reBalance: A Customizable Data Visualization Approach to Keeping a Balanced Health

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Abstract

Maintaining a good, balanced health is important but difficult. People often do not have a clear sense of what is healthy, and where to improve from. In order to help people who are failing to maintain a balanced life, we present **reBalance**, a health data visualization system that allows exploration of one's own data with multiple visualization. In addition, the edit mode in reBalance assists users in defining their own definition of being healthy through choosing one's own metrics.

Keyword

Data Visualization, Health, Customized Support

1. Introduction

The World Health Organization (WHO) defined health as the balance between mental, physical and social health, also known as the health triangle [1]. While most health tracking apps focus on maintaining a good physical health, a good balance in all three areas is essential to living a healthy lifestyle. Current approaches to tracking and evaluating one's health mainly attribute to their physical health [7]. In order to maintain health in all three aspects, users should be provided more data on social and mental health. To show data in a more effective way and not overwhelm users, we should let users choose which metric they want to focus on for each aspect and track them accordingly. To help users personalize what metric constitutes each aspect and get closer to their definition of health, we introduce our system reBalance. reBalance supports three main functions with multiple visualizations - choose which metric defines each aspect of their health, keep track of their weekly trends, and identify which metrics they should improve on - and a customizable set of metrics for the user.

2. Related Work

Our work is in the domain of personal healthcare, tracking based on collected data and generally visualizing personal health data.

There are two influential healthcare apps, Samsung health and Apple health [2, 3]. Both apps provide trend analysis for each metric and allow the users to set goals. In Samsung health app, it provides friendly competition that shows comparison with friends or family to help users be motivated [3]. In the Apple health app, it highlights the most important metric at the main page using machine learning to display what matters most to individuals [2]. Healthcare apps provide various ways to give motivation and customization for users. However it lacks to provide the overall health in three aspects and the specific metrics they should focus on most to keep their health.

In addition to applications that support personal healthcare, the use of one's own data and quantifying them to support understanding oneself has been gaining attention. Choe et al. mentioned that effective data visualization helps non-experts extract insights through exploration [4]. Other work have emphasized the need for customization in the data provided, as users have varying form of queries to the visualizations generated [5], and unhandled cases regarding the data collected may exist, which requires human intervention [6]. The work overall emphasizes the need for insightful, customizable data visualizations for quantified self.

3. Formative Study and Design Goal

To understand the needs in maintaining a good, balanced health, we conducted needfinding interviews with those who aim to live a more balanced, healthy life but are perceiving themselves as failing at the moment. The interviews were carried out through online video platforms due to COVID-19, and lasted about 20~30 minutes. During the interview, we asked the interviewees their definition of being healthy and asked them to draw a health triangle by reflecting on their lives. We also asked questions related to their current efforts in maintaining or becoming healthier, and the information they would prefer to receive to become healthier.

From the interviews, three common needs were identified - (1) *Objectively understand their health status*, (2) *Come up with their own definition or metric of a healthy life*, and (3) *Live a more healthy life by identifying directions to improve their lifestyle*. The interviewees mentioned that although data collected from their lives are everywhere, looking at the raw values does not give them good enough insights on their current health status and where to improve.

Based on the observations, we came up with two design goals to support key features of our system.

G1: Explore one's own definition of health The main function of our system is to help users keep track of their balance in health. However, since the definition of each aspect of health differ from person to person, users should be able to make their own definition.

G2: Give users starting points for improvement Users have difficulty in choosing the metric to improve among plenty of metrics. Users should be provided the visualization of metrics with the amount they are far from the average.

4. Data Processing

We used the KAIST K-Emophone dataset [8] which was collected for one week - 2019/04/30-2019/05/06 - from 79 users with a phone tracking app, Microsoft Band 2 and Polar H10 sensors. It also consists of self-tracking data via experience sampling which records emotion and stress at most ten times a day during the collection period.

Among these data, we selected elements as the metrics for representing health. The following are the descriptions for each metric. The metrics were chosen after careful consideration between authors and the availability of data points.

Physical
- Calories: Total calories spent per day
- Pedometer: Total steps per day

Mental
- Valence: Average of valence (positive and negative feeling states) score per day
- Arousal: Average of arousal level score per day
- Attention level: Average of attention level (how much they focused on the activity they were doing) score per day
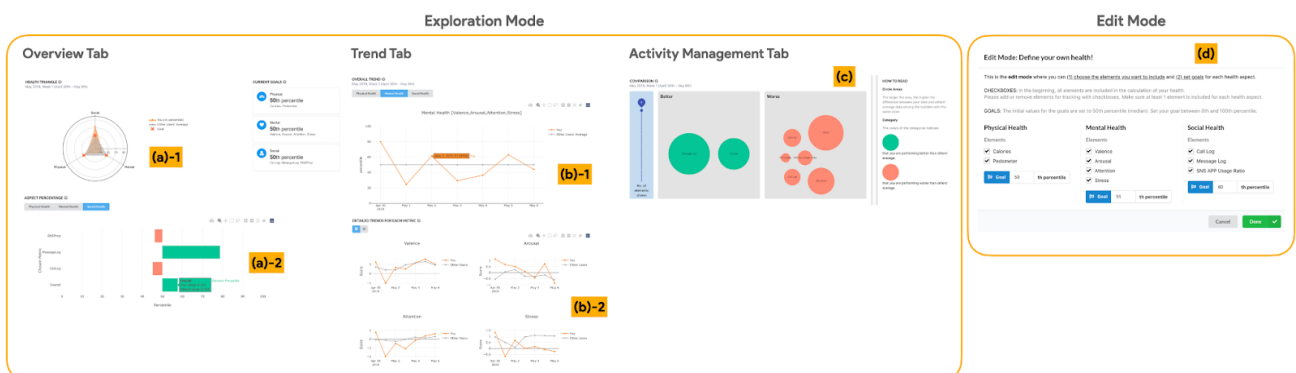

Figure 1 Exploration Mode and Edit Mode (d) of reBalance. In Exploration Mode, there are three tabs — Overview Tab (a) with Radar Chart (a-1) and Aspect Bar Chart (a-2), Trend Tab (b) with Main Trend Chart (b-1) and Individual Metric Trend Chart (b-2), and Activity Management Tab (c).

- Stress level: Average of reverse stress level (how stressed they were within the activity) score per day

Social
- Call Log: Time spent on phone call per day
- Message Log: Number of messages sent and received per day
- SNS App Usage percentage: Percentage of using SNS apps over all other apps as foreground state

4.1 Preprocessing

The high-level data preprocessing idea was to calculate z-score for each metric. Since all the metrics have different ranges and units, we quantified the overall score by calculating the mean value for each z-scores. To make it more intuitive for the users, we chose to use percentiles in the interface for the calculated z-scores.

Due to participants in the datasets being tracked in different periods and the absence of data points, we were able to filter the dataset to five people in the same time frame. We took the mean of those five people's data to calculate values for other's average.

5. reBalance Design

reBalance consists of two modes, *exploration mode* for exploring the data with multiple visualizations and *edit mode* for setting individual metrics and goals.

The exploration mode, which is the default, allows users to read and interact with the graphs to extract insights. The edit mode allows the users to set their own metric and goals. The prototype for reBalance is shown in Figure 1. All the graphs in reBalance support tooltip and zoom in/out which are provided by the Plotly library.

5.1 Exploration Mode

In exploration mode, there are three different tabs, namely the Overview Tab, the Trend Tab, and the Activity Management Tab.

Overview Tab

The Overview Tab provides a compact overview of the user's weekly health status in three different aspects (physical/mental/social) and compares it to other users' average values. The user's selected metrics for each aspect and weekly goals are shown through goal cards. All data values are in percentiles, with the other users' average being in the 50th percentile.

Radar Chart As figure 1 illustrates, there are 3 aspects in the health triangle chart. The orange triangle represents the user's data, the gray triangle represents the other users' average and the x mark represents the goals set by the user.

Aspect Bar Chart The aspect bar chart provides the progress for the metrics of each aspect and how it is compared with average. The red and green bar graphs indicate values that are below and above the 50th percentile respectively. Hovering over the bars will reveal a tooltip with their real data value.

Trend Tab

The trend tab, which aims to visualize the health trend over the week, provides weekly progress for each aspect and metric. Users are able to switch aspects through the buttons above the main trend chart.

Main Trend Chart The x-axis represents the date and y-axis represents the percentile for each aspect. The orange line indicates the user's percentile trend over the week while the grey one is the other user's. Putting both trends in one graph provides an easy way for users to compare themselves with the others'.

Individual Metric Trend Chart Small multiples for each metric are located below the main trend chart. The y-axis consists of values in the unit of the metric so users can see its objective value.

There are two views available: at-a-glance view, where two trend graphs are displayed side-by-side, and detailed view, where one trend graph occupies the whole line.

Activity Management Tab

While the overview tab and trend tab contribute to provide insights in the perspective of health aspects, the activity management tab aims to give

a better insight on figuring out possible improvements.

This tab is composed of green and red areas containing 'Better' and 'Worse' bubble charts respectively. Each bubble represents a single metric, indicating how above or lower compared to average the users are, with the size showing the difference from the average. When hovered, a customized tooltip displays the difference in percentile along with the actual values.

The slider positioned on the left allows users to filter the amount of bubbles present on the chart, based on the size of the bubbles.

With the bubble charts, users are able to figure out which part and how much they should improve to achieve a balanced life at a glance.

5.2 Edit Mode

Edit mode allows users to select metrics for each aspect and set goals. The goals are initialized at the 50th percentile. When new goals are set, the graphs on reBalance updates with the new metrics.

By providing edit mode, users can customize the metrics and define their definition of health.

6. Limitation and Future Work

Our current prototype provides only ten metrics and five people's data as average due to limited dataset. Also, the percentile score for each aspect is calculated with the same weights from the metrics. To provide rich customization, a possible future work would be providing various metrics selectable in each aspect and allow users to choose weights in calculating the percentile score for defining their own health.

7. Acknowledgements

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