

Detecting Multitasking Work and Negative Routines from Computer Logs

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Abstract. Multitasking on digital media has a negative effect on mental health and concentration. At the same time, the negative effects of computer usage are not immediately obvious to most people. We suggest that people can improve their daily experience on the computer if they pay closer attention to their multitasking activities. To this end, we have constructed a system that detects multitasking work and periodic negative multitasking routines from computer logs. We created two indicators: relax rate and multitasking rate. The relax rate is defined on the basis of heart rate variability information and the multitasking rate is derived from how often users switch their computer windows. We analyze whether users' multitasking is negative or not and whether or not negative multitasking is part of a periodic routine. We logged the computer activities and heart rate data of one participant for six days.

Keywords: Human factors · Activity tracking · Computer log · Multitasking · Stress · Time management · Digital lifestyle · Lifelog

1 Introduction

As computers are becoming increasingly ubiquitous, people are spending more and more time on computers. Information and communication technology has greatly improved, to the point that users can read the news, write reports, play games, or watch sports events while easily switching between these tasks on the same computer. People's lives' are made easier this way, but as stated in [1], multitasking is an activity that distracts users and generally has a negative effect on the brain.

For instance, as reported in [5], one college student stated: "I spend so much time on social network sites every day and play games on it that I have to work at night, which increases my stress." This shows that he cannot control his activities on his computer, even though this lack of control induces irritation. Doidge [4] points out that brains keep their neurons' routines whether these routines are positive or negative.

It is often said that we become more knowledgeable through obtaining a variety of information from the Internet. However, as part of this process we are often forced to perform quick task switching and multitasking during Web

browsing. Small et al. show that the human brain is rapidly changed through Web searching [2,3]. According to Small's experiment, users improve some of their capabilities, such as scanning or quickly multitasking. Yet, Ophir et al. state that digital media heavy multitaskers are more likely to be distracted by irrelevant environmental stimuli than light multitaskers [7]. This research indicates that their capabilities, such as concentrating or memorization, are diminishing.

Hence, multitasking and negative routines have a negative effect on users. However, most users are not aware of this effect. We intend to develop a system that analyzes user activity on a computer and then provides users with a visual representation of the results.

2 System Description

Our system has the following two main functions.

- detecting multitasking and negative routines,
- visually representing results on a graph.

Figure 1a shows an overview of our system. First, it records computer activity data (using free software such as ManicTime [11] or Kidlogger) and at the same time monitors the user's heart rate using a ready-made activity tracker. Next, it analyzes the collected data.

2.1 Logging Computer Activity

We log the user's computer activity using an application such as Kidlogger or ManicTime [11,12]. The software generates a log every time a user opens a new window or switches between already opened windows. Each log record includes the starting time and duration of the active window, the name of the application, and a URL (if the window is a Web browser tab), as well as the duration of inactivity. We export raw data as a csv file and use it in our system. Figure 1b shows sample computer logs.

2.2 Observing Heart Rate Using an Activity Tracker

The computer works in conjunction with an activity tracker to gather heart rate information. We use the Fitbit Charge HR, as this device can send heart rate information through a wireless network.

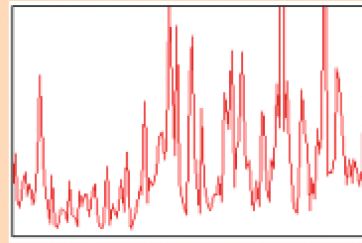
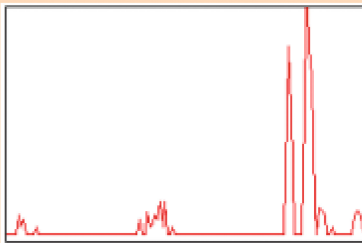
2.3 Detecting Multitasking and Negative Routines

We propose a method of detecting multitasking and negative routines. Two indicators are used for this: relax rate and multitasking rate.

logging computer log observing heart rate



detecting multitasking and negative routines



illustrating results in graphs

(a) Overview of the system

Name	Start	End	Duration	Domain
http://www.msn.com/ja-jp/?pc=SK2M&ocid=SK2MDHP&	19:44:18	19:44:23	0:00:05	www.msn.com
https://toefl-registration.ets.org/TOEFLWeb/profile/sei	19:45:58	19:46:04	0:00:06	toefl-registration.ets.org
https://toefl-registration.ets.org/TOEFLWeb/order/subr	19:46:04	19:46:10	0:00:06	toefl-registration.ets.org
https://toefl-registration.ets.org/TOEFLWeb/order/subr	19:46:15	19:46:23	0:00:08	toefl-registration.ets.org
https://toefl-registration.ets.org/TOEFLWeb/order/subr	19:46:23	19:46:33	0:00:10	toefl-registration.ets.org
https://toefl-registration.ets.org/TOEFLWeb/order/subr	19:46:33	19:46:41	0:00:08	toefl-registration.ets.org
https://toefl-registration.ets.org/TOEFLWeb/order/subr	19:46:41	19:46:49	0:00:08	toefl-registration.ets.org
https://toefl-registration.ets.org/TOEFLWeb/order/can	19:46:55	19:47:03	0:00:08	toefl-registration.ets.org
https://toefl-registration.ets.org/TOEFLWeb/order/sear	19:47:03	19:47:08	0:00:05	toefl-registration.ets.org
https://toefl-registration.ets.org/TOEFLWeb/order/disp	19:47:08	19:47:19	0:00:11	toefl-registration.ets.org
https://toefl-registration.ets.org/TOEFLWeb/order/subr	19:47:19	19:47:29	0:00:10	toefl-registration.ets.org
https://toefl-registration.ets.org/TOEFLWeb/order/disp	19:47:29	19:47:35	0:00:06	toefl-registration.ets.org
https://toefl-registration.ets.org/TOEFLWeb/account/s	19:47:35	19:47:49	0:00:14	toefl-registration.ets.org
https://production.ets-hosted.cybersource.com/ets-ho	19:47:49	19:48:02	0:00:13	production.ets-hosted.cybersource.com
https://production.ets-hosted.cybersource.com/ets-ho	19:48:02	19:48:02	0:01:00	production.ets-hosted.cybersource.com
https://production.ets-hosted.cybersource.com/ets-ho	19:49:02	19:49:12	0:00:10	production.ets-hosted.cybersource.com
document 1	19:49:25	19:49:39	0:00:14	document 1
https://www.google.co.jp/search?q=We+are+unable+to+	19:50:05	19:50:26	0:00:21	www.google.co.jp
https://www.drupal.org/node/941216	19:50:26	19:50:51	0:00:25	www.drupal.org
https://www.drupal.org/node/941216	19:51:00	19:51:37	0:00:37	www.drupal.org
https://www.google.co.jp/search?q=We+are+unable+to+	19:51:37	19:51:48	0:00:11	www.google.co.jp
https://www.google.co.jp/search?q=We+are+unable+to+	19:51:53	19:52:01	0:00:08	www.google.co.jp
https://www.google.co.jp/search?q=We+are+unable+to+	19:52:01	19:52:08	0:00:07	www.google.co.jp
https://production.ets-hosted.cybersource.com/ets-ho	19:52:22	19:52:29	0:00:07	production.ets-hosted.cybersource.com
https://production.ets-hosted.cybersource.com/ets-ho	19:52:34	19:52:48	0:00:14	production.ets-hosted.cybersource.com

(b) Computer activities

Fig. 1. Overview and computer activities

Heart Rate Variability and Relax Rate. We use heart rate information to measure stress. Heart rate variability (HRV) is considered a valid indicator of mental stress in clinical studies [9, 10]. One of the variables used to calculate HRV is the standard deviation of the NN interval (SDNN). NN interval is the interval between two consecutive beats. In medical research, NN intervals per beat are observed by biosensors. However, we do not use precise NN intervals in our research. If we want to observe precise NN intervals, we need to use a large sensor (e.g., one that requires a chest strap), however this is likely to be burdensome for most users. A wrist-worn activity tracker such as Fitbit Charge HR is better, yet this tracker cannot observe NN interval directly. Thus, we use the mean of the heart rate over 60 s (heart rate over the course of 60 s divided by 60). Consequently, we define the relax rate as the standard deviation of the mean of the heart rate interval over 60 s. The relax rate is similar to SDNN and is used to measure stress. Generally, the lower the HRV value, the higher the degree of stress. Therefore, in our research, the lower the relax rate value, the higher the degree of stress.

Computer Logs and Multitasking Rate. We analyze how users multitask and define the multitasking rate as read by computer logs. Logs have the starting time of the active window and include the name of the application or a URL. We calculate the times of switching windows from the logs. Our concept is that the more frequently a user switches the active window, the more that user is multitasking. MR, NA and SW refer to the multitasking rate, the number of applications (and URL, if user is browsing), and the number of times of switching windows, respectively. Then, we define an equation, $MR = \sqrt{NA * SW}$ For example, if we browse three pages and switch windows four times, the multitasking rate is $\sqrt{3 * 4} = \sqrt{12}$.

Detecting Negative Multitasking by Multitasking Rate and Relax Rate. We construct a theory to detect negative multitasking with the relax rate and multitasking rate. First, we define conditional equality with the relax rate and multitasking rate (requirement 1). If a multitasking activity satisfies the following requirement 1 (where RR represents relax rate), we regard it as a negative multitasking.

$$RR < C_{RR} \text{ and } C_{MR} < MR \quad (\text{requirement 1})$$

C_{RR} : median of Relax rate
 C_{MR} : median of Multitasking rate

Detecting Periodic Negative Multitasking Routines. We detect not only negative multitasking activities but also whether these multitasking activities are periodical or not. If a multitasking activity satisfies requirement 1, and if it always takes place at the same time, we consider it a periodical negative multitasking routine.

2.4 Visualizing Results on a Graph

We visualize the relax rate, the multitasking rate, and our analysis of the data on a graph.

3 Experiment

3.1 Overview of Experiment

We tracked the heart rate data and the logged computer activity of one participant over a period of six days. The participant installed our system on his laptop computer and he wore an activity tracker all day, except during taking a shower and charging the battery of the device. We monitored his activities and heart rate for most of the day. We performed an experiment in which our system attempted to detect negative multitasking and periodical negative multitasking routines.

3.2 Results

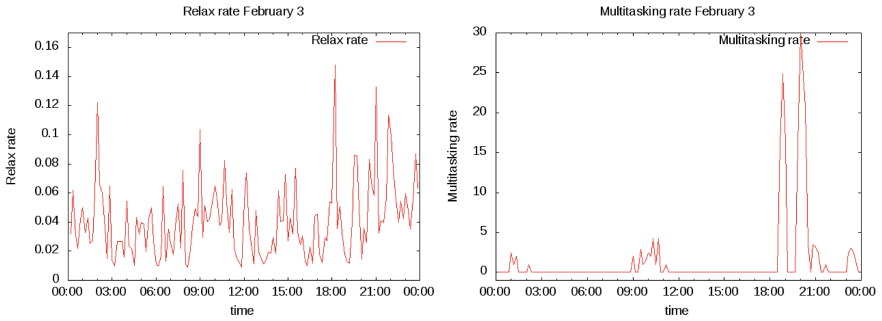
We show the results of calculating the relax rate and multitasking value, as well as our analysis of negative multitasking. We also observe whether negative multitasking activities are periodical negative multitasking activities or not. Figure 2a shows the relax rate for February 3. As we can observe, the relax rate presents lower values than median on February 3 between 19:00 and 20:00. We deduce from this observation that the user feels stressed during this interval.

The multitasking rate is plotted in Fig. 2b. According to the computer activity data (Fig. 1b), the user tends to perform multitasking between 19:00 and 20:00.

Similarly, Fig. 2c shows the relax rate value over a period of six days, and the multitasking rate is drawn in Fig. 2d. According to Fig. 2d, the participant has the habit of multitasking between 19:00 and 21:00, and then he tends to feel stressed, as suggested in Fig. 2c. Figure 2e and f show the results of our analysis, specifically, whether the user's multitasking activities are negative or not. From Fig. 2f, we can observe negative multitasking between 19:00 and 21:00 on several of the six days, leading us to conclude that the user has a periodical negative multitasking routine between 19:00 and 21:00.

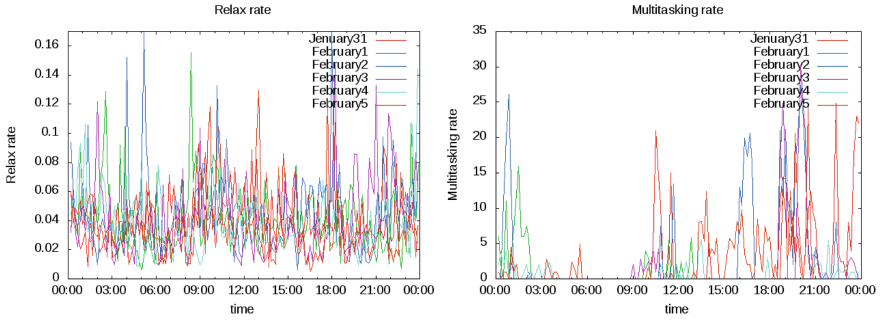
3.3 Considerations

We detect multitasking activities and negative multitasking routines through observing six days of data gathered by our system. We should, however, consider external factors. For example, the participant in our experiment ate breakfast at 10:00 and dinner at 18:00. We can guess that the reason for a significant increase in the relax rate (HRV) is breakfast and dinner. Thus, we need to investigate whether external events, such as dinner or exercise, affect the results or not, even though they are separate from multitasking time.



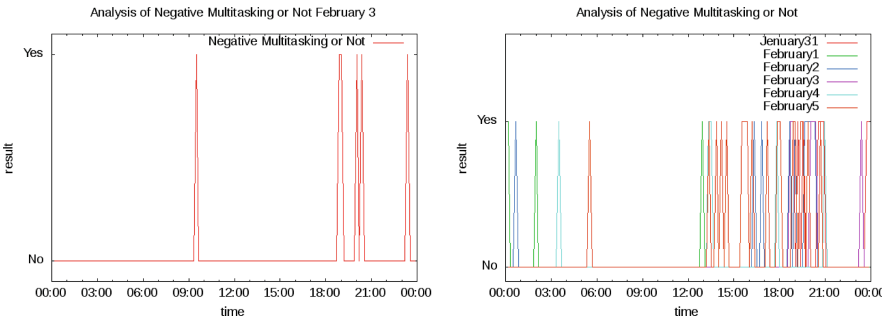
(a) Relax rate on February 3

(b) Multitasking rate on February 3



(c) Relax rate over six days

(d) Multitasking rate over six days



(e) Analysis of negative multitasking on February 3

(f) Analysis of negative multitasking over six days

Fig. 2. Results (Color figure online)

Yet, we could also state that the multitasking activities influence on relax rate. We could assume that the user wants to relax after dinner by surfing the Internet (according to the logs, he often watches sports news). However, our system detects this routine as stressful. In fact, we suggest that he was not relaxed during this routine.

In addition, we also need to solve a problem related to logging. For example, in our experiment, we can observe that on February 4 the multitasking rate is very low. Our system, which uses Manictime running on Windows, logged a low number of activities. This occurred because the participant used a different OS on February 4. In the future, we intend to use other software programs (e.g., Kidlogger¹) that work on various OSs (Mac, Android).

Graphical Interface and Feedback. We intend to collect more data and receive more feedback in order to improve the reliability of our system. Moreover, we are going to develop a graphical interface to visualize our graphs. We found that our results, such as those in Fig. 2c, f, are too complicated for the average user to easily comprehend, meaning they cannot be used to obtain precise feedback. Hence, we will try to reconsider requirement 1 or the way in which we show the results. Finally, we intend to experiment and research the extent to which users realize the nature of their habits (negative, periodic etc.), as well as evaluate the usability of our system.

4 Related Work

4.1 Influence of Multitasking

Lottridge et al. examined how “heavy” and “light” digital multitaskers differ in analytical writing [6]. They observed that “heavy” multitaskers write low quality essays when faced with task-irrelevant distractors and write high quality essays when faced with task-relevant distractors. Lottridge pointed out that multitasking does not cause problems in focusing on the right things; rather, multitaskers have trouble ignoring the wrong things.

Ophir et al. found through examining cognitive tests that heavy multitaskers tend to be distracted by irrelevant environmental stimuli [7]. In their experiments, participants viewed two consecutive exposures of an array of rectangles. First, they memorized an image, and next, they looked at a second image and pointed out whether or not a red target rectangle had changed from the first, while ignoring a blue distracting rectangle. Results showed that heavy multitaskers had less accurate selection than light multitaskers under given condition.

4.2 Analysis of Multitasking

Mark et al. investigated the relationship between computer and mobile activity [5]. Participants installed a logging software (Kidlogger [12]) and logged their computer or smartphone activities. They also wore heart rate monitors to collect heart rate variability, which is a measure of stress. The authors found a positive relationship between window-switching frequency and stress.

¹ Manictime can export richer logs and is more useful than Kidlogger, which is why we adopted Manictime initially.

Dabbish et al. suggested that self-interruption increases depending on the external environmental [8]. They found that people in open office environments interrupt themselves frequently.

5 Conclusion

Digital media multitasking is increasingly common and can negatively affect user memory and concentration. We consider periodic multitasking as having a particularly strong negative influence. In response to this issue, we created a system that detects multitasking routines and visualizes the results of analysis to users. By seeing the results, we believe that users can become aware of the negative impact on their health and possibly give up their negative routines. Our system is effective in the detection of multitasking activities; however, we feel it can be improved further. In our future work, we will gather feedback from more users and analyze their observations and the data we obtain from them.

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