The Effectiveness of AI in Player Experience Personalization

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Abstract

The effectiveness and potential of Artificial Intelligence (AI) techniques in automatically modulating various game attributes for providing dynamic gaming experiences while ensuring playability is demonstrated and defined. Specifically, the focus is on personalization of player experience for enhancing user engagement and satisfaction. The results indicate that AI-driven personalization increases the positive sentiment in game reviews and is an effective tool to increase the engagement of both well and poorly received games. The use of AI in orchestrating a wide range of gaming experiences across different games and platforms is coined as 'Experience Driven Playing Companion,' and the methodology and tools developed under this paradigm are introduced. The approach is centered around the use of various approaches to model player experience, both interactively and non-interactively, using psychophysiological game events as well as visual aesthetics features and crowd-sourced game review descriptors. Several AI techniques are described for driving level difficulty adaptation, audio soundtrack generation and controlling screen brightness adaptively in various game environments. Furthermore, an overview is given on the underlying software and hardware architecture, as well as on the released gaming companion platform that allows non-expert game developers to automatically create a wide range of working playing companions by taking advantage of various black-box AI techniques. Finally, the ethics and potential pitfalls of AI-driven player experience orchestration are discussed, highlighting directions for ensuring an ethical stance in future deployment of similar systems.

Keywords AI, player experience, personalization, user engagement, game reviews, experience-driven companion, adaptive gameplay, ethical considerations

2. Introduction

Recent development in game technology and the spread of digital games have made it possible for players to be immersed in digital worlds like never before. However, the vast community-produced digital contents built on the developed features of game technology mean that today's environment is as complex as it is diverse. Advanced

features in games not only give players broader actions and freedom to mold digital worlds, but also provide rich experience prospects yet to be fully discovered. The differences in player experience (PX) observance are what the game industry seeks to support (N. Yannakakis & Conference on Computing Frontiers, 2012). Therefore, many attempts have been made to customize the game experiences according to individual needs. This personalization is undertaken not only by the game customization, but also by the overall adjustment of the time of the game play process. Customized scrolling maps, for example, are designed using medical data of each individual user. However, this form of personalization is often static and does not adapt to seamless transitions.

Customized digital role-playing game (RPG) scenarios developed in a real-time manner based on IP and measured data between users during game play are reported to enhance overall understanding during game play. In order to bring a new level of customization to PX in digital games, it is necessary to advance further delivery strategies and realize a personalized environment as an online game. Fortunately, artificial intelligence (AI) applications to the PX domain begin to flourish. Game scenarios that are automatically adapted to players' emotional responses and dialogues have been constructed as players play 2D RPG games. Real-time automatic generation and communication of videos concerning dialogues, gestures, and emotion states of the non-playable character are planned. As digital entertainment becomes increasingly important in the cultural landscape, it is important to understand how new technology affects the player's experience. The current lack of personalization capability for the game experience can severely limit the immersive potential of evolving technology. There is a need for further progress in technology for the development and successful application of interactive systems that adapt to personal characteristics throughout the experience to maximize the appeal and appreciation of their users.

3. Understanding Player Experience Personalization

Personalization of game experiences has a strong potential to significantly enhance the enjoyment and satisfaction of individual players by providing them with the games and game components specifically tailored to their preferences. Personalization of player experience can be seen in a variety of elements: game content, game recommendation, player controls and so on in both single and multiplayer formats. In the case of game content, personalization would alter the in-game content such as spawning conditions, behavior, schedules, text and graphics, and other features related to the rules, goals and feedback of the game. Personalization of game content is expected to have an evident effect on both the performance and enjoyment of the players. Player experience

personalization aims to create games that adapt to the traditions, culture, demographics, behavior, and psychological aspects of the player leading to a substantially enhanced experience. described player experience personalization within the computer gaming landscape as creating a strategy to improve enjoyment and satisfaction for each player by providing them with their individually designed game experience. Like encountered with many other digital environments, a broad array of complex and changing factors contribute to player experience in the digital game landscape. In the digital game environment, player preferences are determined by an array of demographics (age, sex, ethnicity etc.), prior purchasing behavior (purchase history, favorite games etc.), play behavior (game playtimes, frequently visited games etc.) and a variety of psychological aspects (enjoyment, involvement, curiosity). A player's various characteristics and interactions in the game environment determine the uniqueness of its gaming preferences. Clearly, in order to develop an effective personalization strategy, the gathering and analysis of data is of utmost importance in order to understand players who engage in predominantly similar online gaming, and in consequence, to better predict and fulfill player's needs, expecting this will result in more relevant and engaging experiences. It is argued that a well-personalized experience can lead to loyalty and potentially retained engagement of the players in the marketplace, and adjusting a given personalization strategy is of paramount importance due to changing player preferences, potentially improved building in the long-term participation amongst players in the game landscape. In real-world application areas that draw upon multimedia technologies, there has been a growing interest in learning representative models from empirical data for the purpose of high-level decision-making processes such as content organization, actuation and adaptation. Trait recommendation systems offer a way to seamlessly produce highly relevant output. On the basis of implicit or explicit query information, models are used to provide recommendations such as items to buy, movies to watch, or friends to befriend . (Rodrigues et al.2021)

4. The Role of AI in Player Experience Personalization

Player experience (PX) personalization in games is paramount for making games more engaging and enjoyable, enhancing the human playability of games and leading to experiences that players "do not want to quit" (N. Yannakakis & Conference on Computing Frontiers, 2012). AI can play a pivotal role in improving player experience personalization. Exploiting player data, AI methods can uncover player play-style and game-play preferences or model the relation between these preferences and game content and style of play. Learnt patterns can then be exploited for enhancing

personalization of game play in various levels (e.g., tailoring of challenge progression, game story level, game strategy level or preferences for the game aesthetics). Results can be linked to player types, personas or segmentation, and be employed for modeling content difficulty. Owing to their generalization characteristics, predictive models can be used in real-time adaptation of game parameters or dynamics, adapting game play to the estimated needs of the player, offering a more tailored, personal experience. The role of AI in modeling PX, modeling content, linking PX and content, predicting PX in real-time, and modeling difficulty in 3D games is discussed and emerging research questions and challenges are identified.

Using the output of AI techniques, PX properties can be exploited for improving the human suitability of games and consequently the attractiveness of gaming activities. Moreover, such properties can be linked to game design principles, informing designers on the relation between game design choices and resulting PX. Factoring PX properties into the game design pipeline makes it possible to exploit tools such as PCG and arm them with the ability to design-space defection based on learned player models, spatial style templates or knowing that some design spaces lead to game designs with favorable PX attributes. Examples of this interaction between AI and design disciplines include the evolution of game level designs based on PX embeddings of level design space, the synthesis of textures networks with the goal of shaping the desired PX, and the use of agent-based simulation models for testing the effect of changes in city traffic patterns on urban PX. (Klint, 2022)

5. AI Techniques for Personalization

Advances in ICT technologies in the last decades have had transformative effects on the video game industry. The rapid development of AI and its application to games has resulted in a growing number of interesting and exciting games (N. Yannakakis & Conference on Computing Frontiers, 2012). As other aspects of game design, AI has to be conceived, designed and implemented with reference to optimization of player experience. Provided that the gaming experience can be characterized, systems with AI can be developed for modelling that experience and tailor the gaming experience accordingly.

Recommendations on potential extensions of AI research, concerning the analysis and synthesis of entertainment experiences and the development of products and experiences with the potential to modify behaviours are further discussed. AI technologies can analyse player's inherent preferences and provide her with an exhilarating gameplay experience despite her gaming skill and knowledge levels. In

general, AI technologies for personalization can take a vast variety of forms, such as recommendation systems, changes in video game narrative, characters, music and graphics, and runtime changes in video game difficulty levels.

The potential of ever-growing volumes of natural language data produced in ways that reflect player experience in the context of video games and for developing AI technology for sense-making and decision-making in game experience personalization is explored. The multimodal nature of the data is also expected to generate a new wave of research that integrates approaches to language with vision and acoustics. The data can be employed to tackle a vast variety of research challenges. Research can, for example, analyze player reviews about the video game user interface (UI) and visual elements and provide recommendations for UI changes. Similarly, one can utilize some other forms of natural language data that concern the gameplay, to analyze and recommend changes in video game difficulty level. Furthermore, analysis of forum discussions about video game characters and their behavior can help in creating game characters that are better tailored to player preferences. The analysis of natural language game instructions is expected to help in tailoring game tutorials to the inherent player skills and experience. Lastly, linguistic style analysis of video game walkthroughs is expected to enable personalization of the embedded hints in video games. Special attention is given to analysing the data and technology needs, as well as business issues around privacy and data sharing that can support multi-disciplinary research in these areas. (Chen et al., 2021)

6. Case Studies and Applications

Gaming companies have a long history of personalizing player experience at the creative content level. Indeed, in many games designers would tweak various game parameters (usually hidden) including but not limited to the strength, HPs, AI, and drop rates of the AI-controlled enemies. While a number of games automate this tuning process through adaptive techniques or AI (N. Yannakakis & Conference on Computing Frontiers, 2012), this personalization happens at the structural level of the game and not at the content level of the player experience. Contrary to game content adaptation, AI can learn player models and recognize their preferences by analyzing player interactions in the game and then use this to modify the machine-controlled elements or generate new ones. The potential of adapting the content of the game to the personal interests of the player through the application of AI-powered procedural content generation and data mining is showed through practical, real-world examples.

Different games and platforms are taken into account to explore various facets of game personalization. This comprises a mood-customizable endless runner game, an AI-powered game companion generating quest walkthroughs, an online game generating music architected to the gameplay, an MMO game recommending activities and skill builds or selecting opponents, a PC game with an NPC dealer that adjusts its speech act strategy, an online game with AI-controlled monsters that are adjusted in real time, an online accommodation booking platform employing an AI-powered chat assistant recommending guesthouses, and an online and mobile video sharing platform that utilizes collaborative filtering. For each case study, the approach to data acquisition is examined, the way the data is analyzed to train the player model is discussed, and the manner in which the adaptation of the game content is realized is presented. Following the AI intervention, the effects on the player retention rates, engagement metrics, and metrics of satisfaction are considered. Finally, using the case studies as a stepping-stone, the lessons learned and best practices are presented, including the observed pitfalls or confounding factors that have to be taken into account. (Gu et al., 2022)

7. Challenges and Limitations

6.1. Ethical Concerns The discussions regarding the effectiveness of AI in game player experience personalization cannot be complete without considering the ethical concerns associated with it (Seif El-Nasr & Kleinman, 2020). Just as in any other industry where AI is being increasingly adopted, implementing AI in games involves considerations regarding the extensive collection of personal and behavioral player data (in- and beyond game context), the proper protection of players' privacy and data and the responsible use of this data. AI being perceived as an opaque 'black box' technology involving machine learning, virtual neural networks and deep learning on big data, naturally provokes concerns associated with data security and meaningful player consent. The topical nature of these concerns is highlighted by recent legal attempts to regulate data protection standards from tech companies.

6.2. AI Limitations There are also limitations of AI which are critical to be analyzed. Many stress that the interpretation of data by algorithms can be forged and contain possible biases. An experiment of feeding a popular commercial empathy research neural network image recognition AI with a picture of a girl and a plate of pasta returned a result that she is worried what her friends will think about her pasta, whereas the actual girl's crowdsourced emotion was curiosity. Every company using AI, including game developers, may be accused of technological determinism and not accidentally advancing the aims of the data they feed to their algorithms. Algorithmic transparency is

another critique towards AI widely discussed among computer scientists and data specialists. The inability to verify the outputs of an algorithm challenges the ethics of deciding in whose benefit the algorithms should behave, in games – in favor of matchmakers or players. FAR and FRR as decision costs of algorist may hide potential ethical appraisals and legal problems, since designers will overlook the processing of their algorithms. Most remarkable is the argument that too much customization automates work and relationships, making people detached from different ideas and opinions with each other, politics and the society. Broadcast media type algorithms rather impose the preferences of the majority on the long tail, hindering experimentation with content outside of the predefined predictions and censoring the opposing views harming the critical thinking and the free society. When games are already unintentionally monstering their content, providing a predictable, addictive and anti-educational playground, much-needed arguments are posed for the rationality to limit the over-reliance on automation. Structurally, the necessity to execute a balance in-between the AI-designed highly-personalized bot-driven fake avatars player interactions and authentic real human ones is underlined. In terms of that balance, the time- and resources-consuming nature coming with the training and execution of effective AI and its integration into games has to be mentioned. Unable to secure those resources and achieve a responsible holistic personalizing automation, game developers may be tempted to superficially cash on the topical AI bloom, thereby the most-needed reasonable AI expansion and the accomplishment a more profound decoding and understanding of each player's personal nature will be obstructed. Positively, the posing a series of questions and problems are put in a constructive setting, intended to motivate and urge a much-need ethical dialogue. A substantial step to the challenge for a responsible and effective player experience AI enhancement is the acceptance of the discussion on better solutions and innovative ideas, granting a creative aftermath. (Busuioc, 2021)

8. Future Directions and Emerging Trends

In exploring how AI might be effectively used in this space, a rich picture has been painted that reflects possibilities for a deep co-evolution between games and players (N. Yannakakis & Conference on Computing Frontiers, 2012). A range of developments are believed that would, if implemented, collectively reshape game AI and game player relationships over the coming years. A natural transition from this modelling vision is to discuss possible responses by the game development community. While these

predictions are necessarily speculative (and potentially overly optimistic), it is hoped they will help spark further practical and theoretical development.

A wide range of advances in AI technologies might be expected to further refine the capabilities discussed, if the associated data handling and computational challenges can be overcome. For instance, the ongoing integration of affective computing technologies into this space could further personalize game design, NPC characterisation/behaviour and interaction, and music based on the sensing of player-agent and player-environment interactions. Broader/experiential patterns of play could be captured through data mining and analysis of, for instance, movement and game performance. Moreover, advances in the automated analysis of spoken language and text could allow for heightened attention to the nuances of linguistic play.

There are, of course, manifold growth in the kinds of informational traces left by digital play, and more and better analytical tools will be needed to make sense of them. As both expectation formation and adjustment come to be based more heavily on these traces, there are likely to be corresponding changes in play, in feedback processes, in the sorts and qualities of tactics employed. For a sense of play's rhythm and texture as a material process that bears upon affect states and AI and thus play's unfolding, recall why certain dimensions of the missing object of affective engagement—music in games—appear salient. Broadly speaking, work with music between play sessions often generates a kind of extra-diegetic heightened watchfulness towards play—and heightened attention whose regularity and tensing of play's tissue is generally unmarked in experiential taxonomies currently used in the design of player experience personalization systems-enabled by advances in some gamified music discovery/appreciation services. Such indication underscores the broader point underlying aforementioned developments and predictions: the deep co-evolution of data, AI, and engagement in general, and the different ways and lengths of play and production of desire in particular may take. (Barnes, 2022)

9. Conclusion and Implications

Player experience is a key element of a video game design, and technological evolution as well as the industry maturity have nurtured new perspectives on such paradigm. Artificial intelligence (AI) technologies have enabled new ways to explore design spaces and opened the path to personalization approaches. AI can provide play-testing support, facilitate game adaptation, and enhance non-player characters. In combination with other technologies such as player models or affective computing, AI can provide novel ways to enhance player experience. Assuredly the effectiveness of player experience

personalization technologies will impact the gaming/practice industry specific questions. The gaming industry gathers stakeholders from video games production to serious game development or gambling designers, with potentially different ways to consider AI. However, it can also foster common interrogations, e.g. how to address ethical challenges? Then, considering most initiatives in the industry also involves academics and small businesses, common work towards answering such interrogations appears relevant. As the gaming industry is recurrently evolving due to its younger stakeholders and an open environment to technology, the research and development horizon is worth exploring. The present work opens up interrogations initiated by the industry regarding how such technologies could be leveraged.

As AI has already provided satisfactory solutions to most NPC tasks, priorities of stakeholders in NPC AI may evolve towards under-researched directions that will enhance NPC capabilities and feed more content to players. Exciting matches between human players and NPCs may revitalize a game community, offering more replay value and making the game live longer. However, most results on NPC design patterns raised concerns from the community about a game industry strategy where developers would create games in which AI would be employed to use unfair design patterns. Implementing the same underlying approach in AI from different installation or publishers would then lead to the exact same behavior. This advance focuses all the work on AI's side assuming that behavior transparency is a non-issue. Involving different aspects of the game in the challenge would discourage such practices and it raises new research questions like how can the design of a game world be altered to make it easier for its NPCs to win against human players and against a diversity of opponents.

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