Enabling Foresight and Reflection: Interactive Simulations to Support Behaviour Change

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Abstract
The domains of personal informatics and persuasive technology have largely focused on supporting self-reflection using previously collected data. In contrast, we argue for a different novel approach: projecting forwards by enabling foresight. By developing interactive simulations that can provide people with predictions on how their current or theoretical behaviour will impact their goals, we hope to encourage them to connect to the future. To study the usefulness of such foresight, we will develop and evaluate a multi-faceted system aimed at supporting sustainable lifestyles for urban inhabitants.

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Behaviour change, personal informatics, foresight, interactive data visualisation, sustainability

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous.

Introduction
The use of technology to help people reflect on their behaviour is a growing domain within Human-Computer Interaction (HCI). Those who are self-motivated to track their behaviour develop and use 'personal informatics', tools that allow the collection of and reflection on

personal information. Similarly, 'persuasive technology' tries to motivate behaviour change, though often by nudging or persuading those who are not self-motivated to adjust their actions. Various attempts have been made to encourage behaviours that benefit individuals, the environment, or both, including energy conservation and physical activity.

There is a large overlap between the kind of issues the personal informatics and the persuasive technology domains address, as well as the way in which they support collection and reflection. Studies have shown that reflection — a practice of trying to extract meaning from past events and experiences [2] — can lead to behaviour change. In addition, there are a number of other popular motivation techniques used in behavioural psychology, as summarised by Froehlich et al [3]. These include: providing *information*, *setting goals*, giving people an idea of how they *compare* against others, letting people make explicit commitments, providing *incentives* and *disincentives* beforehand, or *rewards* and *penalties* afterwards, and finally: providing *feedback* (the more frequently, the better, as found by Abrahamse et al.'s review of intervention studies [1]).

We argue that an important area is left unexplored: the facilitation of foresight. 'Foresight' consists of gaining insight into the consequences behaviour changes will have in the future, either on the individual or on the world. Though the acts of reflecting, goal-setting and processing feedback all — directly or indirectly — stimulate people to project into the future, they require time and significant cognitive effort. Furthermore, people have limited and inaccurate memory and are poor at linking their own behaviours to proven effects, because of a number of biases, including confirmation bias [5]. These human characteristics complicate our ability to accurately analyse the implications of our behaviour. Especially when faced with complex goals, consisting of multiple factors, this can make it difficult to form strategies for behaviour change. Assistance in the shape of interactive simulations could offer support. By explicitly simulating predictions, based on captured data, people can discover how they are performing with respect to their goal, when they are expected to reach it and what they could do to reach it (sooner). In addition, interactive simulations could help people in answering 'what if?' questions. This way, the results of theoretical changes, like 'what if I take the bus from now on', could be investigated. The exploration of theoretical simulations could also motivate more realistic goal setting. Both the simulations based on captured data, as well as the theoretical simulations are meant to connect people more directly with goals that lie further in the future. By developing a system which gives information on behaviour change consequences, we hope to encourage enduring change.

Interactive simulation

Existing tools for personal informatics often use visualisations to enable people to view the data they have collected so far, generally for the purpose of reflection. Additional options, like sharing the data with others, setting goals and receiving feedback on the progress relative to the goal can support people to become and stay motivated to change their behaviour. We argue that one area is left unaddressed in the field of using technology for behaviour change: enabling foresight. By providing people with simulations, made using the already available visualisations techniques and computational power, their insight into the effects of changes in their behaviour in the long run can be enhanced.

Informing people on their progress relative to their goal has already been studied extensively via the provision of feedback, however, explicitly simulating the effects through visualisations has not yet been explored. Especially when working with a multi-faceted system, i.e. a comprehensive system that collects data about a number of facets of a person's life [4] (for example food intake, physical activity, energy usage and number of cigarettes per day), interactive predictions could help defining and reaching goals. To date, the vast majority of the personal informatics and persuasive technology tools have looked into addressing singular issues, like improving sleeping habits. A multi-faceted approach results in a more holistic view of people's lifestyles, aimed at addressing issues that are interwoven in many aspects of a person's life, like an individual's well-being or CO2 emission. Focussing on only a single aspect when tackling such issues simplifies the bigger picture significantly, resulting in an approach that does not cope well with either the complexity of the real issue or the lifestyle of the person using the technology. A multi-faceted approach does take all important facets into account, enabling people to reach their goal in a way that suits their lifestyle, as they are able to understand the role all facets play. However, a multi-faceted approach complicates the ease of interpretation: people will need to understand how the different facets affect their goal. We argue that an interactive simulation showing predictions of these effects could support this process.

Design challenges

There are a number of issues to be tackled when developing interactive simulations for exploration of the effect of behaviour changes. We aim to design such a simulation for a multi-faceted system, which makes calculation, visualisation and interaction challenging.

Calculation

Accurately predicting the outcome of behaviour changes is incredibly difficult: what is the effect of commuting by car 4, instead of 5 days week, on my total CO2 emissions? What is the effect of running 5 minutes longer every day on my resting heart rate? What happens to my carbon footprint when I go by cruise ship instead of by plane? In order to answer these questions accurately, a lot of very specific information is required — and even then modelling the impact of behaviour on, for example, the environment is incredibly complex. Therefore, we aim to provide a simulation that offers sufficient reliability, without aspiring complete accuracy. By using metaphors instead of precise numbers this dilemma could be explicitly assessed, for example by awarding 'transport points' when dealing with the emissions caused by the various means of transport and 'meat points' when describing the amount of consumed meat. Metaphors can also provide more insight in otherwise, for untrained users, meaningless units, like KwH, calories and CO2.

Visualisation

The interactive simulation will be developed with the aim to provide insight about the consequences of behaviour changes. Therefore, users of the simulation should be able to try out theoretical changes, as well as view the effect their actual behaviour is having on their performance. Clear distinctions should be made between the visualisation of captured data, predictions based on the captured data and predictions based on theoretical data. The holistic multi-faceted approach consequently means many sets of data need to be visualised. Appropriate visualisation techniques should be examined, that will prevent the visualisation from becoming cluttered.

Figure 1: Initial menu sketch: an overview of core behaviours

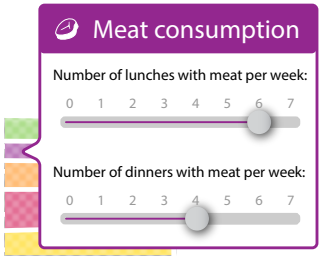

Figure 2: Sketch showing how to simulate scenarios

Interaction

The primary challenge of designing the interaction of the simulation will be establishing clear navigation through the system, without users becoming overwhelmed by the options and the large amount of data shown. Additionally, a prominent phenomenon of personal informatics and persuasive technology challenges the design: how do we ensure people keep interacting with the system over time? How do we support *enduring change* when *enduring usage* is problematic?

Future work

To evaluate the usefulness of foresight, we are developing a multi-faceted system to support sustainable lifestyles for urban inhabitants. By enabling people to explore the long term consequences of their theoretical and actual behaviour change, we hope to connect people to the future, thereby hopefully encouraging enduring change. Initial sketches of the proposed interactive simulation tool can be found in Figure 1, 2 and 3.

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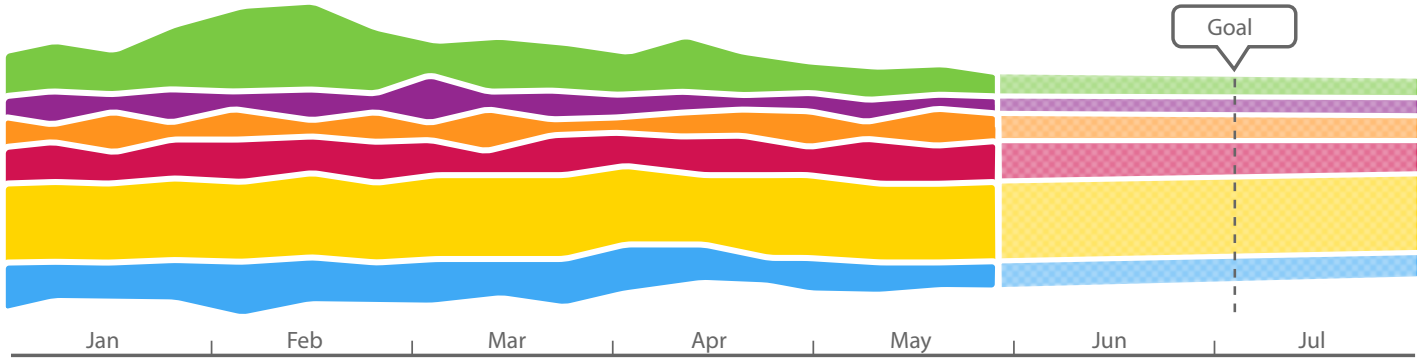

Figure 3: ThemeRiver visualisation as interactive simulation sketch. Predicted future consequences are shown in lower opacity, with an estimate of when the goal will be reached. All facets are normalised to a uniform scale of 'emission points'.