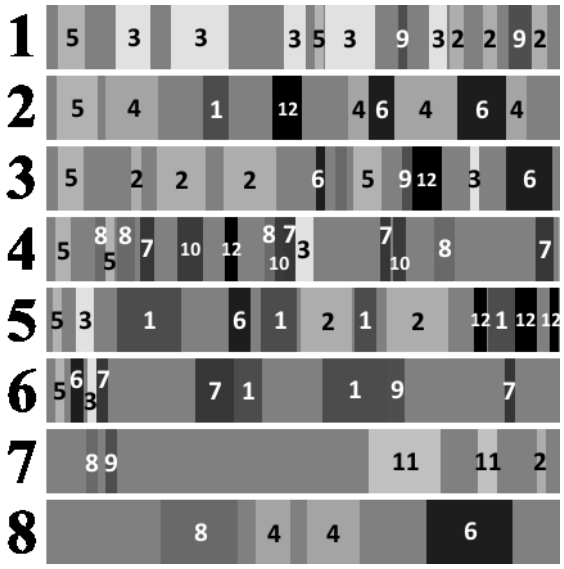

Figure. 1. Visualization of twelve most common abstract patterns in our experiment with eight participants. Horizontal axis corresponds to time.

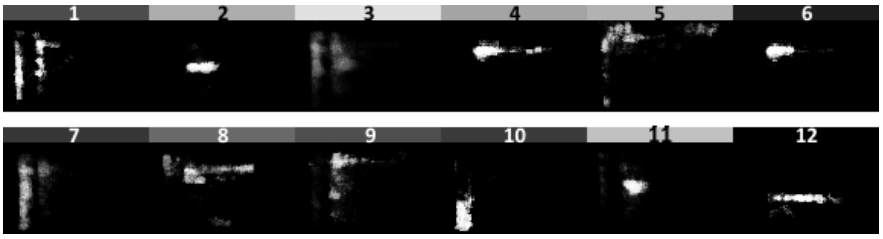

Figure. 2. Color legend of twelve most common abstract patterns in our experiment.

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