Guest Editorial Special Issue on AI-Based and AI-Assisted Game Design

I. Introduction

As RESEARCHERS working with games, we are often faced with terms that either lack a definition entirely or which are contested and debated as part of their very nature. Many papers have tried and failed to define what "fun" is, from where "creativity" originates, or what "difficulty" means, for example, and many more papers in the future will try and fail to do the same. Tangling with ineffable concepts, with moving targets and nebulous ideas is all part of the joy of doing artificial intelligence (AI) research in a complex, multifaceted domain like games.

"Game design" might be considered another concept that struggles to be pinned down by a single definition, but nonetheless it is a term that is understood and used every day by game developers, critics, academics, and players. Game design is a skill, sense, and practice that infiltrates every aspect of game creation from the visual language of an instruction manual to the specific balancing of a number in an algorithm buried somewhere deep in a system of rules. Game design is an art and a science, it is a precise process as well as something done by feel. One could ask: how can AI ever hope to contribute to something so vast and so multidimensional?

It is tempting to peel off problems that respond well to computational leverage, to focus on those challenges with easy to measure outcomes, well-defined boundaries, and mathematical foundations. But we must not shy away from other facets of this practice, the subjective, artistic, and immeasurable. As we develop the field of AI-based and AI-assisted game design, we must ensure that our view of the field is holistic, and that it regularly engages with people doing game design in the real world, to ensure that our work is motivated well and evaluated by the people it impacts the most.

This special issue contains a variety of exciting ideas about how the field of AI can influence and be influenced by different areas of game design. We are fortunate to have some of the most cutting-edge ideas to present here, from fine-grained data-driven problems to systems situated amidst the vast context of human history and culture. They represent a resolute first step toward a science that engages with game design in a broad and open way as well as a call to arms for researchers to move this field forward and discover how we can build AI systems that perform, support, critique, and advance game design.

II. AI-Assisted Game Design

AI has the potential to greatly enhance current game design practices and augment the skills and abilities of developers. In "Trained behavior trees: Programming by demonstration to support AI game designers," Sagredo-Olivenza *et al.* demonstrate how intelligent tools can support designers in rapidly expressing ideas and subsequently help them work better with programmers and achieve more without direct programming. This is an excellent example of artificial intelligence techniques being used to extend the existing abilities of a game designer, which has great promise both for expert-level professional game development as well as applications in hobbyist and educational contexts.

Similarly, in "Perceptual experience management," by Robertson and Young, we see AI being used to mediate between two established approaches for designing interactive fiction: accommodating or intervening in player choice. While each individual approach is easy to understand for a designer and has its strengths, Robertson and Young propose a more effective hybrid system which is only made possible by a more intelligent system that monitors and adjusts the game's design on the fly. As with the first paper, this is an another example of AI helping game developers reach otherwise inaccessible parts of the design space.

AI can also reveal details and subtleties within a design that might otherwise be hidden to designers. In "Learning how design choices impact gameplay behavior," Zook and Riedl show how analyzing the way AI agents play games can provide insights into how good and bad players respond to game structure. Game designers often try to gain this kind of understanding through playtesting and manual analysis, but the approach by Zook and Riedl is automated, detailed, and scalable, and shows intriguing insights into the behavior of players of different levels of ability. Such AI-driven tools benefit not just the design of a particular game, but help expand the field of game design, in general, providing new insights into the practice as a whole.

Finally, in "Multiobjective evolutionary map design for *Cube 2: Sauerbraten,*" Loiacono and Arnaboldi present a system that designs maps for a first-person shooter, evaluating those maps against game design concepts like balance and pacing. This system demonstrates how AI-driven game design systems are not necessarily autonomous and disconnected from direct

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practice, but can instead embody theories about game design and be part of an iterative design process. This paper shows the complexities of expressing game design concepts to an AI-driven system, and how we can validate the success of this process through analysis and visualization.

III. AI-Based Game Design

Beyond AI-Assisted game design, this issue also asks how AI can be more independent in the game design process. The paper "Orchestrating game generation" by Liapis *et al.* provides a good overview of the kinds of challenges posed by the application of artificial intelligence to game design. Liapis *et al.* explore what we might consider one of the fundamental building blocks of game design: arranging smaller parts of a larger design so that they complement one another, emphasize the same themes, or help achieve the same goals. This simple idea underpins so many challenges across the field, and we can see its relevance throughout many of the other papers in this special issue, and particularly for the future of autonomous AI-driven game design.

In a similar vein, the paper "From mechanics to meaning" by Summerville *et al.* describes Gemini, a system for modeling and interrogating game designs. Gemini has been designed to demonstrate an appreciation for both the mechanical nuts and bolts of a game's design, and the higher level conceptual language and meaning that those mechanics represent. Gemini is the system that is capable of autonomous game design, but it is also built with human interaction in mind, and has potential as a creativity support tool and a teaching device. This shows great promise as an exercise in modeling game design in a concrete system that can reason about the results, and continues to broaden the idea of what AI-based game design can look like, beyond simple generate-and-test paradigms.

Finally, in "Who killed Albert Einstein? From open data to murder mystery games," Barros *et al.* reflect on their attempts to build data-driven games that are draw from Wikipedia, perhaps the largest concentration of edited knowledge in existence. This paper shows how AI can drive new kinds of game design, but more importantly it also reflects on the nature of the games that are produced. In order to apply AI to game design, researchers often inevitably become game designers themselves, which is another reason to work more closely with practitioners of game design to tackle these challenges together. Barros *et al.* argue that while there are undeniable challenges inherent in building games from real-world data, it remains an exciting space where interesting new ideas about gameplay exist amidst real and worrying ethical questions.

IV. Beyond This Special Issue

This special issue outlines some of the most recent ways in which researchers have brought together ideas, techniques, and problems from AI and game design. Each paper is a glimpse into a different future for this field of study, from supportive systems to autonomous creators, and many papers also reveal new challenges for AI/games research. At which point do researchers become game designers? What are the fundamental operations of game design? Can we build logic-driven systems that can reason about subjective or philosophical ideas?

The future of this field is far from clear, but we hope that this special issue provides food for thought and highlights some of the ways in which the application of AI to game design can be explored. However, in seeking out this future, we must be aware that game design is a diverse practice with a long history and its own traditions, language, and techniques. Amidst our excitement and optimism for the future of the field, we should also be aware that we are visitors in another community's garden, and with that comes a responsibility to be respectful guests. Our next steps should be informed by the views of those people that may be supported by our software, and our plans should not be limited by our preconceptions of what games are or what design is. In doing so, we can hopefully challenge and advance both artificial intelligence research and game design, and bring those two fields closer together in the process.

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Dr. Liapis was a co-organizer of nine workshops (at Artificial Intelligence and Interactive Digital Entertainment, International Conference on Cognitive Computing, Foundations of Digital Games, and CHI). He was the General Chair in a number of conferences (Computational Intelligence in Music, Sound, Art and Design 2018 and 2019 and Games and Learning Alliance conference 2019), a local Chair of the IEEE Computational Intelligence and Games conference (2016) and as a Track and Demonstration Chair of the IEEE Conference on Games (2019). He is currently an Associate Editor for the IEEE TRANSACTIONS ON GAMES.

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Dr. Colton was the recipient of the national and international awards for his research and led numerous research projects funded by the EPSRC and the European Commission.