iComp: A Tool for Scanpath Visualization and Comparison

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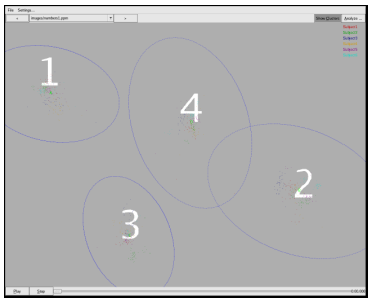

	Same Subj.	Diff. Subj.
← Same Img. →	**R**epetitive 1.0	**L**ocal 1.0 F(1,6) = 176.0, $p < 0.01$ $\chi^2 = 6.14, p = 0.01$
← Diff. Img. →	**I**diosyncratic 0.94	**G**lobal 0.95
S_p		Random 0.51

	Same Subj.	Diff. Subj.
← Same Img. →	**R**epetitive 0.59	**L**ocal 0.91 F(1,6) = 325.0, $p < 0.01$ $\chi^2 = 5.40, p = 0.02$
← Diff. Img. →	**I**diosyncratic 0.63	**G**lobal 0.63
S_s		Random 0.03

Repetitive: same viewer looking at same scene at different times; **L**ocal: different viewers looking at the same scene; **I**diosyncratic: same viewer looking at different scenes; and **G**lobal: different viewers looking at different scenes. The Random entry is provided against which statistical significance of the results is evaluated.

Figure 1: Data visualization and resultant parsing diagrams with $\sigma_s = 100$.

Abstract

To evaluate differences across viewers' visual attentional patterns, scanpath comparison has recently gained popularity in eye tracking studies, supplementing traditional objective (performance) and subjective measures (e.g., heat maps or [retrospective] talk-aloud). We introduce *iComp*, an open-source visualization tool that implements quantitative scanpath comparison in loci and sequence. *iComp* can be used to objectively compare the attentional qualities of synthetic images.

1 Eye Movement Comparison

String-editing has recently been employed in several scanpath comparison studies (e.g., see West et al. [2006]). In most cases, analysis requires assignment of character labels to visual Areas Of Interest (AOIs). The goal of *iComp* is to perform this step automatically over fixations, i.e., perform an automatic data-driven analysis instead of a manual stimulus-driven one.

iComp builds on Privitera and Stark's [2000] two-step scanpath comparison method: fixation clustering for spatial comparison of loci (S_p) and assembly of the temporal sequences of fixations into ordered character strings for sequence comparison (S_s) via string-editing. Similarity coefficients are tabulated in the Y-matrix, from which *parsing diagrams* are distilled, yielding numerical similarity measures akin to correlation.

String-editing is one of the first means to quantify both scanpath spatial similarity as well as sequential order. However, the approach is hampered by its reliance on manual labeling or (in its original form) on k-means clustering, the latter requiring an *a priori* estimate of the number of clusters. To automate the analysis, we substitute in Santella and DeCarlo's [2004] *mean shift* clustering. Our current implementation uses a spatial Gaussian kernel with support limited to $2\sigma_s$: $K(\mathbf{x}_i) = \exp\left(-(x_i^2 + y_i^2)/\sigma_s^2\right)$.

iComp displays a visualization of the clustered eye gaze data of all viewers for each image (see Figure 1) and generates statistical parsing diagrams. Viewers' fixations are distinguished by a color code. An ellipse surrounds each cluster, with a text character at its center denoting its label. User-adjustable parameters include velocity threshold used for fixation classification and saccade removal, and σ_s, the extent of the mean shift kernel's spatial support.

2 Results

A short experiment was performed to validate *iComp*. Hypothesizing that the **L**ocal similarity between viewers given a "fixate-the-numbers" task should be significantly higher than Random for both loci (S_p) and sequence (S_s), eye movements from 6 participants (6 M, age $\in$ [21-42] yr.) were captured using a Tobii ET-1750 eye tracker (17″ TFT 1280 × 1024 display, sampling @ 50Hz with 0.5° accuracy). The stimulus consisted of three black screens with randomly placed numbers (1 through 4; see Figure 1), each displayed one at a time (for 500 ms), with participants seated at 60 cm. Following removal of saccades (eye movements below 130°/sec threshold) and statistical analysis (see parsing diagrams in Figure 1), the **L**ocal metric was found to differ significantly from Random (as expected), suggesting strong similarity of scanpaths of different viewers over the same image. *iComp* is freely available at <http://andrewd.ces.clemson.edu/iComp/>.

References

Privitera, C. M. and Stark, L. W. 2000. Algorithms for Defining Visual Regions-of-Interest: Comparison with Eye Fixations. *IEEE Transactions on Pattern Analysis and Machine Intelligence (PAMI) 22,* 9, 970–982.

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West, J. M., Haake, A. R., Rozanski, E. P., and Karn, K. S. 2006. eyePatterns: Software for Identifying Patterns and Similarities Across Fixation Sequences. In *Eye Tracking Research & Applications (ETRA) Symposium*. ACM, San Diego, CA, 149–154.

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