Collaborative Artificial Intelligence for Supporting the Development of Games

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***Abstract*—Developing games involves a strong creative process. It defines if you are creating games that will generate good experiences when a player interacts with it. This is a difficult task for new game designers or even for experienced professionals. Some support for these tasks are given by artificial intelligence through the use of procedural content generation. However, collaborative artificial intelligence can achieve promising results. The focus of this paper is to present the current state of the art in collaborative AI and open challenges in terms of support for the game development process.**

***Index Terms*—game, artificial intelligence, collaborative AI, creativity**

I. Introduction

The development of games involves a strong creative process. This can be noticed mainly in the game design activities, but also in the development of the game art and sound effects. The creativity is an important aspect in the game development process, since it defines if you are creating something that will generate good experiences when a player interacts with it [1]. This means that the creative thinking has a strong influence in the chances of success of a game.

In fact, creating a game that provides new and good experiences is challenging for new and even for experienced game professionals. To help the professionals regarding these difficulties, some researchers investigate the use of Procedural Content Generation (PCG) [2] during the game development, which focus is to automate some of the tasks performed by humans.

There are some interesting results in terms of PCG, a technique that generally uses artificial intelligence to achieve its goal. Despite the good results of PCG, it is not easy to think that PCG can completely substitute the human in these creative activities. Actually, in some cases, the PCG is used just as an insight that can be evolved by game designers.

A different strategy to combine human and artificial intelligence efforts is collaborative artificial intelligence. Collaborative AI is highlighted by the collaboration between humans and computers to generate more interesting content in the game design. It can help the level designer during her production, helping her in the creative process with suggestions for modifications to the level design being built in real-time, and even suggesting an early-stage prototype to use as inspiration. It can also help to validate whether the building level is playable and has a solution depending on the type of game [3].

Although the use of this approach can lead to significant improvements in terms of player experience and development productivity, it still is not so well explored by academia. Hence, the goal of this paper is to present the current state of the art in terms of using collaborative artificial intelligence to support the game development process, as well as the open challenges that can guide research in this area for the next decade.

II. Collaborative Artificial Intelligence for Game Development

This section presents the current state of the art in collaborative artificial intelligence applied to support game development (Section II-A), as well as the advances in this area that challenges academia (Section II-B).

A. Current State of the Art

Most of the current research is related to level design, which is the art of creating a combination of challenges, interactions, and competition. The development includes the manual placement of elements within the game. However, when a level is made in this way, it is considered a static level, because of the experience that the player will be consistent whenever he plays that level again [4].

The time it takes to create a level can also be reduced. As the AI evaluates in real-time if the scenario is solvable, there is no need always to be testing each level that is created, since it guarantees the solution.

Tanagra [5] is a level design tool for 2D platform games. It allows the level designer to interact with a procedural content generator. It is a mixed-initiative approach that proposes a way to reduce the authorial burden in the design of levels and allows human designers to practice their creativity and aesthetic judgment.

As for the gameplay of the created level, whether it is playable or not, the tool only informs the designer that there is no solution. What can be improved in future work it the development of an AI to suggest modifications so that the level is solvable.

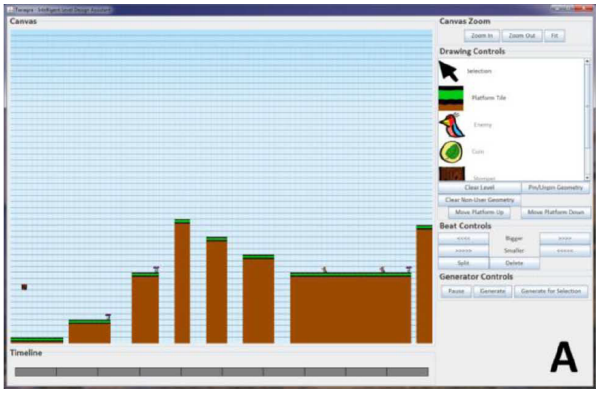

Fig. 1. Tanagra Level design tool for 2D platform games.

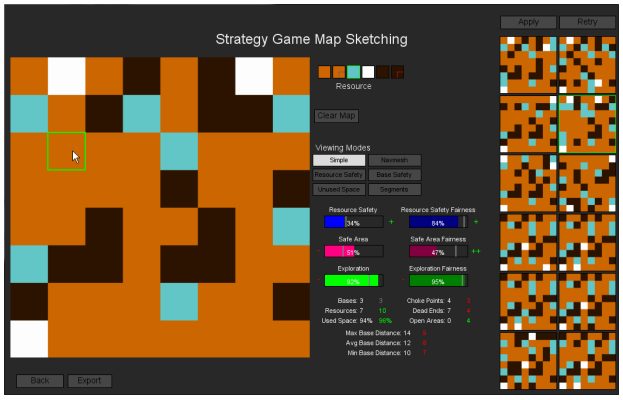

Fig. 2. Sentient Sketchbook Computer-Aided Game Level Authoring.

Sentient Sketchbook [6] is a tool for creating maps for strategy games through a computer-aided drawing interface. The tool automates the evaluation of maps and proposes alternative maps. The suggestion of alternative maps is made through a combination of a feasible-infeasible two-population paradigm with novelty search. A user study was carried out with industry experts who demonstrated the potential of the tool with different cases where the suggestions were useful.

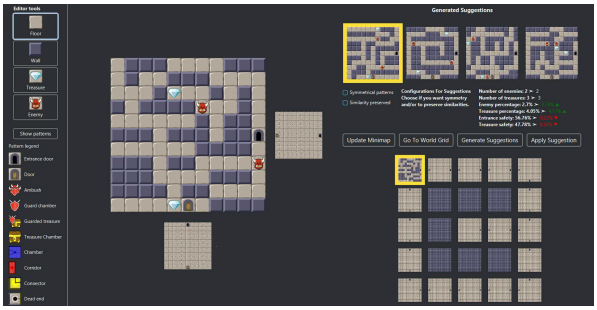

Fig. 3. Evolutionary Dungeon Designer.

Evolutionary Dungeon Designer (EDD) [3] is a mixed-initiative tool for creating dungeons focused on the use of evolutionary computing to generate content that meets game standards procedurally. It allows the user to start the project with an empty room or with suggestions based on PCG.

Alvarez et al. [7] proposed the use of quality diversity algorithms for generating mixed-initiative game content, as a new resource for EDD. The feature uses the MAP Elites algorithm. Users can choose as relevant variation dimensions and incorporate the designs suggested by the algorithm. In addition, any changes made by the user are returned to MAP-elites and used to generate new suggestions.

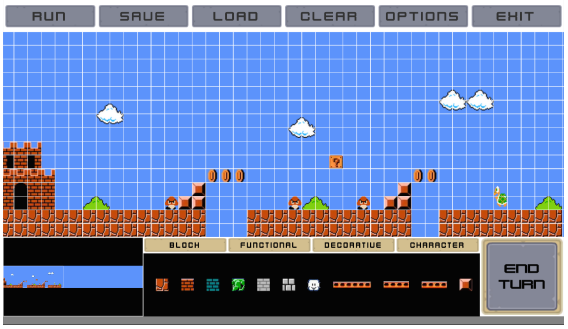

Fig. 4. Screenshot of the Level Editor, reproduced from (Guzdial et al. 2017).

The study presented in [8] evaluated existing approaches of process-level generation based on Machine Learning (PLGML) and adapting for co-creation, calling them AI level design patterns. They conducted the studies based on the Super Mario Bros game and created the three AI level design patterns, Markov Chain, Bayes Network, and Recurrent Neural Network of Short-Term Memory (LSTMRNN or just LSTM). The agents were not allowed to make exclusions at the level. They were only allowed to add new elements in the scenario to minimize the damage that the agents could cause to the level intended by the user.

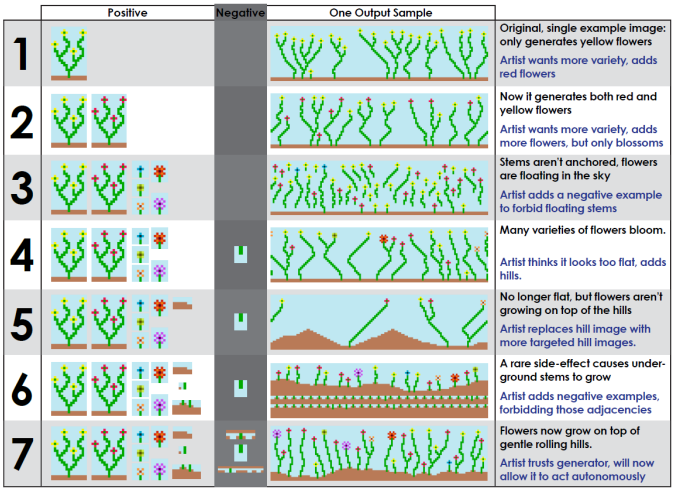

Fig. 5. A practical example of the mixed-initiative conversational teaching model process.

The work of Karth and Smith [9] combines PCGML (Procedural Content Generation via Machine Learning) with mixed-

initiative assistance project tools. It uses machine learning in the WaveFunctionCollapse, which is a content generation algorithm developed by independent game developer Maxim Gumin. A practical example of the mixed-initiative conversational teaching model process can be seen in Fig. 5. The designer observes the results of each iteration and applies a change to the next step. In each iteration, positive or negative examples are added. The source images of each output can be seen on the left, and the output is represented on the right.

According to the book The Art of Game Design [1], puzzles are mechanisms that are an essential part of many games. Sometimes visible and sometimes hidden within the gameplay of the game. The puzzles within the game make the player stop and think about how to solve it.

Creating puzzles can be a difficult task, as it is necessary to create them to be solvable. Game designers create informal puzzle ideas to fit the desired level, but are rarely maintained when changes are needed during development. Thus, violating restrictions, running out of solutions, and changing the entire plan can be costly. Collaborative AI can allow the designer to keep the idea in sync even when the level is modified. In addition, it enables the automatic detection of problems that may be caused by the change in the level.

Fig. 6. The level editor, which embeds Refraction's custom editor. There are additional views for editing constraints and playtesting.

The work presented in [10] is a mixed-initiative tool to design level progressions in games. In the paper, the authors present an implementation of the prototype of the tool for a Puzzle game, intended for elementary education to practice fractions called Refraction. The tool seeks to help the designer quickly explore and test the game's progressions.

B. Open Challenges

As shown in the previous section, the academic community already has interesting results in collaborative artificial intelligence applied to support the game development process. However, several possibilities not yet explored can be found by analyzing the game development process activities and related work in the literature [11]. Collaborative AI applications are still limited. Most of this research is related to level design, and still need advances to achieve better results and to be ready for use by the game industry. In addition, there are still more challenging activities to be developed. For example, activities that involve the production of game design texts can be supported by collaborative artificial intelligence.

A first step to be taken to better understand the state of the art would be to carry out a systematic review on the topic. However, regarding PCG we have a systematic review that presents the last achievements of PCG research [11].

In terms of gameplay and mechanics, there are several activities involving creative processes. Defining the structure of the mission, the objectives, the main rules that are applied to the game and those applied to each individual game character. The definition of which objects, players and non-player characters a game should contain can be supported by a collaborative AI, based on existing games or in random proposals that could lead to innovative approaches. Another aspect that can be supported is the definition of how the user interacts with the game, in terms of hardware and controls in the game.

Some challenges are related to the construction of the game story. This may include suggestions related to the back story, game progression and cut scenes, definition of the characters personalities, appearances and animations. The selection of existing audio, music, and sound effects or even the elaboration of new ones could be supported by collaborative AI. The same idea applies to the selection and elaboration of the game art (assets, sprites, art style, ...).

III. Characterization as a Grand Research Challenge in Games

The challenge presented in this paper is related to the use of artificial intelligence (AI) for helping the game development process, being aligned to the computing track of the Brazilian Symposium on Computer Games and Digital Entertainment. In fact, collaborative artificial intelligence is a more recent area of AI with several applications that should be investigated by academia. New research in the proposed challenge will represent advances in state of the art for both Game and AI areas.

As presented in Section II, there are different applications of collaborative AI to the game development process. Some applications are harder challenges as they involve natural language processing or image analysis. Hence, it may require the use of modern techniques, such as pre-trained neural network models (i.e., GPT-3) for producing human-like texts, or other advanced techniques to recognize elements in storyboards and drawings created by hand.

Several research projects may be necessary to achieve good coverage of solutions for supporting that AI collaborative process. It should take a decade or more to have relevant results for the whole game development process.

The success of these collaborative AI supports can be objectively measured by empirical studies comparing the quality

level of the resulting artifacts created manually with those created with the collaborative AI support and the automatic AI support (traditional PCG). An important aspect that should be observed is the impact in productivity; that is, the effort required to produce the artifacts. In addition, it is important to analyze the impact on quality. This can be done by analyzing the user experience (UX) in games, using techniques such as Games User Research [12] for evaluating all aspects of the game, from mechanics and interface, visual and art, interaction and progression, ensuring that each element works together and supports the game UX.

For developing solutions for this challenge, professionals of different areas should be involved. According to the type of support to be given, one should build a multidisciplinary research team composed of software engineers, artificial intelligence specialists, game designers, musicians, graphic artists, and so on.

For all these characteristics, the support of collaborative artificial intelligence for game development activities can be considered a grand research challenge in games.

IV. Conclusions

This paper presented the current state of the art in collaborative AI and open challenges in terms of support for the game development process. These insights can promote the development of new research and support the creative process used in the game industry.

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