Supporting Varying Attentional Demand in Personal Visualization and Personal Visual Analytics

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Abstract

Designing visualizations for personal use has been catching increasing research interest. While visualization and visual analytics have primarily focused on a professional context, it remains unclear whether we can directly apply lessons we have learned from traditional visualization research and practice within a personal context without any modification. What different requirements do we need to consider when applying visualization in our personal lives? One of those could be that visualization designs need to support varying attentional demand; that is, low attentional demand to facilitate on-going passive awareness, high attentional demand to enable focused deep analytics, and the transition in between. Passive awareness likely plays a more prominent role in a personal context than in professional situations, because visualization tools need to fit in our surroundings and life routines. We proposed a design approach that integrates visualizations of personal data into an existing personal information ecosystem. With longitudinal field studies, we aim to understand how people use visualization in their everyday lives and explore if our approach could enhance on-going passive awareness and deep analytical reflections.

Author Keywords

Personal visualization; user interface design; attentional demand; personal context.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous; H.1.2; H.5.2.

Introduction

Due to open data policies and availability of sensing technology, we can access and collect substantially more data than any time before in history, not only in work life but also in our everyday lives. We are surrounded by data in our everyday lives (e.g., household utility bills, personal finance, health monitoring, social network feeds, etc.). People are intrigued to collect, explore and make sense of these data, many times beyond their occupational needs, for understanding themselves better or making better decisions. Accordingly, researchers and practitioners have been designing tools to facilitate these needs and interests, e.g., making data collection easier with wearable sensors and making data well organized and reachable through an online API. However, making data accessible does not necessarily lead to insights, because data must be understandable and comprehensible while people are interacting with them. We believe that visualization, as a powerful data exploration and reasoning approach, can fit in this gap and empower every one of us to understand and act upon data in our daily lives.

Actually, research of this field has started, and many design approaches have been explored, e.g., applying an ambient display at home to enhance awareness of domestic energy consumption [3], visualizing music listening history for reflections [2], etc. Attention in this field is steadily increasing, but before we move forward it is time to step back and reflect on previous lessons. Personal visualization and personal visual analytics are applied in a quite different context (i.e., personal context) compared to a professional context where traditional visualization tools are usually used. How are the design requirements different compared with traditional visualization and visual analytics tools? What design concepts should we consider to advance this field?

In a personal context, people have a different role expectation, e.g., switching from project managers or data analysts at work to caregivers or finance managers of the family. In this case, they probably have different priorities, and limited budget in terms of time and resources. Their situations may dynamically change with respect to life routines (e.g., at work, at home, commuting, shopping, socializing, etc.). That is, people may not able to commit long periods of time to do deep analysis of the data, using workstations with substantial computing power, which is typical for most traditional visualization applications. Thus, visualizations designed for a personal context need to fit into people's life routines. With respect to that, designs need to support varying attentional demand, suitable for the variety of situations that people may find themselves in. Other than active, in-depth analysis that requires high attentional demand, passive attention [4] with low attentional demand are also involved (e.g., ongoing monitoring, entertainment, or ambient awareness), for example, facilitated by mobile devices and ambient displays. These passive attention activities need to fit seamlessly into other aspects of people's lives. Passive attention plays a role in traditional visualization applications too (e.g., monitoring tasks for situational awareness), but it may play a more prominent role in personal visualization and personal visual analytics.

Designing visualization for personal context may share a lot in common with traditional visualization designs; however, personal context may have unique

characteristics, which may require us to rethink our design requirements. In this paper, we propose that designs need to consider supporting varying attentional demands for use in a personal context. Although this may not be the only difference from traditional visualization tools, we hope it could be a start to engage researchers and designers to reflect on design approaches to advance this field.

Varying Attentional Demand

In everyday lives people interact with visualization tools with varying attentional demand with respect to their situations. Particularly, they use passive attention (low attentional demand) more often than in an occupational situation. Passive attention usually facilitates in-the-moment or on-going awareness with respect to one's behaviors in their current condition (e.g., avoiding activities that would harm one's sleep patter, tracking blood sugar, or inducing green transportation habits). For this reason, visualizations designed for passive attention tend to be ambient to provide continuous awareness, and enable high-level information to be perceived with a quick glance; that is, these tools need to fit harmoniously into one's life and physical environments without interrupting life routines. In many cases, designers use mobile phones to support passive attention due to their accessibility and flexibility. For example, ShutEye was implemented as a cell phone wallpaper that provided sleep-related activity reminders [1].

Passive attention is not the only mode of interaction, however. When an unusual pattern (e.g., huge spikes of energy use at home) is perceived, this could motivate people to do more in-depth analysis. They may wish to gain more information about the abnormal

behavior because it is inconsistent with their previous knowledge and expectations. In this case, the best tools may more closely resemble traditional visualization tools; these facilitate data exploration and reasoning, e.g., gathering evidence, generating and evaluating hypotheses, and elaborating models. Different from traditional visualization though, people's interpretation of data would heavily rely on personal context with a self-centric perspective. People need to relate their personal data to personal events and activities (e.g., "place I have been to", "people I have talked to", "what I was doing at that moment", "documents or computer programs I have used", etc.). Passive awareness and deep analytics may not happen in a particular order, and the two modes may build upon each other iteratively, helping people develop insights and elaborate knowledge.

Most importantly, passive attention plays a more prominent role in personal context compared with professional context, because tools designed for passive attention can flexibly fit into people's environment and life routines. This uniqueness may require designers to particularly consider providing support for the varying attentional demands and also the transition between passive awareness and active deep analytics.

Case Studies: On-Calendar Visualization

We propose a design approach that involves integrating visualizations of personal data into an existing personal information ecosystem, i.e., a routinely used information tool in everyday life. Specifically, in our case, we integrate personal data into a digital calendar. We hypothesize that adding a data stream into a digital calendar will support passive attention and ongoing awareness, because people use their digital calendars
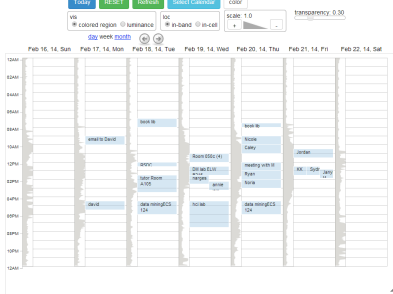
Figure 1. On-calendar visualization with data stream displayed in juxtaposition.
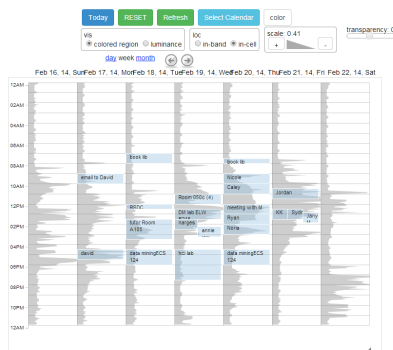

Figure 2. On-calendar visualization with data stream displayed in overlay.

on a regular basis and therefore will encounter the data visualization frequently. Meanwhile, the calendar also provides contextual information (i.e. event entries on the calendar) to help people reflect on their historical data and understand the causes of data fluctuations.

We developed our working prototype (see Figure 1&2) by integrating personal data (specifically, household smart-meter data and physical-activity data) with people's existing Google or Exchange calendars. The application basically works as a digital calendar tool with a calendar look and functions, with the addition of an extra data layer. The salience of the visualization layer can be adjusted to be attentionally appropriate; that is, continuous awareness could be maintained without interrupting the primary tasks (i.e., routinely calendar tasks). The visual encodings were selected based on the findings of a preliminary study. The data stream can be synchronized with household smart meters, fitbit API server or smartphone sensors.

Acknowledgements

References

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We are deploying our visualization tool in longitudinal field studies to investigate how people use visualization tools in real life scenarios and if the mash-up approach can facilitate varying attentional demand.

Conclusion

Personal visualization research and design have been growing in the recent decade, but to date there has been little consideration of the different design requirements needed for visualization use in a personal context. The uniqueness of personal context requires designs to better support varying attentional demand, enabling them to adapt to the dynamic situations in one's everyday life; that is, visualization designs for everyday use need to facilitate low attentional demand to facilitate on-going passive awareness, high attentional demand to enable focused deep analytics, and the transition in between. Particularly, future designs should better support on-going passive awareness, making it easily fit into people's life environment and routine

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