Human-Centered AI

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AI technology and systems are increasingly used in devices and systems that are part of the pervasive computing fabric of the world, e.g., enabling physical games, supporting home and outdoor activities, and empowering the workplace. However, people are critical in the design, operation, and use of those AI systems, and society has to ensure that those systems operate transparently, promote equitable outcomes, respect privacy, and effectively serve people's needs.

In this context, this special issue of *IEEE Pervasive Computing* with a focus on human-centered AI provides a forum for papers investigating new forms of human–AI interactions and experiences that enhance and extend human capabilities in the context of pervasive applications and systems.

The issue opens with the article [A1] by Crowley et al. with a thorough discussion about collaborative intelligent systems. Based on the problems of communicating comprehension, the role of explanation, and the social nature of collaboration, the authors propose four key research challenges for collaborative AI.

In the second article [A2], Ungersböck et al. discuss the design of a dashboard to visualize the stages of federated learning of industrial systems. This article presents a prototype and evaluation with stakeholders from the field. *Disclaimer: This article was handled by a nonconflicted Editorial Board member who oversaw peer review and made the recommendations on the outcome.*

In the third article [A3], Liao et al. propose a design support system based on multiobjective Bayesian optimization (MOBO). In a study of the design of a tactile smartwatch interface, a reduction in effort of designing such interfaces is observed, demonstrating how AI can collaborate with a human user navigating the design space of interactive applications.

In the fourth article [A4], Echeverria et al. describe a framework for analyzing team performance. A storytelling editor integrates sensor recordings and provides feedback to students in an education scenario of nursing teams. This article provides building blocks for personalized feedback, decision-making processes, and collocated training experiences.

In the fifth article [A5], Freire et al. discuss the development and use of AI-powered assistants to support manufacturing processes. In particular, this article suggests context sensing to determine situations where workers may apply tacit expert knowledge. The cognitive assistant described in this article uses text and audio messages in a conversational interface, and other usage scenarios are also described.

In the sixth article [A6], Anderson et al. combine on-device sensing and machine learning with social science to identify opportune moments for delivering information. Their results suggest that social roles can be used to enhance interruption management, beyond established techniques, such as breakpoints and mental workload.

In the seventh article [A7], Constantinides and Quercia address how productivity tracking technologies are perceived by workers. The use of productivity tools was found to be acceptable if the tools are well integrated to existing tools, do not interfere with work, and do not infringe on individual rights.

In the eighth article [A8], Tag et al. look into the security issues of human–AI systems and, in particular, in new forms of sponge attacks aiming to move the input data into low-confidence areas and, therefore, pushing human users to do errors or extra work.

In the final article [A9], Kang et al. investigate how people living apart can connect over distance. They create a sense of togetherness by melding between space and time: this article applies deep neural networks to replace with telerobots the actual presence of the user, creating a photographic memento of a possible scenario of being together in the same time.

The collection of research articles included in this special issue illustrates the wide range of directions in which pervasive computing technology can be enhanced by human-centered AI. It also brings together work and researchers from many different backgrounds, interests,

1536-1268 © 2023 IEEE
Digital Object Identifier 10.1109/MPRV.2023.3244009
Date of current version 27 March 2023.

and geographies, providing a diverse view of the challenges and opportunities of integrating AI to pervasive computing applications and systems. We hope that you will enjoy this special issue as much as we have enjoyed preparing it.

APPENDIX: RELATED ARTICLES

[A1] J. L. Crowley et al., "A hierarchical framework for collaborative artificial intelligence," in *IEEE Pervasive Comput.*, vol. 22, no. 1, pp. 9–18, Jan.-Mar. 2023.

[A2] M. Ungersböck, T. Hiessl, D. Schall, and F. Michahelles, "Explainable federated learning: A lifecycle dashboard for industrial settings," in *IEEE Pervasive Comput.*, vol. 22, no. 1, pp. 19–28, Jan.-Mar. 2023.

[A3] Y.-C. Liao et al. "Interaction design with multi-objective Bayesian optimization," in *IEEE Pervasive Comput.*, vol. 22, no. 1, pp. 29–38, Jan.-Mar. 2023.

[A4] V. Echeverria et al., "HuCETA: A framework for human-centered embodied teamwork analytics," in *IEEE Pervasive Comput.*, vol. 22, no. 1, pp. 39–49, Jan.-Mar. 2023.

[A5] S. K. Freire, S. S. Panicker, S. Ruiz-Arenas, Z. Rusák, and E. Niforatos, "A cognitive assistant for operators: AI-powered knowledge sharing on complex systems," in *IEEE Pervasive Comput.*, vol. 22, no. 1, pp. 50–58, Jan.-Mar. 2023.

[A6] C. Anderson et al., "Toward social role-based interruptibility management," in *IEEE Pervasive Comput.*, vol. 22, no. 1, pp. 59–68, Jan.-Mar. 2023.

[A7] M. Constantinides and D. Quercia, "Good intentions, bad inventions: How employees judge pervasive technologies in the workplace," in *IEEE Pervasive Comput.*, to be published, vol. 22, no. 1, pp. 69–76, Jan.-Mar. 2023.

[A8] B. Tag et al., "DDoD: Dual denial of decision attacks on human-AI teams," in *IEEE Pervasive Comput.*, vol. 22, no. 1, pp. 77–84, Jan.-Mar. 2023.

[A9] B. Kang, S. Kang, and I. Hwang, "AI-driven family interaction over melded space and time," in *IEEE Pervasive Comput.*, vol. 22, no. 1, pp. 85–94, Jan.-Mar. 2023.

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