ROTATION

A Novel Stress and Workload Management System

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Abstract

1 Abstract

A lot of people in nowadays affluent societies suffer under the tedious and in the long-term exhausting consequences of perennial tasks like sitting in front of a computer for several hours. In this work we sketch a system where people or groups of people can break this cycle of monotony and, within a certain time-frame, conduct an activity in rotation with other activities, so called events. The system is designed to motivate the user to deal with a given workload while enabling him to explore new kinds of activities. Over time, by participating in events, the user is gradually being given recommendations for activities he can perform in rotation with his primary task of dealing with a certain workload. The recommendation system is fine-tuned by an optional rating-system for events as well as an optional measurement of the heart rate.

2 Introduction

2.1 Related Information on the Topic Field

As a fact group work and learning cooperatively with others increases the overall individual achievement compared to working alone. For example, in their meta-analysis examining over 168 studies of undergraduate students, Johnson et al. (2014) [1] determined that students learning in a collaborative situation had greater knowledge acquisition, retention of material, and higher-order problem solving as well as reasoning abilities than students working alone. Students’ interactions and discussions with others allow the group to gain new knowledge, bed it in a conceptual framework of existing knowledge and assess what they do know and do not know. This group dialogue helps them make sense of what they are learning and what they still need to understand or learn (Ambrose et al. 2010; Eberlein et al. 2008) [2, 4]. In addition, groups can tackle more complex problems than individuals and thus have the potential to gain more expertise and become more engaged in a certain discipline (Qin et al 1995) [3]. Group work creates more opportunities for critical thinking and can promote students in learning and achieving goals. Furthermore working in groups enhances communication and development skills. For instance creating facilitated opportunities for group work in a class allows students to enhance their skills working efficiently with each other (Bennett & Gadlin 2012) [5]. Group work gives students the opportunity to experience skills critical for processing information, evaluating and solving problems as well as management skills through the use of roles within groups. Assessment skills are involved in evaluating options to make group decisions. All of these skills are critical to successful teamwork both in the classroom and the workplace.

2.2 Purpose of the Human Computation System

This report sketches a human computation system called "ROTATION", a recommendation system to inspire people for group activities while minding a settleable time interval. In the current version activities are recommended in pairs. The major purpose of ROTATION is to intermit tasks for the goal of planned diversion and thus to ease a potential workload. But since there is no restriction in the field of activities the usage of ROTATION allows for a plethora of different use cases and therefore a high variety in possible recommendations for activities. Since most activities are considered as a singular instance and most people don’t even think about the idea of combining one activity with another, the question we basically would like to find answers to is: What activities are people interested in and which activities could turn out to be complementary?

2.3 Human Contribution to the System

ROTATION can be used with just a smartphone or tablet where the application is installed and a working internet connection is provided - but it works best in combination with a heart rate detection device like a fitness bracelet (as commercialized for example by FitBit). By participating in an event, either by creating the event himself or by invitation, his user-id is related to the event and therefore the name of the event, activities, duration, location and other participants. If the user wishes to be part of the scoreboard which is displayed after the event happened or if he wishes to get more accurate recommendations for his activities he can optionally synchronize his heart rate data from systems like FitBit with ROTATION. Furthermore the user has the option to give a detailed star rating on a
scale from 1 to 5 stars for past events’ activities whereby he has the possibility to give some personal feedback that is of little effort since it requires no typing, only tapping on the stars.

3 Functionality of a Novel Human Computation System

3.1 Functionality as Seen by a User

The system provides a time-management functionality designed as an interval timer for any activities preferably conducted in groups. He can create and participate in events created by people he knows, therefore the system supports real life socializing. By participating in events, rating the events afterwards and providing the system with his heart rate data he can gain personalised recommendations for other activities he may like to explore or which may be good for him based on his heart rate and rating data. The recommendation system is envisaged to inspire people to stay active while dealing with a certain workload. A scoreboard after each event shows a summary of the overall performance per user as well as badges for every participant as an incentive of personal motivation as well as for the group spirit. The system can also be considered as a framework to avoid procrastination by explicitly setting time-frames and embracing alternative activities. The system’s benefits for the user are not only avoiding monotony by keeping people in connection while sharing their activities, but also creating a strong group character and making people connect with each other in real life situations. Furthermore, this system may inspire users how to manage their time properly under the circumstances of the dynamics of the group while having fun.

3.2 Functionality as Seen by a Stakeholder

There are two main aspects to be considered as potentially ‘functional’ for a stakeholder. First, the value of the data itself or the insights the stakeholder can gain from it. Second, the immediate benefit by letting people actually use ROTATION. In the prior chapter we already discussed the benefits for the user. Partially the same benefits apply to the stakeholder as well, since some stakeholders are interested in the well-being of the user as well. Among those may be employers who would like to improve their team building effort and use ROTATION as a tool to motivate the employees to work in groups and experience out-of-the-box thinking by including alternative activities in their working space. Another stakeholder of this kind could be the university. Students spend hours sitting in lectures and exercise groups. Oftentimes, as a natural occurrence, the mind starts wandering and one gets carried away by the thoughts due to the undergone monotony. Situations like this could be spiced up with tiny breaks of a couple of air squats or chair yoga exercises which would probably be beneficial for the students focus and concentration level.

The students data can then be used to give an indicator about the quality of the lecture.

By the usage of ROTATION the user provides our system with valuable data. We gain an insight about the preferences of users regarding what, when, where, how often and in which manner they prefer to perform certain activities. In connection with the authorisation of the heart rate measurement software (like Fitbit) we can associate this data with further personal information about for example the user’s height, weight and of course his heart rate data for each event. Bringing his ratings for the events in relation can in addition provide us with his opinion about certain activities, durations and combinations of activities. Considering the substantiality of this connection of data and the users freedom of choice for activities anyone who has interest in the habits of people is a potential stakeholder.

3.3 Incentivization Concept

The group work will encourage a participant to be better and make an effort to reach the same level as the other fit members through looking at the same dashboard, which shows the different heart-beats curve each participant. Furthermore the participants motivate each other through the group spirit by pushing them to achieve goals, learn new things and keep them in touch.
4 System Design and User Interface Elements

4.1 System Architectures (Component Diagram)

As the usage cycle reveals, the system is composed of 4 subsystems that interoperate with each other: the event system, the rating system, the aggregation system and the recommendation system.

- **Event System** Any user can create events. When he creates an event, he can freely choose a name for the event, two activities, the duration of the intervals for each activity as well as time, date and place. Furthermore he can invite friends to participate in the event. The invitation can be send to users in his friend list. Only users who have an account associated with ROTATION can be invited. An invited user can either accept or decline the invitation. If he accepts, he can participate in the event. After the event happened, the user has to confirm his participation in order to see the event results. The creator/administrator of the event also confirms the participation of the invited users.
4.2 Algorithm for Data Aggregation

- **Rating System**
  Rating an event is optional for the user and can be done at any time opening the history of past events. With the rating system the user can give a detailed star rating on a scale from 1 to 5 stars for the activities of the event to give some personal effortless feedback which requires him only tapping on the stars. For example he can give 4 stars for a physical activity that he liked and to give 1 star for the location if he thought the activity was great but the location was not right.

- **Aggregation System**
  After collecting the data from different users by different events we aggregate it by calculating the overage of stress level by each user and the overage of the feedback value.

- **Recommendation System**
  Based on the rating system and the average of stress level by an event the application yield a list of recommended events, they sorted through the calculated score function. When an event has a high feedback value and in which the average of stress level is low, its ranking will be increased and the event will be appeared on the top of the recommendation list.

4.2 Algorithm for Data Aggregation

Because the events are created deliberately by the user’s liking, the type of the activity, if it can be categorized as a mental or physical activity, is unknown. Furthermore some events can be similar or identical. Therefore we decided to use the decision-tree algorithm to classify the events looking for the location, HRR, duration, stress level (pRR20) and label. After the classification we obtain more opportunities to make our application suitable for different stakeholders. For example, a university could be interested in the mental activities in order to improve method for teaching. When students attend a lesson wearing the HR-watch and using ROTATION, the university could access the tracked stress level data and analyze if the lesson is tiring or invigorating.

In order to optimize the recommendation system we calculate the diversity of events by utilizing the formula for the cosine-similarity.

\[
similarity(A, B) = \frac{1}{8} \sum_{i=1}^{K} w_i \times \text{sim}(X_{Ai}, X_{Bi})
\]  
\[
\text{sim}(X_{Ai}, X_{Bi}) = \cos(X_{Ai}, X_{Bi}) = \frac{X_{Ai} \cdot X_{Bi}}{|X_{Ai}| \times |X_{Bi}|}
\]

where:
- **K**: number of set’s elements
- **A** und **B** : ordered set \( \{ \tilde{Na}, \tilde{Lo}, \tilde{D}, L\tilde{A}_1, L\tilde{A}_2 \} \)
  - \( \tilde{Na} \) : vector of count(label’s words)
  - \( \tilde{Lo} \) : vector of count(location’s words)
  - \( \tilde{D} \) : vector of activities’ durations
  - \( L\tilde{A}_1 \) : vector of count(words of first activity’s label)
  - \( L\tilde{A}_2 \) : vector of count(words of second activity’s label)
- \( w = [2, 1, 1, 2, 2] \)

For future adjustments the formula is open for introducing weights to each elements in the sets of A and B. The weight vector can be used to optimize the similarity function after evaluating the quality of the recommendations by cross-checking the recommendations vs. the actual choices of the users. In addition the algorithmic validation can be supported by user studies to get even more insights about the quality of the recommendation.
### 4.2 Algorithm for Data Aggregation

#### Example:

<table>
<thead>
<tr>
<th>Event</th>
<th>Name</th>
<th>Location</th>
<th>Duration $act_1$</th>
<th>Duration $act_2$</th>
<th>Label $act_1$</th>
<th>Label $act_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>&quot;Learn and Squats&quot;</td>
<td>&quot;Home&quot;</td>
<td>60 min</td>
<td>5 min</td>
<td>&quot;Learn&quot;</td>
<td>&quot;Squats&quot;</td>
</tr>
<tr>
<td>B</td>
<td>&quot;Learn&quot;</td>
<td>&quot;Home&quot;</td>
<td>60 min</td>
<td>0 min</td>
<td>&quot;Learn&quot;</td>
<td>-</td>
</tr>
</tbody>
</table>

*act : activity

\[
\begin{align*}
\vec{Na}_A &= \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}, \quad \vec{Na}_B &= \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}
\end{align*}
\]

\[
sim(\vec{Na}_A, \vec{Na}_B) = \frac{\vec{Na}_A \cdot \vec{Na}_B}{|\vec{Na}_A| \cdot |\vec{Na}_B|} = \frac{1 \cdot 1 + 1 \cdot 0 + 1 \cdot 0}{\sqrt{3}} = \frac{1}{\sqrt{3}} = 0.577
\]

\[
sim(\vec{Lo}_A, \vec{Lo}_B) = 1
\]

\[
sim(\vec{D}_A, \vec{D}_B) = \frac{\vec{D}_A \cdot \vec{D}_B}{|\vec{D}_A| \cdot |\vec{D}_B|} = \frac{60 \cdot 60 + 5 \cdot 0}{\sqrt{60^2 + 5^2} \cdot \sqrt{60^2}} = \frac{3600}{60.207 \cdot 60} = 0.996
\]

\[
sim(\vec{LA}_1A, \vec{LA}_1B) = \frac{\vec{LA}_1A \cdot \vec{LA}_1B}{|\vec{LA}_1A| \cdot |\vec{LA}_1B|} = 1
\]

\[
sim(\vec{LA}_2A, \vec{LA}_2B) = \frac{\vec{LA}_2A \cdot \vec{LA}_2B}{|\vec{LA}_2A| \cdot |\vec{LA}_2B|} = 0.5
\]

\[
\Rightarrow similarity(A, B) = \frac{1}{8} \left( 2 \cdot 0.577 + 1 \cdot 1 + 1 \cdot 0.996 + 2 \cdot 1 + 2 \cdot 0.5 \right) = 0.768
\]

#### Recommendation:

To offer good recommendations we give each event a score on a scale from 0 to 1 and sort the events by their score. The score indicates the popularity of an event and depends on the overall user’s stress level, rating, number of participants as well as the number of times the event happened in this configuration.

#### Recommendation for physical activities:

We recommend events that let participants keeping the target zone 'Healthy Heart' (50 to 60% of Max HR) during an intensive exercise and that have a good feedback.

\[
score(E) = \frac{1}{2NM} \sum_i^N \sum_j^M (HZ(j) + \frac{\text{Rating}_{ij}}{5}) \quad (4.2.2)
\]

where:

- $0 \leq score(E) \leq 1$ : score of event E
- $N$ the number of iteration of an Event
- $M$ the number of the event’s participants
- $\text{Rating}_{ij}$ is the averaged rating for each attribute on the event i by the user j
- 
  \[
  HZ(i) = \begin{cases} 
  1 & \text{if } 50\% \text{ of Max HR} < HR_j < 60\% \text{ of Max HR} \\
  1 - |HR_j - 50\% \text{ of Max HR}| & \text{otherwise}
  \end{cases}
  \]
where:

- \( HZ(j) \) is the Healthy heart Zone for the user j.
- \( HR_j \) is the Heart Rate for the user j.
- \( Max_{HR} \) is the max heart rate for the target user.

**Recommendation for Mental Activities:**

\[
\text{score}(E) = \frac{1}{2NM} \sum_{i}^{N} \sum_{j}^{M} \left( pRR20_{ij} + \frac{\text{Rating}_{ij}}{5} \right)
\]

(4.2.3)

where:

- \( 0 \leq \text{score}(E) \leq 1 \) : score of event E
- \( N \) the number of iteration of an Event
- \( M \) the number of the event’s participants
- \( pRR20_{ij} \) : The number of pairs of adjacent RR-intervals differing by more than 50 ms to all RR-intervals. Stress level for the participant i on the event’s iteration j
- \( \text{Rating}_{ij} \) : feedback from the participant i on the event’s iteration j

The rating function is the average of the evaluated criteria divided by 5. For example a user has evaluate an event as follow:

- **Squats**:
  - I like it = 4
  - duration = 3
  - intensity = 4

- **Study**:
  - I like it = 3
  - duration = 4
  - intensity = 5

- **Overall**:
  - actives fit = 4
  - location = 4

\[ \Rightarrow \text{Rating}_{ij} = \frac{4 + 3 + 4 + 3 + 4 + 5 + 4 + 4}{8} = 3.87 \]

A high \( pRR20 \) indicate low stress level and a high feedback indicate a good participant’s satisfaction.

The score of events can be used for example for education to calculate the score of a lecture. When a lot of students attend the same lecture and they give a high rating and the measured average of stress level is low it could mean that the students are satisfied with the lecture. An otherwise low rating value and a high average stress level could mean that the lecture is tedious and the teaching methods or contents can be reconsidered.

**Recommendation for combined activities:**

If a user is too stressed on a regular basis during certain activities he can get recommendations for cool down activities like meditating or yoga.
4.3 Technologies Used for the Implementation

Using a heart rate measuring bracelet different data like "pulsation" and "heart-rate-beats" can be measured and collected. To get the collected data a smartphone or a similar device is required to synchronize the data from the bracelet with the server.

We propose to create a mobile application that requires the Android or IOS system. To analyze the collected data and aggregate it we propose to use Python on the backend looking to its efficiency by data analysis.

4.4 Mockup Examples

Create an event:

- Give a label as event name through an input field
- Localise the area where the event will be happened
- Schedule the event by selecting a preferred date from a calendar input
- Set the period of an activity
- Invite friends to participate the event and enjoy it together
All group participants see the same dashboard which display a live tracking of a heart-rate-beats for each participant.

At any time can the user evaluate a passed event by selecting a number stars, for example how much did he like the Squats activity or how did he find the duration and the location.
The user get a list of recommended events, which is done by other users and had a good rating and a lower stress level.

5 System Evaluation and Success Criteria

5.1 Limitation of the System

Since the user rating and the heart rate measurement are optional, the granularity of the data associated with each event depends on the user’s willingness and equipment. In the worst case, the user only has a smartphone at hand and no heart rate detection device. Therefore solely his participation can be associated with a certain event. In the best case, he participates in a group with a multitude of other participants, all delivering heart rate data which allows our recommendation system to offer fine-granular recommendations for activities. In the present version of ROTATION users can only participate in events if they are invited. The reason is that we think that for every new system there is a barrier of trust - users have to build trust in the system. In an invitation-based network people are invited by other people they already know and trust - the trust in the people rubs off on the system. The drawback is that people in the long run are hardly able to break out of their known social circles to explore and participate in events from very different circles - therefore the recommendations we generate can be limited too. To avoid this limitation we propose to optionally create open events, which are users can search and register for instead of having to rely on an invitation. Another limitation could be that in the proposed version of ROTATION users are limited to two activities when creating an event. This is done to simplify the creation of events and not overwhelm the users. In 5.1 we discuss the possibility of an extension to allow a variety of events. Furthermore the number of activities when creating an event is limited to two activities. This is done to simplify the creation of events as well as the recommendations. In 5.1 we discuss the implementation of a variety of activities per event.
5.2 Evaluation and Success Criteria

To evaluate the success of our system we established a cascade of questions we can use to analyse if and where the system fails. If one of the questions can be denied, a further problem analysis is indicated.

1. Do people actually use the application?
   - Does the community grow or shrink?
   - How does the proportion of regular vs. casual users evolve?

2. Does the user actually use the recommendation system to create new events and does he use the system on a regular basis or just casual?
   - E.g. by measuring the overall ratio between events created using recommendations and events created not using recommendations (per user).

3. Does the recommendation system actually convince people of trying out new activities?
   - E.g. by measuring the overall ratio between different and equal activities for all events a user has attended.

All these questions result in the ultimate question to determine whether the recommendation system is used or not and if so, in which way. The way of usage is of interest for the further development of the recommendation system.

6 Future Works

The generic nature of the human computation system introduced in this work allows a variety of possibilities for extensions and interactions with other human computation systems.

6.1 Possible Extensions of the Human Computation System

The presented version of ROTATION comprises an invitation-based social network. A possible extension would be to make the creator of events choose, if he wishes the event to be open and or closed. A closed event would allow invited participants only. An open event would allow for events to be searched for and aim for a much larger target group, which could be interesting especially for public events of any kind that want to attract large groups of people. For example: Imagine a public sports event like a half marathon where people don’t get invited but register for. One could easily transform it to a new experience by not just running 21,1km, but spice the run up with a set of squats every 20 minutes for 1 minute. Another opportunity would be to leave the number of activities that are used in rotation to the user and not restrict it to the scheme of two activities. In terms of the public sports event a rotation cycle for a half marathon could be configured as follows: 10 minutes of running, 1 minute of squats, 10 minutes of running, 1 minute of push ups. With the advantage of not only offering recommendations of pairs of activities but offering sets containing an arbitrary amount activities the network for recommendable activities gets even more dense.

Furthermore it is possible to fine tune events. For example if someone created an event containing "studying" and "push ups" as the activities of choice, he then would be able to implement activities in more detail. He could create instead an event that rotates between activities like this: 25 minutes "study algebra", 2 minutes "regular push ups", 25 minutes "study spanish", 5 minutes "clapping push ups". As the example demonstrates this extension would offer the flexibility of a plethora of further use cases and would allow for even more fine-grained data which could also result in more accurate recommendations.
6.2 Thoughts on Interaction with other Human Computation System

The data gained from every event extended by the user’s ratings and heart rate data is ample and facilitates a plethora of possible interactions with other human computation system.

In interaction with Google maps pairs of activities can be recommended based on the user’s preferred locations for certain activities. If the extension for creating optional open events is implemented (as mentioned in 5.1), one could also get recommendations for events happening nearby that match the user’s profile of interests. In interaction with online shopping sites like amazon the user could get recommendations for equipment he could need for activities he participated or, on step further, the user could get recommendations for activities he may like based on his prior activity profile in combination with the right set of gear.

Instrumentalizing the heart rate data, if a user is too stressed on a regular basis during certain activities, he can get recommendations to buy equipment to get less stressed - for example a fascia roll if he is usually stressed after doing squats so he can mobilise the fasciae of his glutes.
References


