# Workshop on Algorithmic Behavior Change Support

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**Abstract**

To increase the effectiveness of behavior change applications, a large variety of algorithms has been developed to adapt *what* the applications offer, *when*, *how*, and *with whom*. Given the multitude of challenges related to the concept of algorithmic behavior change support, its development, evaluation, and impact on behavior change, this workshop aims to strengthen the community of people with diverse backgrounds (e.g., computer science, psychology, human-computer interaction) and roles in behavior change support (e.g., researcher, designer, practitioner). Combining keynotes of leading researchers with sessions in which individual workshop participants present their work and discuss problems with the audience, the workshop encouraged a lively exchange of ideas that benefits current and future research on algorithmic behavior change support.

**Keywords**

Behavior change support systems, Persuasion, Persuasive technology, Algorithmic acceptance

## 1. Introduction

Health, sustainability, education - being potentially easy to use, available at all times, scalable, and cost-effective, behavior change applications have a large potential and have thus been developed for diverse domains (e.g., [1, 2, 3]). However, despite their potential, users commonly

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do not adhere to these applications or abandon them entirely [4, 5, 6]. Thus, there appears to be a mismatch between what the applications offer and what users need.

To create behavior change applications that do meet users' needs, a variety of algorithms has been developed to adapt *what* the applications offer, *when*, *how*, and *with whom*. For example, Zhou et al. [7], Adams et al. [8], and Costa et al. [9] have adapted daily step goals and the choice of activities for elderly people, Wang et al. [10] and Trella et al. [11] have developed algorithms for adapting the timing of notifications for physical activity and oral self-care, Kaptein et al. [12] and Bertolotti et al. [13] have adapted the use of Cialdini's persuasion principles and different message frames, and Piette et al. [14] and Forman et al. [15] have optimized the addition of human support to eHealth applications for pain management and weight loss. These algorithms thereby consider various elements from dynamic factors (e.g., user states derived from the COM-B model [16], self-efficacy [13]) to more stable user characteristics (e.g., personality and gender [17]) and employ various algorithmic techniques from reinforcement learning (e.g., [10]) to recommender systems (e.g., [18]). Placing the human at the center and combining the strengths of humans and technology (i.e., augmented or hybrid intelligence) is often an important design guideline, as is accounting for ethical and societal values.

This workshop brings together researchers, designers, developers, practitioners, and educators who are interested in the concept, development, evaluation, and impact of algorithmic behavior change support. We explicitly invite participants from various backgrounds such as artificial intelligence, human-computer interaction, psychology, medical practice, and ethics of technology to contribute their perspectives and experiences. The broader objective of this workshop is to strengthen the community of people working on adaptive support in behavior change applications. To this end, the workshop aims to create a lively exchange of ideas that benefits the individual workshop participants' current and future research. Specifically, the workshop's aim is to a) learn about each other's work, b) jointly work on problems of the workshop participants, and c) establish a vision for future work on algorithmic behavior change support.

## 2. Organization

This was a one-day workshop that was primarily designed as an in-person event. It combined sessions where participants presented their work and worked together on their individual problems (e.g., provide feedback on an idea for an algorithm, serve as a focus group, or brainstorm on a research question) with keynotes by leading researchers.

### 2.1. Accepted Papers

Researchers interested in attending the workshop were asked to submit a short position paper of their work as well as a problem that they would like to work on together with the other workshop participants. We received ten submissions by authors from diverse countries such as Canada, India, and Australia. Each submission was reviewed by at least two reviewers and the authors of four accepted papers presented their work and problem at the workshop. The accepted papers broadly covered the personalization of eHealth applications for different types

of behavior change (e.g., sleep adherence, stress management, diabetes lifestyle change) and algorithm design guidelines.

## 2.2. Keynotes

The workshop featured two keynotes, one online and one in-person:

- **Nina Deliu** is an Assistant Professor in Statistics at Sapienza University of Rome, Italy, and a long-term visitor of the MRC–Biostatistics Unit of the University of Cambridge, UK. Her research focuses on exploring and developing reinforcement learning and multi-armed bandit algorithms for applications in behavioral sciences (e.g., education, mobile health, clinical trials). Moreover, she investigates how we can perform valid inference based on data that has been adaptively collected in such settings.
- **Deborah Richards** is a Professor with the School of Computing in the Faculty of Science and Engineering at Macquarie University in Sydney, Australia. She is an expert on intelligent virtual agents, which she has developed for various domains including health and education.

## 2.3. Organizing Committee

The workshop was organized by a multidisciplinary team of researchers from several institutes, with expertise in human-computer interaction, artificial intelligence, health communication, statistics, and behavioral science:

- **Nele Albers** is a PhD student in Computer Science at Delft University of Technology. She studies how adaptive algorithms can be used to tailor behavior change applications to individuals and their state in time, especially using reinforcement learning.
- **Amal Abdulrahman** is a research fellow at Macquarie University and Delft University of Technology. Her main research interest lies in exploring how technology can support humans in achieving a better quality of life. For this, she has developed embodied and text-based virtual agents that use techniques ranging from reinforcement learning to argumentation.
- **Deborah Richards** did, besides giving a keynote, also help with organizing the workshop. Deborah is a Professor at Macquarie University. Her research focuses on intelligent systems, agent technologies, and virtual worlds to support human learning and well-being.
- **Caroline Figueroa**'s research focuses on developing, testing, and disseminating personalized digital health tools for behavior change, and tailoring these tools to the needs of underserved populations such as people from ethnic and racial minority backgrounds and low-income individuals.
- **Bibhas Chakraborty** is an Associate Professor at the Duke-NUS Medical School. His main research focus revolves around the development of novel statistical methods and associated study designs aimed at advancing data-driven precision health, particularly in settings with varying temporal factors.

- **Ananya Bhattacharjee** is a Computer Science PhD student at the University of Toronto, Canada. His main research interest lies in developing and understanding technology that can help people manage their psychological well-being. To this end, he has developed several text message services, mobile applications, and websites.
- **Linwei He** is a PhD student at Tilburg University in the Netherlands with a background in communication science and especially persuasive communication. Her research focus lies on using conversational agents to accomplish long-term health behavior change, for example in the context of quitting smoking.
- **Mark Neerincx** is Full Professor in Human-Centered Computing at the Delft University of Technology, and Senior Research Scientist at TNO Perceptual and Cognitive Systems. He is an expert on fundamental and applied research on human-computer interaction in domains such as health, security, and defense.
- **Joseph Jay Williams** is an Assistant Professor in Computer Science at the University of Toronto. His vision is to develop intelligent, adaptive systems that are continuously enhancing and personalizing interventions to help people in contexts such as education and mental health.
- **Nezih Younsi** is a PhD student at Sorbonne University in France. He is interested in how algorithms such as reinforcement learning can be used to help people change their behavior, specifically in the context of healthy eating.
- **Tibor Bosse** is Full Professor of Artificial Intelligence and Communication Science at Radboud University. His main research interest is the social interaction between humans and socially intelligent systems, applied to various domains such as social skills training and behavior change.
- **Annemiek Linn** is an Associate Professor in Health Communication at the University of Amsterdam. Her research lies at the intersection of technology and health communication. She is specifically interested in developing healthcare technologies that place the patient at the center.
- **Crystal Smit** is an Assistant Professor in Clinical Child and Family Studies at Erasmus University Rotterdam. In her research, she focuses on encouraging positive health behaviors among young individuals, especially considering the impact of their social networks.
- **Willem-Paul Brinkman** is an Associate Professor at Delft University of Technology. His research focuses on human-computer interaction, human-centered artificial intelligence, and behavior change support systems, specifically in eHealth.

## 3. Outcome

The workshop's goal was to enable a fruitful exchange of ideas that benefits both the current and future research of the workshop participants. More specifically, the workshop outcomes were that a) participants gained insights into current research projects that their peers from different disciplines are working on, b) participants contributed to addressing problems of other workshop participants, and c) participants established a vision for future work on algorithmic behavior change support.

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