Guest Editorial: Special Issue on Computational Aesthetics in Games

AGENT-BASED artificial intelligence (AI) research, traditionally, seeks to optimize the performance of artificial agents in their given domains. In the area of games, however, this does not mean simply constructing stronger opponents as we do not necessarily increase players' enjoyment of a game by challenging players the most, but by engaging them and providing an entertaining experience [1]. While such gameplay and aesthetic considerations are more difficult to quantify as objective functions, and much less straightforward to measure than playing strength, they are becoming increasingly important as more consumer content becomes digitally created and tested.

Recent years have seen a demographic diversification of computer game players as well as a boost in their numbers [2]. This, in turn, has increased the diversity of player skills, preferences, and experience. Therefore, the need for tailoring games to individual experiences is growing and the availability of reliable computational models of aesthetics within games has become increasingly important.

The aim of computational aesthetics in games is to enhance the richness of the playing experience, and afford sensual, visceral, and/or intellectual stimulation to the player. Computational aesthetics utilizes AI as a framework that covers the multidisciplinary intersection of the fields of user experience, affective computing, experimental psychology, and human–computer interaction. The field of computational aesthetics, at large, has recently seen a growing number of dedicated workshops, special sessions in conferences, and special issues in relevant journals (such as this special issue). In addition, top game developers (including Zynga, Blizzard, Bioware, Square Enix Europe, and EA Games) have recently started to experiment with multiple modalities of user input [e.g., physiology in *Left 4 Dead* (Valve, 2008)] and exploring the use of massive-scale player and game contextual metrics for personalizing player experience [3].

We identify three main areas in which computational aesthetics apply to games.

1) *Aesthetics as player experience*: Capturing and modeling player engagement, enjoyment, and immersion as functions of playing behavior and game context.
2) *Aesthetics as player emotion*: Game contextual stimuli affecting the player's emotional state: issues related to capturing emotions, and creating models of player aesthetics from them.
3) *Aesthetics as style*: Aspects of visual presentation and elegance that can be computationally modeled.

The purpose of this special issue is to draw together the various aspects of computational aesthetics as they relate to AI in games, and to shed light on the relationship between game aesthetics and player satisfaction. The call for papers for this special issue raised a number of questions (such as: What exactly is beauty in a game? How do we measure this and use it to best effect? How do we make AIs more entertaining?) and encouraged an open interpretation of aesthetics in any sort of game. This was reflected in the range of papers submitted.

A total of 15 papers were submitted for this special issue of the IEEE TRANSACTIONS ON COMPUTATIONAL INTELLIGENCE AND AI IN GAMES (TCIAIG), which underwent a process of peer review and revision, yielding the seven papers accepted for publication. These offer a snapshot of current work in the broad areas listed above.

I. AESTHETICS AS PLAYER EXPERIENCE

The essential function of any game (among other functions that include training and learning in serious games) is to entertain the player. As games—and our understanding of them—become more sophisticated, we are well beyond the point of increasing entertainment value simply by raising the difficulty level or throwing more nonplayer characters (NPCs) at the player. Greater rewards for the player in terms of replayability and overall enjoyment can be gained by studying (and predicting) what the player wants, and adapting the game to suit those desires (and intentions).

In our opening paper, "Unsupervised modeling of player style with LDA," Gow *et al.* [4] describe how log data of playing sessions can be used to model the player, and adapt future gameplay to increase the player's enjoyment of the game. This technique is demonstrated for a simple arcade-style game called *Snakeotron* and the more sophisticated first-person shooter *Rogue Trooper*.

Delalleau *et al.* [5] demonstrate another way in which player enjoyment can be increased for first-person shooter games in "Beyond skill rating: Advanced matchmaking in *Ghost Recon Online*" through team selection for simulated battle scenarios. Again, players are profiled according to their in-game behavior and personal preferences, but in this case, the aim is to match players of different skill levels to form not only balanced teams, but more importantly teams that maximize the "fun" factor for each member.

Such notions of engagement do not only apply to visceral first-person shooters. In "Evaluating the aesthetics of endgame studies: A computational model of human aesthetic perception," Iqbal *et al.* [6] describe how aesthetic measurements of *Chess* endgames can identify positions and puzzles that expert players are likely to deem "pleasing." In this context, the engagement of the game lies in the intellectual challenge that it presents to its protagonists, and the scope for each player—or the puzzle designer—to trick, trap, and bluff the opponent.

II. AESTHETICS AS PLAYER EMOTION

Another way to enhance the player's experience of a game is to reflect their emotional state, and an obvious way to achieve

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this is through music. In "Experience-driven procedural music generation for games," Plans and Morelli [7] propose a method for adaptive musical composition, so that the game's background score may be synthesized in real time according to developments in play. For example, engaging passages of play might be accompanied by exciting music, while difficult passages might benefit from more calming music to soothe the player.

Savva *et al.* [8] consider the opposite process in "Continuous recognition of player's affective body expression as dynamic quality of aesthetic experience"; by predicting the player's emotional state through dynamic body features. They consider what this information reveals about the player's enjoyment of the game, and how it might be used to improve their enjoyment in future.

III. Aesthetics as Style

In addition to notions of gameplay experience and emotional resonance, there is also the ability of games to captivate players through beauty, elegance, and style, for the sheer ludic enjoyment of playing.

Liapis *et al.* [9] describe the evolution of visually pleasing spaceship designs in their paper "Adapting models of visual aesthetics for personalized content creation." The evolved designs, based on studies of human psychology and perception, were found to be both functional and visually appealing. A model of the designer's visual preference is tailored to the selections of the user and personalizes the design process, which is achieved through interactive evolution.

Finally, Browne [10] considers the abstract notion of "Elegance in game design," focusing on what it means for a set of rules to be "elegant." He demonstrates how such intangible concepts can be measured empirically, how such measurements can provide new metrics with which games can be evaluated, and how this might benefit players.

IV. Summary and Future Directions

This issue draws together a number of case studies that demonstrate the practical application of aesthetic principles in computational game design and analysis. The papers in this issue offer a snapshot of the state of the art in our understanding of games from an aesthetic viewpoint, and the importance and benefits of this understanding. We place the investigation of such aesthetic concerns in the overall research push into AI for games, by observing the boost of academic interest in the topic demonstrated by the increasing number of relevant papers published in the key venues of game AI [e.g., IEEE Conference on Computational Intelligence in Games (CIG), AAAI Conference on Artificial Intelligence and Interactive Digital Entertainment (AIIDE), IEEE TCIAIG]. We observe that the papers published in these venues reveal a trend toward nontraditional uses of AI for games, such as the modeling of aesthetics and player experience, which now outnumber papers with a more traditional focus on game AI for nonplayer characters. This is in complete contrast to the early days of IEEE CIG and AIIDE.

The impact of work in this area is increasingly being seen as key for academic AI to reach industrial problems and provide reliable solutions to them. For a long time, major commercial (AAA) and indie game developers have taken different approaches to capturing player experience and aesthetics and—to a lesser degree—designer aesthetics for the improvement of their final products. With the current increased level of interest in the topic of computational aesthetics in games, we now hope for a convergence of these different approaches into a unified research push.

Future directions for research in this area include:

- the investigation of generic models of aesthetics across game genres;
- the examination of appropriate player and game contextual input for the construction of accurate computational models;
- the investigation of the most suitable AI and CI methods for capturing and modeling aesthetics;
- the comparison of methods for aesthetics-driven game adaptation;
- the examination of the potential of modeling-group-based collective aesthetics;
- the integration of massive-scale player metrics for computational aesthetics.

In summary, the papers collected in this special issue demonstrate the breadth of work in this area. We believe that they yield useful insights into a diverse range of topics and applications, and provide a snapshot of the state of the art of current research into computational aesthetics in games.

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