



Delft University of Technology

MuM'23 Workshop on Interruptions and Attention Management

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MuM'23 Workshop on Interruptions and Attention Management: Exploring the Potential of Generative AI

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ABSTRACT

Attention management systems seek to minimize disruption by intelligently timing interruptions and helping users navigate multiple tasks and activities. While there is a solid theoretical basis and rich history in HCI research for attention management, little progress has been made regarding their practical implementation and deployment. Building sophisticated attention management systems requires a great variety of sensors, task- and user models, and multiple devices while considering the complexity of user context and human behavior. Novel AI technologies, such as generative systems, reinforcement learning, and large language models, open new possibilities to create intelligent, practical, and user-centered attention management systems. This proposed workshop aims to bring together researchers and practitioners from diverse backgrounds to discuss and formulate a research agenda to advance attention management systems using novel AI tools to manage and mitigate interruptions from computing systems effectively.

CCS CONCEPTS

• **Human-centered computing** → *Ubiquitous and mobile devices*; **Ubiquitous and mobile computing theory, concepts and paradigms**; *Ubiquitous and mobile computing systems and tools*; *User interface management systems*.

KEYWORDS

Human-computer interaction, ubiquitous computing, attention management, attentive user interfaces, interruptions, notifications, workload, cognitive load

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1 ATTENTION MANAGEMENT IN HUMAN-COMPUTER INTERACTION

Human attention has become a target of business interests, yet this resource is limited in contrast to the permanently increasing computing power of those who compete for it. Some consider the “Always-on-Mentality” [22] as an addiction, fearing that we are manipulated by services that try to maximize our on-screen time [1]. The fact is, many humans nowadays expose themselves to multiple conversations or media content [22], a behavior that is even more intensified by digital services like messengers, email, or social media, which frequently interrupt humans via notifications or warnings [6]. These interruptions come with a price: sequential multitasking [18] leads to “switch costs” resulting from the time and effort needed to stop one and engage in another task. Additionally, interruptions have been shown to increase stress, frustration, and error rates and to impede overall performance [4, 10, 13], which illustrates the damaging toll multitasking takes on people’s lives. In workplaces, multitasking is suspected to reduce productivity by up to 40% [21], representing consequential economic costs. In safety-critical settings, it can lead to property damage or even death, making it a severe safety risk. For example, distraction is already connected to every 10th fatal crash, and nearly half of the drivers frequently use their smartphones while driving [11] – a behavior that will intensify with further technologies introduced to the vehicle, which compete for driver attention [24]. Still, multitasking should not, and cannot, be eliminated. Doctors must care for and alternate between patients, and pilots and drivers must interact with multiple assistance systems. In the future, cooperating with machines/algorithms while engaging in other tasks will be expected in various domains such as mobility, manufacturing, or health. The

major question about multitasking is not the “if” but the “how”; consequently, “managing user attention has emerged as a critical challenge” [5].

Today, most notifications and interruptions we receive are unmanaged, i.e., they are communicated to the user as soon as they appear. Phone vendors have started to introduce notification management techniques (such as iOS Focus) into their systems, but most of these systems have to be configured by hand and show limited adaptability to individual needs. Consequently, many users deactivate notifications from a wide range of apps or frequently put their devices into silent mode when they do not want to get disturbed [14]. However, blocking all notifications may cause a feeling of disconnectedness [12] and even anxiety [16]. The issues associated with multitasking and human attention have led to calls for so-called “attention management systems” (AMSs).

AMSs can be defined as “systems that sense, model, and manage the attentional state of a user. Managing the attentional state is considered as any system action that supports an individual to maintain concentration on a task or activity” [3]. Calls for AMSs are frequently included in system design guidelines [2, 8], and such systems may provide various features to allow users to better cope with their resources. Thereby, two system properties are especially relevant – the timing of interruptions and the provision of information to support the re-uptake of a task [3]. Regarding timing, it has been shown that interruptions work best at task boundaries or phases of low mental workload. Holding back an interruption, even “for a short time, i.e., just a few seconds, can lead to a large mitigation of disruption” [4, 23]. A large body of work has looked into gauging user interruptibility [26] and detecting opportune moments for notification delivery [7, 17] by using sensors defer user context using machine-learning models. Subsequent mitigation strategies include an indication of availability status [25] or the use of aids to help users resume their tasks more effectively after an interruption occurs [20]. Considering task-switching support, it has been shown that adequately organized interfaces can also ease task resumption [15] by using cues. Task resumption cues can be designed in an explicit (providing specific information about the task) or implicit (guiding users’ attention, for example, their gaze) way, and they can be communicated before, during, and after interruptions using different modalities [19].

2 THE TIME FOR ATTENTIVE USER INTERFACES IS NOW!

Still, since the idea of AMSs was presented quite some time ago, one could ask why sophisticated AUIs have not yet been developed? Janssen et al. [9] presented a research agenda with important issues to be addressed, including new frameworks to relate theory and practice, more inclusion of the neuroscience community, and the role of behavior logging technology and machine learning. Anderson et al. [3] reviewed many works in the area and identified a list of important future directions.

We believe that it is time to revisit the ideas and brainstorm how novel AI technologies, such as generative AI, large language models, or reinforcement learning could help progress toward future attention management systems. For example, language models could provide ad-hoc summaries of suspended activities or task

resumption cues, image-generation tools may have the power to generate visual cues that support the re-uptake of a task, and reinforcement learning could be utilized to realistically model humans acting in uncertain environments. Consequently, we want to discuss the topic in a group of 10-15 people in the form of a workshop at MuM’23.

3 WORKSHOP GOALS

In this meeting, we want to discuss the issues of interruptions in the modern world, and how AI-enhanced AMSs as a potential solution could help. In particular, we ask:

- **How can AMSs empower humans?** *How can we build technology to help individuals navigate modern information overload and achieve effective task accomplishment? How can we guarantee that AMSs satisfy human needs such as feeling autonomous, competent, and meaningful? How do AMS’s features depend on life situations?*
- **What limitations must be considered?** *Limitations include comfort with sharing information, privacy, ethics, safety, and security. How do people feel when AI decides for them whether something is important and demands immediate attention? How do we responsibly balance performance optimization with mental well-being?*
- **How to use novel AI tools?** *Can we detect task boundaries with AI? Can language models or generative AI build task resumption cues for arbitrary activities on the fly?*
- **What are new opportunities due to advances in AI?** *More robust approaches for real-time monitoring and prediction of cognitive states will make attention management in everyday life possible, thus allowing us to research more complex application scenarios. This includes collaborative attention management or habit formation, which has not been implemented yet due to technological restrictions.*
- **What are the long-term implications?** *The usage of AMSs in everyday life settings over a longer period has not been studied yet. Many open questions remain, such as how AI-supported attention management will affect users’ inherent attention management skills, productivity, and well-being.*
- **What are the areas of applications for AMS?** *How could they be categorized (e.g., are they time-/safety-critical)? Which specific requirements for the AMS can be derived from these classifications?*

4 SCHEDULE AND ACTIVITIES

We want to attract a diverse but small group of conference attendees (about 10-15 participants) interested in the topic. Ideally, participants have either worked on interruptions, mobile notifications, or attention management in the past or consider doing so in the future. As organizers, we plan to provide activities before, during, but also after the workshop date.

4.1 Before the workshop

We will share the Call for Papers (CfP) via established HCI mailing lists and social media channels and advertise it in research groups

and at HCI conferences. We will create a workshop website¹ to introduce the subject of our workshop and share contact information and updates about the workshop. We further plan to conduct a small online survey to gather the needs and interests of potential participants. The survey will allow specifying which topics are most relevant to be discussed during the event, and potential participants can add their own ideas. The results of this survey will be included in the planning of the event schedule.

4.2 In-Person event at MuM'23

The in-person workshop at MuM'23 will be planned as a half-day. Participation will not be limited to having accepted position papers. First, the organizers will introduce themselves as well as the main topics of the workshop in the form of a presentation. Then, all workshop participants can introduce themselves and their position papers (if any). This is followed by two one-hour sessions where workshop participants themselves have to become an "Attention Management System", meaning we will divide participants into two equal-sized groups of 7-10 people. One group will have to work on multiple workshop-related brainstormings/discussions simultaneously (in particular, discussing the potential of generative AI systems to support attention management in different contexts like at work, in private, etc.; see the list of workshop goals above). The other group will try to identify sub-task and task boundaries, issue the working group with switching tasks/topics, or provide task-resumption cues for currently suspended discussions.

After a short (coffee) break, the roles of the two groups will be exchanged so that every participant will be part of the group work and part of the attention management once. This allows participants to immerse in the topic and better understand how attention management could help in real-life settings. Specifically, this method provides a good ground for discussing in what situations and to what extent AI systems could further support humans in dealing with interruptions. Finally, the groups are merged again, and we will discuss with all workshop participants about the learnings, potential future projects emerging from the workshop, and a small research agenda to progress in the domain of AMSS.

4.3 After the workshop

The organizers will keep in touch with participants interested in additional collaboration. We plan to host a quarterly online meeting to foster progress in this area and, for example, organize a follow-up at MuM'24 or other conferences. Furthermore, we will propose instigating a journal special issue on the topic.

5 ORGANIZERS

Alexander Lingler is a researcher at the University of Applied Sciences Upper Austria (Campus Hagenberg). His Ph.D. work focuses on human cognition modeling and attention management systems to develop and train domain and task-independent Attentive User Interfaces (AUI). He has studied computer science at the Vienna University of Technology and focused on machine learning, especially reinforcement learning.

Dinara Talypova is a PhD student and associate researcher at the University of Applied Sciences Upper Austria (Campus Hagenberg). Her research interests cover the topics of human interaction with automated systems. She is interested in how intelligent technologies can support and empower individuals. She has a background in Cognitive Science (University of Vienna), focusing on computer-mediated communications.

Fiona Draxler is an HCI researcher at LMU Munich. Her Ph.D. work focused on the learner-centered design of context-aware ubiquitous learning technologies, including automatically generating personalized learning opportunities and integrating task resumption cues. She has also investigated user perspectives in interacting with large language models for education and other tasks. She is an active member of the HCI community, with publications at venues such as ACM CHI, IUI, and DIS. She serves as Short Paper Chair at MuC'23 and as a program committee member for conferences, including MUM'22 and '23 and MuC'21–23.

Christina Schneegass is an assistant professor for Cognition & Design at Delft University of Technology. Her research aims to incorporate users' cognitive processes into the design and evaluation of technology to empower users in their increasingly complex relationship with technology. This specifically includes the design of cues that support memory and task resumption during learning tasks and beyond. Christina will lead a workshop on personal informatics at MobileHCI'23 and is involved in the HCI community (e.g., MuC'23 Program Chair, IoT'22 Local Chair). Her publications span numerous HCI venues, including ACM CHI, IUI, IMWUT, and Augmented Humans.

Tilman Dingler is an Associate Professor at Delft University of Technology. In his research, he investigates the notion of cognition-aware systems, i.e., systems that sense, moderate, and adapt to user's cognitive states. Tilman designs and builds technologies that support users' information-processing capabilities.

Philipp Wintersberger is a Professor of Interactive Systems at the University of Applied Sciences Upper Austria (Campus Hagenberg). His research addresses human-machine cooperation in safety-critical AI-driven systems. He has (co)authored many publications published at major journals and conferences (such as ACM CHI, ACM AutomotiveUI, IEEE IV, Human Factors), and his contributions have won several awards. Further, he is a member of the ACM AutomotiveUI steering committee, has contributed to HCI conferences in various roles in the past (Technical Program Chair AutomotiveUI'21, Workshop Chair MuC'21, Diversity and Inclusion Chair MuC'22), and is one of the main organizers of the CHI workshop on Explainable Artificial Intelligence (XAI). Currently, he leads a group of researchers and Ph.D. students working on human-AI cooperation in multiple FWF and FFG-funded projects.

6 CALL FOR PARTICIPATION

This workshop explores the potential of novel AI tools and systems to impact and even revolutionize attention management systems (AMS) in human-computer interaction. We invite submissions along the workshop goals, including but not limited to:

- Explore new perspectives on AMSS

¹<https://attentiveui.jimdosite.com/>

- Research into special application areas for AMSs
- Research into the design of AMSs
- Research into how AMS for human empowerment
- Investigate potential implications (e.g., ethical, legal, regulatory, inclusivity) that arise from the use of AI in AMSs

We invite participants to submit 2-4 page position papers in the CHI Extended Abstract format, describing the researcher's prior work, interest, and/or research agenda related to the workshop topic. Papers will be reviewed based on their relevance, diversity, and potential to stimulate discussion. The workshop organizers will coordinate the review and acceptance of the submission. Upon acceptance, we will contact our participants to inquire about any accessibility needs within the workshop format. More details can be found at our workshop website <https://attentiveui.jimdosite.com/>.

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