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# Visualizing the effect of actions in personal informatics systems

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**Abstract**

In this paper we present Tracer, a system that tracks aspects of a user's cognitive and affective processes, and behavior through their personal writing, social network website activity, browsing activity and physical activities. Tracer contains several data analysis tools. We focus here on one of its features, an Engagement Gauging Function that measures behavioral engagement. Tracer generates four types of visualizations, individual, group, generic and specific visualizations. Our future work will focus on how to effectively visualize the behavior and affect data for supporting wellbeing and mental health.

**Author Keywords**

Quantified self; visualization; personal analytics.

**ACM Classification Keywords**

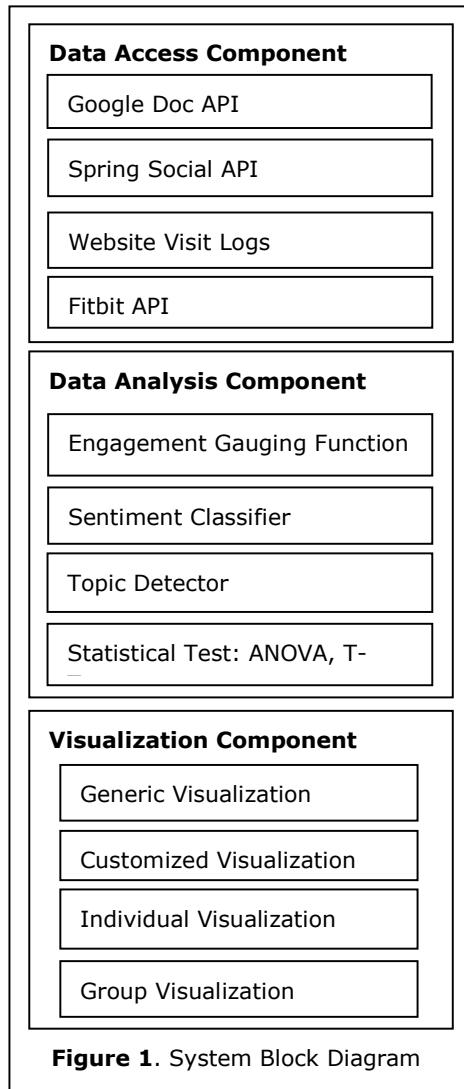
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

**General Terms**

Measurement, Human Factors

**Introduction**

Work and learning in the 21st century is typically performed using digital devices connected to the Internet. While writing (e.g. email, papers, etc) for



example, technology enables writers to interact with content and with other people in completely new ways. This increased interconnectedness opens the door to new opportunities as well as challenges. In particular, these technologies allow for new choices in the way we work, and we need to understand how to select from them. What is the best way to teach youth about quality work patterns and behaviors?

In this project we propose to use personal informatics [6,7,8] tools to provide a means of reflection that allows users to discover work habits that help us be productive and enjoy the activity. Productivity and enjoyment are often related, particularly when the motivation to be productive is intrinsic, and the person feels autonomy (freedom to act), competence (the capacity to do it) and connectedness [5]. Environments that invite reflection are the key to this type of motivation. Reflection can be scaffolded through visualizations or specific types of feedback [2]. Our research is also driven the psychological literature pointing to evidence that engagement and flow are related to wellbeing [3].

### System Architecture and Visualization

Tracer is a web application hosted on Heroku Cloud Environment<sup>1</sup>. It is developed by using Spring Roo<sup>2</sup>, which is an agile web development framework. Tracer contains three major components, Data Access Component, Analysis Component and Visualization Component. Data Access Component focuses on collecting data to derive a user's affect and behavior. Thus, the data source can be divided into two categories, Affect and behavioral data source. Affect

data is either elicited explicitly through asking questions based on standard questionnaires (e.g PANAS – Positive Affect Negative Affect Scheme) or sources such as personal diaries and social networks that may contain affective information that needs to be extracted using NLP techniques (an important part of our project).

Behavioral data source includes the type of information used to measure productivity and engagement (based on the revision history of the document and access logs to webpages) and others that have been suggested to influence a person's cognitive productivity, mostly intrapersonal physical information such as sleep activity and general exercise activities. When a user accesses an assigned Web tutorial, it is logged in that web application. The Data Analysis Component contains several tools, which analyze collected data to derive a user's affect and behavior. A sentiment classifier is used to classify the text written by the user, such as Facebook data or Diary. A topic detector is used to find out the main topics which the user writes about. The Engagement Gauging Function is designed to measure the time the user spent on a particular task. For example, the total time a student spent on the writing assignment. Due to the advantages of the Google Document on managing document revision history, we can use Google Doc API to retrieve the number of revisions with timestamp. Currently, we proposed two engagement gauging functions: point-based and line-based function. The point-based function simply counts the total number of time events which the user engaged in that task. The line-based function takes the intensity of the engagement into account. If the adjacent time events are intensive, the engagement for that period of time is assigned a higher weight, and vice versa. In order to measure the effectiveness of a

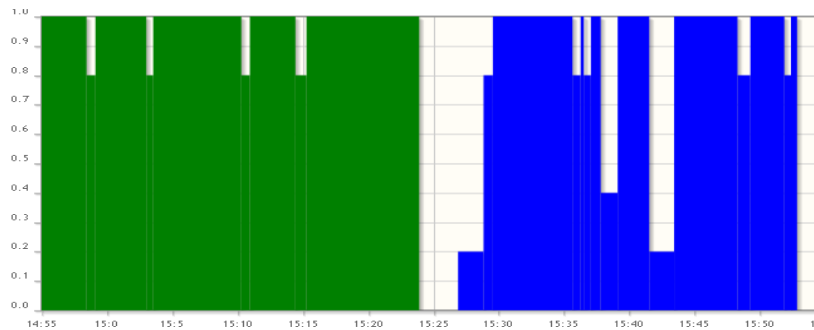
<sup>1</sup> <http://www.heroku.com>

<sup>2</sup> <http://www.springsource.org/spring-roo>

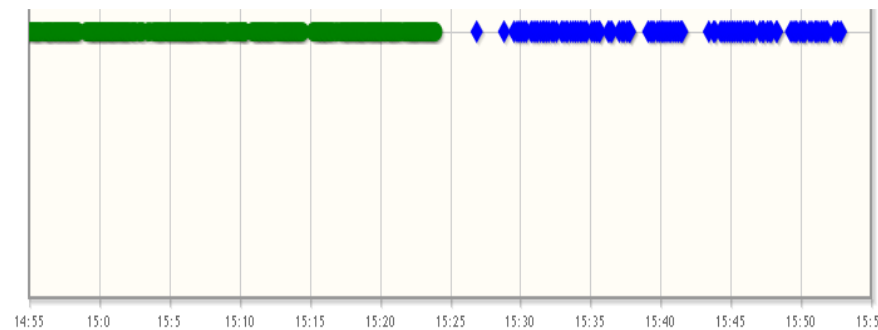
particular feedback intervention (e.g. writing feedback from teachers), some statistical tests, including ANOVA, are performed by using the Apache statistics package.

Visualization component is the most important part of the system because it provides final feedback to the end user. The visualization component is implemented by using the JqPlot, which generates line, bar and pie charts with many features. According to the purpose of visualization, we divided it into four sub-components: generic, customized, individual and group visualization. Generic visualization draws a timeline for any data

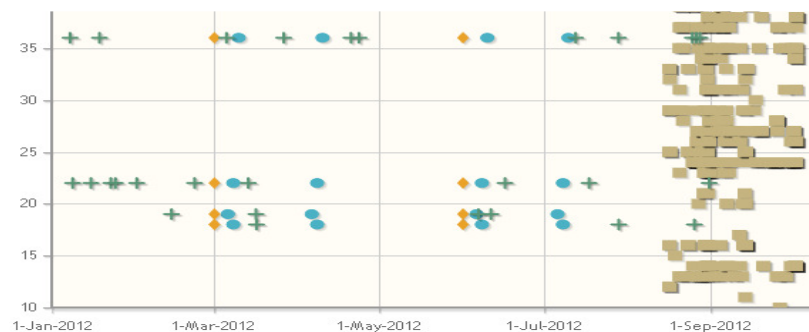
source. Based on the engagement function mentioned earlier, it produces different visualizations. For example, Figure 2a and 2b shows the individual visualization, which contains the information about the amount of engagement. The group visualization sub-component is useful for coaches to monitor the working progress of a group. Figure 2c shows a group of users' behaviors, such as accessing web pages, writing a diary or doing exercise over a period of time. Each row represents a user. Each type of behavior is indicated by using a different shape and color. Figure 2d illustrates a group of user's affect status on Facebook.



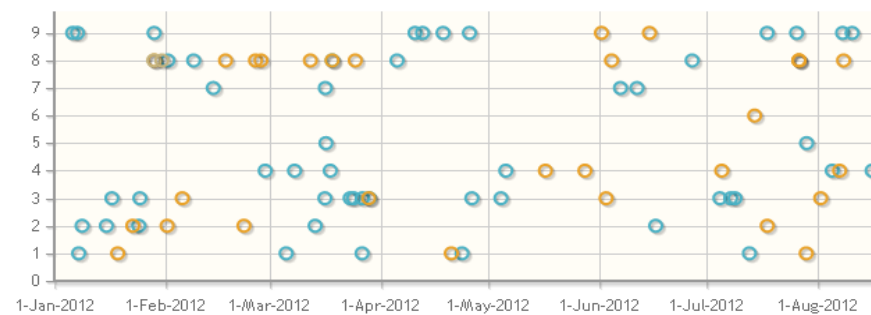
(a) Individual visualization based on line-based engagement function, where x axis represents the timeline and y axis represents the engagement intensity



(b) Individual visualization based on point-based engagement function, where x axis represents the timeline.



(c) Group Generic visualization for accessing web tutorial, writing personal diary and exercising events. It shows only the time event information.



(d) Group Specific visualization for displaying user's affect on Facebook. The specific visualization is called as it shows some specific information about an event.

**Figure 2** Individual and Group Visualization

### **Work-in-progress Study and future work**

The aim of the current study is to find out which visualization is more useful for writers to reflect on what they have done in a writing activity, and how it impacts on the writing. This study includes two writing activities: 1. writing a software project proposal in one week. 2 writing a personal traveling experience blog in 1 hour. Tracer generates individual visualizations and gauges the engagement time for each participant. Some example visualizations are shown in Figure 2a and 2b. We have been asking writers how good our representations are in different quality measures (accuracy, ease to understand, useful to reflect). Our future work will focus on the evaluation of the group visualization, and how to effectively visualize the behavior and affect data from the data sources for supporting mental health. We are also looking at computer vision based approaches to gauging engagement.

### **Conclusion**

This paper presents a system that tracks a user's while occupied in a writing activity. The aim of the system is to generate different types of visualizations for individual and coach. Currently, we are evaluating a visualization that tracks behavioral engagement and the results are promising.

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