A Crowdsourced Alternative to Eye-tracking for Visualization Understanding


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Key Summary

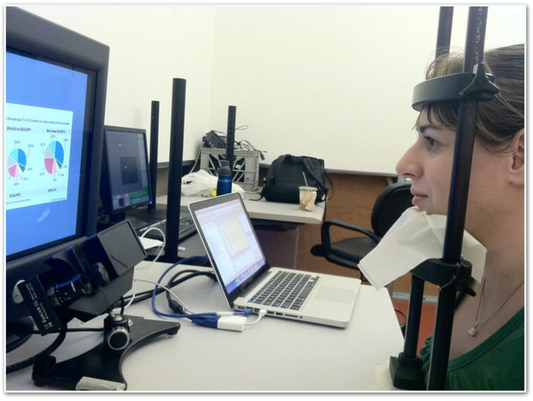
Motivation
Understanding what elements people attend to is important to create effective data visualizations.

Problem
Collecting accurate eye-tracking data is often expensive and tedious.

Research Question
Can crowdsourced mouse clicks be an alternative for eye fixations in the context of understanding data visualizations?

Result
A high similarity score between the saliency maps of mouse clicks and eye fixations.

Eye Tracking Experiment



50 visualizations from the infographic, news, media, and government source categories.

These visualizations were **shown to participants for 10 seconds** at a time, separated by a 0.5 second fixation cross.

Eye-tracking was performed using an **SR Research EyeLink1000** with a chin-rest mount 22 inches from a 19 inch CRT monitor with a resolution of 1280x1024 pixels.

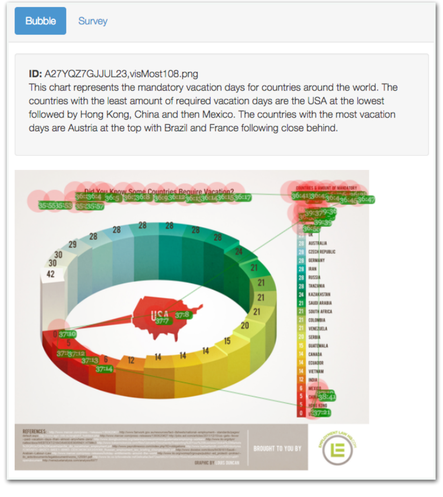
Crowdsourced Online Study

Crowd on Amazon's Mechanical Turk

Click to reveal full details of small, circular regions ("bubbles")

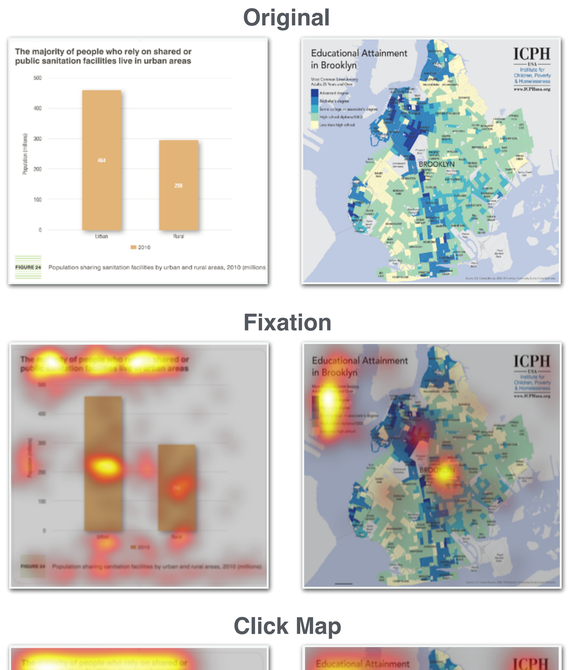
Describe the blurred image

Evaluated bubbles with text descriptions



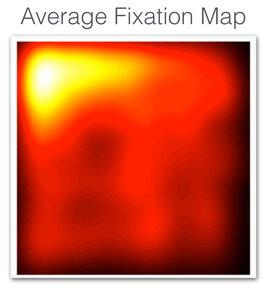
Results

Click maps: aggregated clicks over all participants in bubble experiments.
Fixation maps: aggregated fixations over all participants in eye-tracking experiments.
Similarity measure: histogram intersection between corresponding heatmaps.

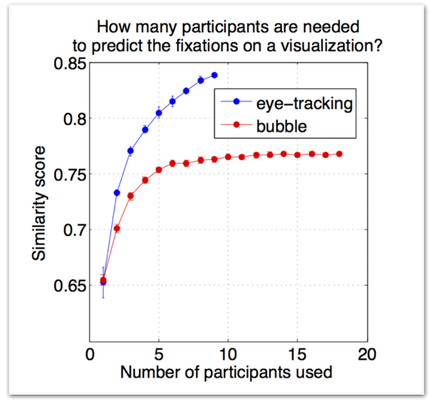


Two example visualizations: (**left**) with **high consistency** between fixation data and click data, (**right**) with **low consistency** between fixation data and click data. Note the center bias appearing in the fixation data.

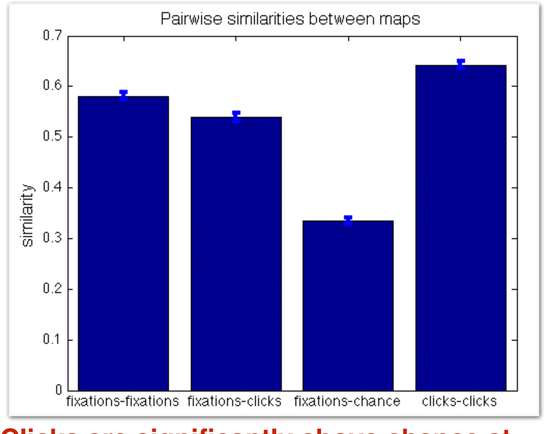

Average Click Map


Average Fixation Map

(**left**) An average taken over all bubble click maps and all visualizations, resized to 500 × 500. (**right**) An average taken over all fixation maps and all visualizations.



When there is little or no human eye-tracking data available, **bubble clicks can help predict ground-truth fixations on visualizations** (as compared to a chance baseline with a similarity score of 0.33, see text). However, we also observe systematic differences between the two modalities.



Clicks are significantly above chance at predicting fixations, but still not as good as other participants' fixations. Also, **consistency between participants is higher in the bubble modality** compared to the eye-tracking modality. This might be because clicks are the result of a slower, more **conscious process** than eye movements.