Guest Editorial Special Issue on User Experience of AI in Games

I. Introduction

TALKING about artificial intelligence (AI) and games, there are two main endeavors that spring to mind—making AIs that are good at playing games and making AIs that make games good. Examples for the first case are the development of deep blue [1], AlphaGo [7], and other subsequent developments that outperform humans at several abstract and computer games. A defining feature of this case is that games here are usually seen as an interesting and challenging testbed to develop an AI for, but the games itself are seen as a means to an end. In contrast, the second case is concerned with using AI to improve games for the human players, i.e., develop AIs to elicit specific, usually positive, emotions [6]. Examples here include procedural content generation (PCG) to increase replayability and reduce repetitiveness, or the generation of believable nonplayer character (NPC) behavior and to increase immersion and engagement. Several scholars have argued that AIs to elicit emotions is in fact the defining feature of AI in games research [9] as a whole. This special issue is focused very much on this second case, and we should acknowledge that there are already many works that broadly fall into its scope out there—too many to even list them.

This special issue resulted from a workshop on "User Experience with AI in Games," which ran for several years at the Foundations of Digital Games conference. During the course of the workshops, we identified two main challenges to this work that we hoped to address. The first was the fact that in recent years we have seen more and more good examples in the games industry that used AI or AI adjacent techniques in professional computer games. They provided exciting examples of how to use AIs to improve player enjoyment or satisfaction and have served as common examples in many introductory lectures into AI in games. For example, the foregrounding of AI communication in the game *F.E.A.R.* [4] is a great example of how the relationship between the AI and the player can be moderated by the game. The game *Creatures* [5] or the famous *Tamagotchi* [3] produced relatable avatars, and the NPCs in games such as *Skyrim* [8] provide a lived-in feeling to the world. Games such as *Minecraft*, *Diablo*, or *RimWorld*, showcase how PCG can provide the player with nearly endless worlds to explore [2]. Unfortunately, many of the abovementioned games lack publicly available documentation, and even more lack a rigorous academic evaluation. They provide exciting but anecdotal evidence—making them both hard to reproduce, and even harder to use them as academic evidence.

A second challenge we saw in this field was the need for a highly interdisciplinary team to realize this kind of research. Testing, if a specific, technical sophisticated AI approach, in a professionally looking computer games, elicits a specific emotional response that should ideally be done by a team of people, including at least AI experts, game designers, and psychologists. Few academic laboratories can assemble such a diverse team, so matchmaking was one of the foci of our past workshops. A secondary problem of such an interdisciplinary approach is the difficulty of finding an appropriate venue to present said work.

This special issue, and our past workshops, is our attempt to address these challenges. We hope to provide a venue for interdisciplinary approaches that look at all the facets of how AI can create different user experiences in games, and we hoped to make this also accessible to participants form a professional game development background that wanted to share their work in a more academic fashion.

II. This Special Issue

This special issue of IEEE Transactions on Games features four publications spanning the gamut of research on the user experience of AI in games.

In [A1], Lai et al. surveyed existing research on mixed-initiative content creation and proposed a definition of the concept *mixed initative*. Although their survey was not specific to games, they connected to research in adjacent fields, such as art creation, experience-driven procedural content generation, explainable AI, and interactive evolutionary computation. Their survey also provided a categorization of how mixed-initiative research has been used for different types of assets in games, and common techniques used for mixed-initiative generation. Finally, the authors provided recommendations for future directions of research within the field of mixedgeneration research.

In [A2], Reid et al. described, designed, and evaluated a system to automatically detecting toxic behavior based on in-game audio features. Their article proposes a modeling approach for how toxic behavior can be detected through in-game verbal communication. The authors used a machine learning approach to generate a model that can detect toxic behavior in *Overwatch* with great reliability. The model relies only on data available to the player, and does not need integration into the game engine to be functional. They believe that this approach can be useful for detecting toxicity in games in a way that is low cost, low effort, and nonintrusive to players.

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In [A3], Wang et al. described how to design real-time strategy (RTS) games in order to deemphasize a high number of actions per minute and instead focus on strategic planning. As part of this study, the authors created three different versions of an RTS game that were tested on users. The study discusses how changes in resource management and the AI scripts of units affect the player experience. The authors provided recommendations on RTS game design, and how developers could use AI to help the player achieve increased awareness and make it easier for the player to control their units.

Finally, in [A4], Lora-Ariza et al. described how case-based reasoning frameworks could be used to maintain player flow using dynamic difficulty adjustment. Their system focuses on generating game sessions that are similar in difficulty level to session that have previously induced a flow state in the player. The authors found that their dynamic difficulty adjustment system has a measurable impact on the perceived feeling of flow among players.

III. Conclusion

The four publications included in this special issue show the great diversity of research that exists within the intersection of user experience and AI. Together they span the gamut of many different disciplines and approaches to both user experience and AI, and provide an overview of what research in this field can look like. They also show that studying the UX of AI is indeed an interdisciplinary task, where knowledge from several different fields is necessary in order to achieve a cohesive understanding of the impact of these novel technologies. Furthermore, the publications in this special issue highlight just how many and diverse forms of AI exist within games, and how they have vastly different impacts on the gaming experience. It is our hope that the content of this issue will act as an inspiration to future researchers active in this space, and help build a stronger understanding of how people and AI coexist within games.

Henrik Warpefelt, *Guest Editor*
Department of Software Engineering
and Game Development
Kennesaw State University
Marietta, GA 30060 USA
research@warpefelt.se

Christoph Salge, *Guest Editor*
University of Hertfordshire
AL10 9AB Hatfield, U.K.

Mirjam Palosaari Eladhari, *Guest Editor*
Stockholm University
11859 Stockholm, Sweden

Magy Seif El-Nasr, *Guest Editor*
University of California at Santa Cruz
Santa Cruz, CA 95064 USA

Jichen Zhu, *Guest Editor*
IT University of Copenhagen
2300 København, Denmark

Appendix: Related Articles

[A1] G. Lai, F. Fol Leymarie, and W. Latham, "On mixed-initiative content creation for video games," *IEEE Trans. Games*, vol. 14, no. 4, Dec. 2022, doi: 10.1109/TG.2022.3176215.

[A2] E. Reid, R. Mandryk, N. A. Beres, M. Klarkowski, and J. Frommel, ""Bad vibrations": Sensing toxicity from in-game audio features," *IEEE Trans. Games*, vol. 14, no. 4, Dec. 2022, doi: 10.1109/TG.2022.3176849.

[A3] H. M. Wang, C.-Y. Hou, and C.-T. Sun, "Using simple design features to recapture the essence of real-time strategy games," *IEEE Trans. Games*, vol. 14, no. 4, Dec. 2022, doi: 10.1109/TG.2021.3128753.

[A4] D. S. Lora-Ariza, A. A. Sánchez-Ruiz, P. A. González-Calero, and I. Camps-Ortueta, "Measuring control to dynamically induce flow in tetris," *IEEE Trans. Games*, vol. 14, no. 4, Dec. 2022, doi: 10.1109/TG.2022.3182901.

References

[1] M. Campbell, A. J. Hoane, and F. H. Hsu, "Deep blue," *Artif. Intell.*, vol. 134, no. 1/2, pp. 57–83, 2002.

[2] M. Dahrén, "The usage of PCG techniques within different game genres," Bachelor's thesis, Malmö Univ., Malmö, Sweden, 2021.

[3] L. Lawton, "Taken by the Tamagotchi: How a toy changed the perspective on mobile technology," *iJournal: Student J. Fac. Inf.*, vol. 2, no. 2, 2017.

[4] J. Orkin, "Three states and a plan: The A.I. of F.E.A.R.," in *Proc. Game Developers Conf.*, 2006.

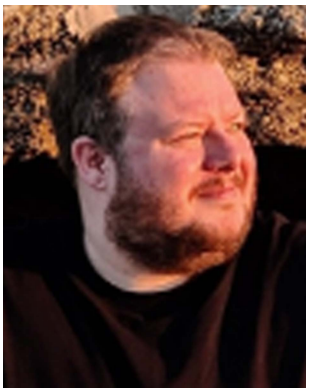
[5] J. Schindler, "Creatures," *Simul. Gaming*, vol. 29, no. 4, pp. 482–483, 1998.

[6] N. Shaker, J. Togelius, and G. N. Yannakakis, "The experience-driven perspective," in *Procedural Content Generation in Games*. New York, NY, USA: Springer, 2016, pp. 181–194.

[7] D. Silver et al., "Mastering the game of go without human knowledge," *Nature*, vol. 550, no. 7676, pp. 354–359, 2017.

[8] H. Warpefelt and H. Verhagen, "A model of non-player character believability," *J. Gaming Virtual Worlds*, vol. 9, no. 1, pp. 39–53, 2017.

[9] G. N. Yannakakis and J. Togelius, *Artificial Intelligence and Games*. New York, NY, USA: Springer, 2018. [Online]. Available: http://gameaibook.org



Henrik Warpefelt received the Ph.D. degree in computer and systems sciences from Stockholm University, Stockholm, Sweden, in 2016.

He is currently an Assistant Professor of game design and development with the Department of Software Engineering and Game Development, Kennesaw State University, Marietta, GA, USA, where he runs the Novel Game Design Lab. His research interests include expanding our understanding of how players perceive and interpret game design, as well as eliciting good design practices for how novel technologies can be applied in games.

Prof. Warpefelt is the Head Organizer of the User Experience of Artificial Intelligence in Games (UXofAI) workshop and a Community Engagement Chair for the Foundations of Digital Games conference.

Christoph Salge received the Ph.D. degree from the University of Hertfordshire, Hatfield, U.K., in 2012, with a dissertation titled "Information-Theoretic Models of Social Interaction."

He is currently a Reader in artificial intelligence in games with the University of Hertfordshire, Hatfield, U.K. He is interested in the driving principles behind AI, such as intrinsic motivations, and how they can be used to generate believable NPC behavior, or be used to evaluate procedural generated content.

Dr. Salge recently completed a Marie-Curie Global Fellowship on Information Theoretic Evaluation of Random Content Generation in Games. He is an Associate Editor for *Adaptive Behavior*. He was the recipient of the Best Paper Award at the IEEE Conference on Games for his work "New and surprising ways to be mean."

Mirjam Palosaari Eladhari received the Ph.D. degree in computing science from the University of Teesside, Middlesbrough, U.K., in 2010.

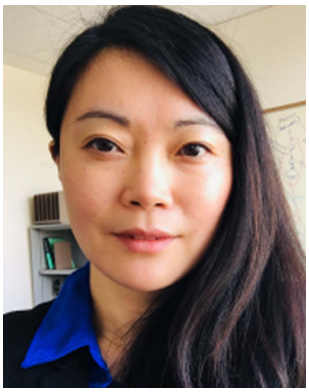
She is currently an Associate Professor with Stockholm University, Stockholm, Sweden. Her research interests include artificial intelligence, game design, interactive narrative, and computational expression. A main theme of her work is cocreation, in particular how interactors can add elements to games and interactive narratives.

Prof. Eladhari is a Board Member of HEVGA and ARDIN, and an active member of the EU project INDCOR (Interactive Narrative Design For Complexity Representation). She is the Principal Investigator in the newly started project Platform for Smart People (PSP) funded by Digital Futures. PSP will create a platform using IoT technologies and machine learning helping people with cognitive diversities, such as autism, in their everyday lives. She also works as an independent artist and game designer under the label Otter Play.

Magy Seif El-Nasr received the Ph.D. degree in computer science from Northwestern University, Evanston, IL, USA, in 2003.

She is currently a Professor and Department Chair of computational media with the University of California, Santa Cruz, CA, USA, where she directs the Game User Interaction and Intelligence (GUII) Lab. She worked in collaboration with several game companies both in the serious as well as the entertainment game spaces. She authored the first book on the subject of game analytics, titled *Game Analytics: Maximizing the Value of Player Data* (Berlin, Germany: Springer, 2013), and recently authored the book *Game Data Science* outlining the standard methods used for data science within game research and industry. Her research interests include developing automated tools and techniques for authoring, adapting, and personalizing virtual environments (e.g., interactive narrative, believable agents, and games), developing evidence-based methodologies to measure the effectiveness of game environments through the development of novel process mining and visual analytics systems.

Dr. El-Nasr is internationally known for her research works. She was the recipient of several awards and recognition within the HCI, agents, and games research communities, five best paper awards, one exceptional paper, and two honorable mentions. Further, she was named a Higher Education Video Game Alliance Fellow.



Jichen Zhu is currently an Associate Professor of digital design with the IT University of Copenhagen, Copenhagen, Denmark. Her focus is designing and developing novel human–AI interaction, especially in the forms of personalized games for learning and health. She has coauthored more than 100 peer-reviewed research publications. Her research interests include intersection of human–computer interaction, interaction/game design, and artificial intelligence (AI).

Prof. Zhu was the recipient of several best paper awards. Her research has been funded by the National Science Foundation, the National Institutes of Health, and Novo Nordic Foundation among others. She is currently a Co-Editor of the Software Studies Book Series at MIT Press and a Board Member of the Society for the Advancement of the Science of Digital Games (SASDG).