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REVOLUTIONISING GAME DESIGN: THE ROLE OF AI IN ENHANCING PLAYER EXPERIENCE, INTERACTION, AND ENGAGEMENT

OYUN TASARIMINDA DEVRİM: OYUNCU DENEYİMİNİ, ETKİLEŞİMİNİ VE KATILIMINI ARTIRMADA YAPAY ZEKANIN ROLÜ

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Abstract

This study explores the critical role of artificial intelligence (AI) in contemporary game design, focusing on its influence on user interface (UI), user experience (UX), and player experience (PX). AI technologies have the potential to revolutionise game environments by adapting to individual players' behaviours and preferences, significantly advancing beyond traditional game design paradigms. The evolution from static to adaptive gaming experiences underscores the growing importance of AI in game development, promising new dimensions of engagement and immersion. This paper examines the development and application of AI design components, such as machine learning algorithms, neural networks, and procedural content generation (PCG). It also critically analyses examples of AI integration in games, highlighting instances where AI significantly enhanced gaming experiences and those where it fell short. Additionally, the study underscores AI's transformative potential in crafting next-generation video games, enhancing the user interface and experience. Through an examination of current tools and technologies, critique of AI applications in game development, and a forecast of AI's future trajectory, this paper provides a comprehensive roadmap for game designers, developers, and players alike.

Keywords: artificial intelligence, game design, user experience, procedural content generation, adaptive gaming.

Öz

Bu çalışma, oyun tasarımında yapay zekanın (YZ) entegrasyonunun kullanıcı arayüzü (KA), kullanıcı deneyimi (KD) ve oyuncu deneyimi (OD) üzerindeki kritik rolünü incelemektedir. YZ teknolojilerinin, oyuncu davranışlarına ve tercihlerine uyum sağlayarak oyun ortamlarını devrim niteliğinde değiştirme potansiyeline sahip olduğu vurgulanmaktadır. Geleneksel oyun tasarım yaklaşımlarının ötesine geçerek, oyuncuya özel deneyimler sunan dinamik ve etkileşimli oyunlar oluşturulması hedeflenmektedir. Bu bağlamda, oyun içi yapay zeka bileşenlerinin geliştirilmesi ve uygulanması, oyun tasarımının temellerini yeniden şekillendirmektedir. Bu çalışma, YZ entegrasyonunun KA, KD ve OD üzerindeki etkilerini analiz ederek, oyun tasarımında yeni boyutlar kazandıran ve oyuncu etkileşimini artıran örnekleri ele almaktadır. Ayrıca, YZ'nin oyun geliştirme süreçlerindeki araç ve teknolojilerin etkinliğini değerlendirmekte ve gelecekteki eğilimleri öngörmektedir.

Anahtar kelimeler: Yapay zeka, oyun tasarımı, kullanıcı deneyimi, prosedürel içerik üretimi, uyarlanabilir oyun.

1. Introduction

The integration of Artificial Intelligence (AI) in game design represents a paradigm shift towards creating dynamic and interactive experiences, profoundly enhancing user interface (UI), user experience (UX) and player experience (PX). As highlighted by Keiper, Fried, Lupinek & Nordstrom (2023), AI technologies offer the potential to revolutionise game environments by adapting to individual players' behaviours and preferences, significantly advancing beyond traditional game design paradigms. This evolution from static to adaptive gaming experiences underscores the growing importance of AI in game development, promising new dimensions of engagement and immersion previously unattainable.

Historically focused on crafting captivating narratives and challenging gameplay within visually stunning environments, the game design field is now embracing the capabilities of AI to create personalised gaming journeys. In gaming, traditional AI approaches typically involve Finite State Machines (FSM), rule-based systems, navigation and search strategies (An & Kim, 2023). These methods are foundational for creating intelligent behaviours in non-player characters (NPC) and game scenarios. The advent of AI has introduced the potential for games that learn from and adapt to the player, creating a personalised gaming journey. From enhancing NPC behaviours to generating infinite game scenarios, AI technologies are reshaping the foundation of game design and development. Mariselvam, Rajendran & Alotaibi (2023) illustrate the transformative impact of AI through reinforcement learning algorithms, enhancing player engagement and skill development in therapeutic game settings. This indicates a broader trend of AI technologies reshaping game design and development fundamentals.

Integrating AI into game design marks a transformative era for UI/UX/PX, significantly enhancing game immersion and engagement. According to Mahajan (2023); McFarland (2024); and Singh (2023), AI-driven animations offer fluid, lifelike visuals, while advanced NPCs contribute to richer narratives through autonomous decision-making. Dynamic, AI-crafted scenarios ensure unique gameplay experiences, enhancing replay value. Personalisation tailors the gaming experience and deepens engagement by analysing player behaviour. AI also personalised game development, especially in testing and debugging, leading to higher-quality games. This integration heralds a new era of immersive, adaptive, and personalised gaming, pushing technological and creative boundaries.

This paper sets out to explore the critical role of AI in contemporary game design, with a particular focus on its influence on UI, UX, and PX. Drawing from a rich body of research, including the works of Inie, Falk & Tanimoto (2023) and Ratican, Hutson & Wright (2023), it delves into the development and application of AI design components such as machine learning algorithms, neural networks, and procedural content generation (PCG). Moreover, this study will critically analyse examples of AI integration in games, highlighting three instances where AI significantly enhanced gaming experiences alongside three instances where it fell short of expectations, thereby offering a balanced view of AI's current state in gaming.

Additionally, this study aims to underscore the transformative potential of AI in crafting next-generation video games, illuminating its role in enriching the user interface and experience. As AI continues to evolve, its integration into game design not only signifies technological advancement but also foreshadows the creation of more engaging, responsive, and inclusive gaming experiences. Through an examination of current tools and technologies fuelling AI-supported game design, critique of AI application in game development, and criticism of the limitations of AI in the gaming industry, this paper provides a comprehensive roadmap for game designers, developers, and players alike (Liang et al., 2023; Touretzky, Gardner-McCune & Seehorn, 2023; Westera et al., 2020; Ye et al., 2020).

2. AI-supported game design

2.1. AI-driven procedural content generation

As the domain of AI-driven PCG advances, its augmented fusion with the gaming industry is anticipated to not only refine the methodologies of game development but also to substantially tailor the PX in manners hitherto unexplored. Contemplating the substantial progress in AI for the creation of game levels and content, as exemplified by the works of Sun, Jiang & Zhang (2024), we find ourselves on the brink of an epoch wherein the role of AI extends beyond simple content generation to shape entire gaming ecosystems with unprecedented intricacy and customisation.

The potential of AI to transform game design resides in its capacity for dynamically modulating game mechanics in reaction to player interaction, a concept endorsed by Dai, et al. (2024). Through real-time player data analysis, AI is poised to meticulously calibrate difficulty settings, narrative trajectories, and even gameplay modalities to precisely match individual proclivities and competencies, signalling a move towards fluid, evolving game experiences that develop in concert with their participants. Such adaptability amplifies the depth of player immersion and guarantees a unique odyssey for each gaming session, thus, enhancing the replay value and longevity of games.

Furthermore, AI's ability to craft deeply individualised narratives presents a remarkable opportunity to captivate players as never before. Revelations from the inaugural 1st ChatGPT4PCG Competition (Taveekitworachai et al., 2024) envision a future where games might feature narratives. These narratives adapt in response to the player's choices, emotions, and even conversational inputs, utilising sophisticated natural language processing (NLP) and sentiment analysis technologies. This level of customisation could render gaming an exceedingly immersive and emotional venture, with each player's narrative journey being distinctly singular.

AI is ready to considerably enhance social interactions within games, fostering more profound connections among players. By analysing social dynamics and player interactions, AI could suggest activities or challenges that encourage cooperation or rivalry, based on mutual interests or synergistic abilities. Nelson (2024) suggests that AI could also play a crucial role in developing virtual environments that promote community engagement and social interaction, thereby further enriching the PX.

In summary, the imminent integration of AI within the gaming sector promises offerings that are not only dynamic and rich in content but also deeply personalised and socially cohesive. As AI technology forges ahead, it will unveil new horizons for game design and player engagement, crafting experiences that are increasingly immersive, interactive, and tailored to individual preferences like never before. The journey towards this future is paved with continuous research and innovation, positioning AI-driven PCG as a pivotal element in redefining the landscapes of gaming and entertainment.

2.2. Player Modelling and Personalisation

Player modelling and personalisation encompass a suite of strategies and technological applications leveraging AI to analyse, comprehend, and forecast player behaviours, preferences, and proficiency levels. Subsequently, this nuanced understanding is harnessed to customise the gaming experience for individual players. Such an approach facilitates the creation of a gaming environment more engaging, enjoyable, and distinctly tailored to align with the unique preferences and capabilities of each player, thereby enhancing the overall user experience. This is why, AI facilitates a highly personalised gaming experience by adapting game scenarios, challenges, and narratives to individual player profiles. This is achieved through analysing player data to tailor the game environment accordingly. As Zhu and Ontañón (2020) articulate, a player-centred AI framework allows for the customisation of game elements to fit individual preferences, enhancing the player's emotional and psychological engagement with the game.

The first step in leveraging AI in game design is the meticulous collection and analysis of data derived from player interactions. This data includes, but is not limited to, player behaviour patterns, decision-making processes, and interaction styles with the game environment. By employing sophisticated AI algorithms, developers can dissect this vast amount of data to uncover underlying patterns and preferences. For instance, the use of decision tree algorithms, as explored by Li and Xu (2016), illustrates how AI can dynamically adjust game mechanics based on real-time data, thus maintaining a balanced and engaging game environment.

Yannakakis et al.(2004) contend that for a game to be engaging and playable, it should neither be too difficult nor too easy. They suggest that the behaviours of in-game opponents should be diverse and non-static. Building on this premise, it has been assessed that the in-game components should not exhibit a strictly optimal behaviour; rather, these components should be dynamic, evolve, and adopt behaviours that model human interaction towards the player (Pfau, Smeddinck & Malaka, 2018). Player behavioural modelling, an emerging field of study within game research that attracts interest from both scholars and developers, focuses on the creation and application of models to simulate player behaviour in video games (Herik, Donkers & Spronck, 2005).

The examination of the interaction between the player and the game can reveal the player's actions, behaviours, tendencies, motivations, and objectives within the game context (Yannakakis et al., 2013). Hooshyar, Yousefi & Lim (2018) have discussed three distinct data domains that can be utilised in the creation of player models. The first comprises data collected during the player's interaction with the game, the second involves subjective data gathered through surveys, and the third consists of objective data obtained through biometric observations. The data was then analysed using various machine learning models and fitting algorithms, such as Hidden Markov Models, deep learning, clustering, and regression, to facilitate player modelling.

One of the key applications of AI in game design is the dynamic adjustment of difficulty levels. This adaptive difficulty setting ensures that the game remains challenging yet accessible to players of varying skill levels. The AI assesses a player's performance and adjusts the game's difficulty to provide a continuously challenging environment that is neither too easy nor frustratingly hard (Yannakakis et al., 2013). Player modelling is constituted by a trio of core components: (1) behavioural analysis, (2) skill assessment, and (2) preference prediction. In parallel, personalisation is achieved through the application of dynamic difficulty adjustment, the facilitation of customised content delivery, and the employment of adaptive narratives. This framework delineates a strategic approach aimed at optimising the gaming experience, leveraging analytical insights into player behaviour to inform targeted enhancements in-game difficulty, content personalisation, and narrative flexibility, thereby ensuring a tailored and immersive interaction for the user.

Player modelling opens the way for personalising the game flow based on the player model. Tan & Pisan (2012) have defined personalised gaming as the game's ability to reconfigure itself by utilising information about the player. This personalisation adjusts the gaming experience from various perspectives, such as narrative, level of difficulty, game content, and interface theme (Zhu & Ontañón, 2020). Zhu & Ontañón (2020) have highlighted two significant challenges persisting in personalisation. The first one is the need for a substantial amount of data about a specific player, including the labelling of this data, to model the player effectively. It is a challenging task for experts to determine a player's intent at any given moment during gameplay and to label it accordingly. The second major issue is deciding whether the model used for personalisation should be data-driven or theory-based. The theory-based approach relies on social sciences, developing models using literature and field experience, validated through empirical methods (Lucas et al., 2013).

In contrast, the data-driven approach, grounded in computer and natural sciences, prioritises collecting significant amounts of data and applying computational methods to derive new models (Yannakakis et al., 2013). Theory-based approaches require evaluation with the involvement of one or more domain experts. The predominantly open-ended nature of games and their extensive range of possible actions complicate the application of this approach. On the other hand, data-driven approaches are not dependent on experts and allow for the assessment of every action within the game as data. Using a data-driven approach can accumulate a much larger set of user data in a shorter period. Therefore, the data-driven approach is employed more extensively than the theory-based approach (Hooshyar, Yousefi & Lim, 2018).

Moreover, AI-supported performance optimisation in gaming refers to using AI techniques to improve the efficiency and quality of the gaming experience, focusing on aspects such as graphics performance, load times, and overall gameplay smoothness. The incorporation of AI facilitates notable advancements across a spectrum of pivotal areas like Dynamic Adjustment of Game Settings, Predictive Loading and Resource Management, Balancing Graphical Fidelity and Performance, and Network Optimisation for Multiplayer Games.

Furthermore, AI supports game testing and balancing by automating and enhancing various processes, significantly improving the efficiency, effectiveness, and depth of game testing, and ensuring a well-balanced gameplay experience for all players. Key domains in which AI enhances game testing include (1) Detection and documentation of bugs and errors, (2) Evaluation of game performance through code analysis, (3) Assessment of the game's compatibility with various hardware systems, (4) Optimisation of gameplay by identifying parts of the game that are excessively challenging or overly simplistic, (5) Examination of the game's usability and functionality.

2.3. Modelling techniques & AI tools for game development

In the evolving landscape of video game development, AI plays a pivotal role, particularly in the context of enhancing PX through data-driven design. The integration of AI in game design not only revolutionises how games are played but also provides a framework for understanding and improving upon the dynamic interaction between the game and its players.

Game development intertwines complex systems, aiming to create engaging PX through orchestrated game elements like narratives and visuals. Developers typically lean towards Unity or Unreal engines, while 3D modelling, a challenging aspect, often involves tools like Sketchfab, Blender, or Maya (Tacgin, 2020). Accurate 3D model generation with AI necessitates vast databases and reusable assets. The EU Horizon-funded gamecomponents.eu portal supports serious game developers by offering a platform for sharing advanced technologies and resources, distinct from commercial platforms, focusing on software over media assets (Westera et al., 2020).

To accelerate the creation of 3D designs, innovative AI tools like NVIDIA's NeRF and Kaedim have emerged. NVIDIA's NeRF generates realistic 3D models from 2D images through inverse rendering, significantly enhancing game environments and character realism. Kaedim, on the other hand, excels in converting 2D images to 3D models, requiring users to specify the model's complexity, thereby streamlining the design process for gaming applications. These tools are instrumental in creating detailed and immersive gaming worlds directly from artists' visions (Ratican et al., 2023).

Game engines now support advanced Reinforcement Learning algorithms enabling AI agents to act as virtual assistants or helpers. Techniques like Deep Q-Network (DQN), Asynchronous Advantage Actor Critic (A3C), Quantile Regression Deep Q-Network (QR-DQN), and Proximal Policy Optimization with Actor-Critic (PPO-AC) allow these AI agents to efficiently learn and adapt within game environments, enhancing both the development process and the player's experience (Mariselvam, Rajendran & Alotaibi, 2023).

The Unity Machine Learning Agents toolkit is favoured by developers for crafting and educating AI agents in Unity games. UnityML is a machine-learning SDK designed for Unity, facilitating the integration of TensorFlow's capabilities with Unity environments. This setup enables developers to apply machine learning techniques directly within game projects, enhancing game AI and interactions (An & Kim, 2023). It also encompasses algorithms such as A3C and DQN, which Mariselvam, Rajendran & Alotaibi (2023) employed in their study to create a virtual reality (VR) therapy game aiding children with Down syndrome. Their research demonstrates AI's capacity to personalise therapeutic activities, showcasing AI's value in healthcare and rehabilitation settings. An & Kim (2023) developed a simplified hyper-casual futsal game featuring three key player positions and used AI agents to simulate gameplay using PPO and Soft Actor-Critic (SAC) algorithms. The study evaluated these algorithms' stability and effectiveness, finding SAC to offer more stable gameplay outcomes. This work underscores the potential of AI in refining player-position learning and game strategy, highlighting SAC's advantages in exploring and optimising gameplay through advanced reinforcement learning techniques.

Investigations elucidate the advent of Promptable Game Models (PGMs), which furnish high-level semantic oversight in-game simulation dynamics, facilitating player engagement with the gaming milieu via intuitive language prompts (Menapace et al., 2023). Concurrently, Virtual Mine exemplifies the fusion of gaming AI with Unreal Engine, streamlining the creation of behavioural AI sans the constraints of inflexible scenario sequences, paramount for the efficacious execution of training simulations within virtual realms (Abu-Abed & Zhironkin, 2023). Moreover, the exploration of human-AI collaboration within Minecraft seeks to amplify cooperative endeavours in the accomplishment of intricate assignments, shedding light on the intricacies of cooperative dynamics within multiplayer contexts (Amresh, Cooke, & Fouse, 2023). Implementing serverless computing technologies within adaptable virtual ecosystems promotes scalability and operational performance, heralding a promising frontier for the bolstering of extensive multiplayer online engagements (Donkervliet et al., 2023). These innovations, in aggregate, signal a movement towards increasingly dynamic, interactive, and user-centric game design interfaces, heralding a future of enhanced and personalised gaming experiences across a multitude of virtual platforms.

These tools are designed to enhance gameplay, improve NPC behaviour, and create more immersive experiences for players. Additionally, the study considers the use of reinforcement learning algorithms and natural language processing to develop AI assistants (Mariselvam, Rajendran & Alotaibi, 2023), offering innovative solutions for inclusive gaming (Ye et al., 2020). These advancements indicate a significant impact of AI on game design, promising more engaging and personalised gaming experiences.

Ye et al. (2020) developed a new way to use deep learning AI for playing Multiplayer Online Battle Arena (MOBA) games, tackling the big challenges of the game's wide range of possible actions and complex controls. Their research shines a light on the difficulties and smart solutions needed to create AI that can handle the complicated aspects of MOBA games, which is quite different from using AI in simpler games.

Meanwhile, Liang et al. (2023) looked into how the AlphaZero algorithm can be used in Gomoku, a game about solving well-structured problems like chess. Their study showed how AI can get good at complex game strategies all by itself, marking a big step forward in how AI can help with making strategic decisions. The difference between AlphaZero learning on its own and the older ways of doing AI highlights a big change in gaming AI. There is a field where AI not only matches but in some cases, beats human thinking in games that require a lot of strategy. This change shows a future where AI, working on its own, doesn't just compete but does better than humans in games that need careful planning and problem-solving.

NLP is another significant constitute of developing interactive games. NLP has expanded the possibilities for enhancing NPC dialogues and interactive storytelling in games. This technology allows for more natural and engaging conversations with NPCs, enriching the gaming experience with deeper narrative immersion (Yannakakis & Togelius, 2018). Mariselvam, Rajendran & Alotaibi (2023) demonstrated this by employing CherubNLP to convert voice commands into meaningful in-game actions. NLP's versatility is further shown through its applications in sentiment analysis and automated essay grading, broadening its utility in game development (Westera et al., 2020).

Overviewing today's popular tools in the realm of game development shows that generative AI is transforming how content is created, offering novel ways to craft levels, narratives, NPCs, and items, enhancing player immersion and experience. Examples of platforms that embody this innovation include OpenAI Codex, which optimises coding processes, DALL-E 2, known for generating imaginative visual content, and AIVA, which composes unique soundtracks. These tools underscore generative AI's broad application, significantly enriching game development and creating more dynamic, engaging gaming environments.

According to McFarland (2024), the gaming industry has seen a surge in AI game generators that streamline development across various aspects. Tools like Scenario and Promethean AI enhance game art and character creation, while Ludo.ai focuses on adaptive gameplay. Rosebud.ai, Leonardo AI, and Meshy simplify the art generation process. For immersive environments, developers turn to Layer.ai and InWorld. Character development is bolstered by Hotpot.ai and Charisma. These AI platforms employ machine learning to tailor game elements, ensuring unique and narrative-aligned content.

Beyond game design, AI also contributes significantly to the development process itself. AI-driven tools assist in various aspects of game production, from initial design to testing and debugging. These tools streamline the development process, reduce costs, and improve the overall quality of the final product. Furthermore, AI can simulate player interactions in a controlled environment, offering developers insights into how changes in game design might impact PX before the game is released.

In conclusion, the integration of AI into game design is transforming the gaming industry by providing more immersive, engaging, and personalised experiences. As AI technology continues to evolve, its potential to further enhance game design and development remains vast and largely untapped.

3. Enhancing Realism and Interaction

3D modelling techniques have seen significant evolution, particularly with the incorporation of (VR) elements that demand high fidelity and real-time interaction capabilities. Lan (2023) discusses the progression of 3D modelling technology, emphasising its crucial role in creating realistic game environments and characters. The paper highlights how 3D modelling combines artistic design with computer technology, offering a profound sense of depth and realism widely utilised in the gaming industry (Lan, 2023).

Tang & Ho (2020) review specific 3D modelling techniques such as smoothing and mesh editing, which are vital for maintaining visual effects while meeting the computational demands of real-time VR interactions. These techniques enable designers to create detailed, yet less computationally intensive models, which are essential for seamless gameplay in VR environments (Tang & Ho, 2020).

The integration of AI in 3D modelling has significantly transformed the game development process, particularly in terms of automating and refining complex modelling tasks. This includes everything from character creation to environmental design, where AI assists in generating detailed, realistic models with less manual intervention. AI significantly influences 3D modelling by automating complex processes and enhancing the adaptability of game environments to player interactions. Ionescu et al. (2010) explore the use of AI in controlling real-time 3D sensor-based games, where AI adapts to player movements detected through 3D cameras and motion sensors. This adaptation requires a sophisticated AI engine capable of real-time decision-making and learning from player behaviour, showcasing how AI tools are crucial in developing interactive and responsive game environments (Ionescu et al., 2010).

One of the most compelling uses of AI in 3D modelling is in the context of real-time simulation and adaptation within games. Advanced AI algorithms are now capable of adjusting game environments in real-time to player actions or environmental variables, enhancing the immersive experience. For example, AI techniques can dynamically alter the topology of a game terrain based on player interactions or environmental factors, creating a more engaging and responsive game world (Prakash et al., 2009). AI also helps manage the complexity inherent in creating detailed 3D models. By employing algorithms that simplify models without losing detail, AI enables faster processing and rendering times, essential for smooth gameplay on various hardware systems. This is particularly vital in VR applications where maintaining a high frame rate is crucial for preventing motion sickness while preserving visual fidelity (Tang & Ho, 2020).

The next frontier for AI in 3D modelling lies in the areas of texturing and animation. AI algorithms are beginning to assist in the automatic generation of textures and the animation of characters, making these processes more efficient and realistic. As outlined by Prakash et al. (2009), AI's ability to analyse and synthesise complex data can be leveraged to create more life-like animations and detailed textures, which are essential for producing high-quality game visuals (Prakash et al., 2009). Looking ahead, the role of AI in 3D modelling is set to grow, with more sophisticated algorithms handling complex tasks like texturing, lighting, and animation more efficiently. The convergence of AI with cloud computing and real-time data analytics will further enable games to offer personalised experiences at unprecedented levels.

4. UI / UX / PX and Player Behaviour

Human-computer interaction (HCI) studies increasingly focus on computer games and try to provide a guide for the evaluation of games. With the growing influence of computer games in the media and software industry, experts from the field see the importance of analysing UX not only for productivity software but also for games. Although games offer a type of UX, they provide vast and more complex capabilities of interaction with a system. The aim of the software and design considerations as well as complex interaction patterns are fundamentally different than productivity software. Sanchez et al. stated that usability evaluations are not sufficient and indicated the difference between usability and playability (Sanchez et al., 2009). Such as studies on UX in various platforms and forms of applications, video games offer new perspectives for investigating the experience. Conventional UX and usability methods provide insufficient results when applied to games and as of this, the term shifted towards PX instead of UX. While UX research has mostly focused on usability and design topics, there is a lack of understanding concerning how the interactive modalities of games affect UX (Sutcliffe & Hart, 2017). A better understanding of the PX is necessary not just because it would help identify the interaction tendencies of players but also would allow industry designers and developers to produce games that would meet the desires and needs of the players.

UI, UX, and PX go hand in hand when creating and consuming a game by its nature. A game developer must consider the players' visual and aesthetic reception while the game is being produced. Games heavily rely on the players' interaction through its core and players usually expect holistic wording and fashion in it. A developer or a game artist could not consider UI, UX, and PX separately from the game itself. A game's fundamental AI could play many roles including UI, UX and PX when it's necessary in a game design. The relationship between AI and games is multifaceted, encompassing representational, historical, aesthetic, technical experimental and processual aspects. Adaptive difficulty systems like Crash Bandicoot 2 (Naughty Dog Studios, 1997) enhance PX by adjusting the gameplay based on real-time performance, games, like Left 4 Dead (Valve Corporation, 2008), utilise AI to create emergent gameplay experiences, enhancing player engagement and replay value and AI systems in games like Alien (Creative Assembly, 2014): Isolation and Soma (Frictional Games, 2015) can contribute to horror aesthetics by creating unique and unpredictable gameplay scenarios (Jagoda, 2023).

A player can experience AI in a game willingly or unwillingly depending on many conditions such as a player knowing what game AI is, player having an understanding of game development conditions or the opposite side as a game hiding its AI working principles to give a player more unique playing and using in-game presence. How PX AI in games, focuses on aspects such as player feelings towards AI, communication of AI decisions, interaction dynamics, social aspects, believability, creativity, and impact on game experience naturally differs from game to game (Warpefelt, 2022).

Metagaming holds a critical place in AI emplacement in games. According to Stephanie Boluk and Patrick Lemieux (2017), metagaming can vary from the game-playing aspects to many sub-gaming features like cheating and trading in a game. A player's inventory box and the game's inventory design can be considered as one of the subgaming features a game has and when examined in detail can open up new conversations such as aesthetic futures and AI support in a game.

Inventory design itself and its various uses can be discussed from the perspective of AI part and its help on aesthetics with different examples throughout digital game design history. "Inventory design in games is crucial when it comes to managing in-game items efficiently. In multi-user settings, an additional goal is to support awareness concerning a co-player's inventory and his/her available actions" (Wegner et al., 2017). Before everything else, an inventory is a UI in a game that the player uses as an access point to reach, manage and use the various items they have collected and given during their gameplay. Considering the UX goes hand in hand with a game's UI and its usage by the player during the game.

An inventory can be a pause to the players alongside the item management aspects of a game. Games like Doom (2020), Legend of Zelda (1986), and Resident Evil (1996) alongside their continuations all have their different perspective on the inventory design itself. Doom from the very beginning of its design gives the player an item wheel that slows the gameplay down to give the player a quick action to choose different weapons and also has a fast reading of the current level so the player can reassess the current gameplay. Legend of Zelda has an item bag that has dedicated buttons for the player to have quick access to their fast-use items when necessary. Resident Evil has a puzzle-like inventory system that forces the player to manage the limited area given to them with the geometrical calculations.

The game Zork (1977) had one of the first ideas of item holding in digital games that tied its item bag to the command ">inventory" to take the player to their item collection. The future of having a sub-menu dedicated to the player items started the idea of an inventory UI for games that immediately brought a different UX that was yet to be discovered and discussed by game developers.

Even though the importance of games is increasing rapidly, the literature does not have many studies focusing on PX. Along with the lack of studies on PX, there is no common definition of the terms 'playability' and 'player experience'. Among the clutter, none of the researchers were able to present a holistic set of heuristics for analysing playability.

4.1. Methodological Implications

Although researchers have presented new heuristics for evaluating the gaming experience, there are several different methodologies utilising heuristics (Aker, Rızvanoğlu & Bostan, 2017). Among them, there are; empirical evaluations, expert evaluations, inspections, and mixed-method approaches. Many of the methods used in Games User Research (GUR) are inherited from HCI and usability studies, and these methods mainly focus on either users' behaviour or users' attitudes (Medlock, 2018). Some methods can be applied early in the lifecycle of the game design such as focus groups, interviews or ethnographic field studies as well as card sorting, personas, and online surveys to envision what the game is going to be like. During the design and development phase, usability tests, physiological measurements, expert reviews, and heuristic evaluations can be used to assess users' behaviour, whereas surveys and playtests with interview sessions help to understand users' attitudes. In addition, many researchers have favoured the use of expert evaluation because of its advantages, especially in terms of applicability, and have proposed different sets of heuristics to do so. (e.g. Desurvire, Caplan, & Toth, 2004; Federoff, 2002; Korhonen & Koivisto, 2006). The common denominator in these studies is the introduction of heuristic sets to be used in PX and playability studies. However, they have not reached a holistic heuristic set approach that can provide a common ground in the field of PX.

Although the PX evaluations in the GUR field mostly utilise task analysis such as performance-based evaluations, hands-on playtests, or expert evaluations, there are a significant amount of exemplary studies utilising the use of questionnaires for assessing the experience. Researchers from different disciplines have different approaches to UX in games and aim to analyse experience with heuristic methods through expert evaluation, assessment based on players' performance, ad hoc surveys, usability questionnaires, or game-specific scales such as the GUESS questionnaire (Phan, Keebler & Chaparro, 2016). Some widely known examples of questionnaires used in the evaluation of gameplay experiences are the "Game Experience Questionnaire (GEQ)" (Ijsselsteijn et al., 2007), "Gameplay Experience Questionnaire" (Ermi & Mäyrä, 2005), "Player Experience of Need Satisfaction (PENS) (Ryan, Rigby & Przybylski, 2006) and Immersion questionnaire (Jennett et al., 2008). Phan, Keebler & Chaparro (2016) criticised the lack of psychometric validation for some of the GEQ (Game Experience Questionnaire (Ijsselsteijn et al., 2007) and PENS (Ryan, Rigby, & Przybylski, 2006). PXI (Player Experience Inventory) is another recent addition to the GUR toolbox, which is highly similar to GUESS in its content.

As mentioned above, the PX evaluations utilise these methods which could be understood as theory-driven perspectives, yet many companies are also benefitting from data-driven analyses at the same time. Because of its beneficial properties, such as gathering large amounts of data in a relatively short period, data-driven techniques for experience evaluations are rather accepted by the industry in the current state (Hooshyar, Yousefi & Lim, 2018). Nevertheless, combining both theory and data-driven evaluations would provide the most comprehensive analysis for designing better PX in the long run. Hence, the influence of AI not only would open up novel perspectives on understanding the player experience but also would possibly shed some light on understanding how the players respond to these curated experiences.

4.2. The Gamer Psychology

Humans sometimes tend to devote extraordinary amounts of time, energy, and attention to activities that, on their own, do not produce anything substantial. One example of this is, of course, games. So why do people play games? Research on the reasons for human gameplay reveals a complex interplay of factors. Hamari (2015, 2017) both emphasise the importance of enjoyment and usefulness in gameplay, with the latter highlighting the multi-purpose nature of games. Cyan (1965) adds a psychological dimension, suggesting that games can serve various intentions such as manipulation, desire for gain, and self-justification. Spiel & Gerling (2021) extend this discussion by highlighting the need for games that cater to diverse populations, particularly neurodivergent individuals, and the importance of supporting their self-determination. These studies collectively suggest that humans play games for a variety of reasons, including enjoyment, utility, and psychological fulfilment, and that there is a need for inclusive game design.

There have been various attempts to theoretically model the ways people are motivated to play, i.e. "enjoy" games. Since it is understood that different people may have different reasons for playing the same game. For instance, before analysing the reasons why people play digital games (also commonly known as video games), there were attempts at modelling the motivational behaviour of pen-and-paper role-playing games to guide the efforts of game designers to come up with successful products. One example is the GNS Theory set forth during the 90's by Ron Edwards (Appelcline, 2011). The three basic perspectives that the GNS theory explains are (1) Gamist (focused on strategic challenges and competition), (2) Narrativist (emphasising storytelling and character development), and (3) Simulationist (aiming for immersive, realistic experiences), which categorise different player priorities and preferences in tabletop role-playing games.

Consequently, as digital games continue to develop, researchers from various disciplines are moving away from the traditional perspective of games as mere entertainment media that provide players with enjoyment and pleasure. Instead, they are uncovering more intricate and fundamental human responses to games (Klimmt & Possler, 2019). Experience design should strive to create technologies that afford both pleasure and meaning, while Desmet & Pohlmeyer (2013) outlined that positive design may improve people's well-being by not only providing pleasure but also supporting personally significant goals and/or facilitating virtuous behaviour. Through an understanding of the factors that impact PX, game designers can produce games that are more enjoyable engaging, and meaningful for their players. It encompasses a wide range of factors, including emotional responses, cognitive engagement, social engagement, the player, and of course, the game itself. The importance of the PX in science extends far beyond the boundaries of entertainment. It is a dynamic and diverse field that offers valuable insights into many areas of knowledge and provides an insight into the intersection of technology, human behavior with social dynamics.

5. Limitations of AI in the game industry

The significant apprehension that AI, becoming a predominant tool for research, may 'dumb down the population' is noteworthy. The increasing reliance on AI for research tasks might inhibit individuals from developing critical research skills, a foundational aspect of education (Keiper et al., 2023). This concern highlights a potential downside to the convenience offered by AI, suggesting a future where the development of independent analytical skills could be compromised. The impact of losing these significant skills will be felt not only in the realm of education but also by game designers and developers, who may find themselves facing this dilemma.

Similarly, Inie, Falk & Tanimoto (2023) explore creative professionals' unease regarding generative AI. The core of their worry is the potential for AI to undermine their creative ownership and agency by autonomously producing high-quality content. This fear points to a broader existential crisis within creative fields, where the ability of AI to replicate or surpass human creativity could destabilise traditional notions of authorship and creativity. Moreover, a recent study with 494 university students revealed that the generative AI tool ChatGPT is particularly preferred when they face heavy academic workloads and tight deadlines.

A pivotal concern raised by the study is the association between ChatGPT usage and negative academic outcomes, including a heightened degree of procrastination, memory issues, and slipping grades. This points to a potential risk that excessive dependence on AI for academic tasks could impair learning behaviours and achievements (Abbas, Jam, & Khan, 2024). This observable shift in education and learning habits is likely to shape future work behaviours.

Even today, LinkedIn categorises job listings into three categories, one of which is AI jobs that require machine learning or related skills. These AI-related jobs, including non-technical positions, require knowledge of AI products and AI literacy, seeking individuals who can leverage AI tools for business purposes. This paradigm shift indicates an inevitable AI-dominated world in the near future, underscoring the importance of addressing AI dependency.

The advent of AI in the realm of the gaming industry heralds a confluence of promising prospects and formidable challenges, as elucidated by various scholarly inquiries. Rath & Preethi (2021) commend the prowess of AI in augmenting the verisimilitude and player gratification in video game creation, proposing a paradigm to prognosticate the future coordinates of in-game entities for the genesis of boundless virtual universes, thereby illuminating AI's efficacy in refining the intricacies of game design methodologies. In tandem, Gunawan et al. (2022) underscore the burgeoning allure of video games that incorporate intricate AI mechanisms, ascribing this trend to the heightened sense of engagement and amusement they furnish, which accentuates the critical role of AI in elevating the gaming experience. Nonetheless, the inventive and heuristic problem-solving faculties of AI conspicuously lag behind those of human intellect, as expounded by Levytskyi et al. (2023), delineating a pivotal impediment that game developers must surmount. Notwithstanding these impediments, the instrumental role of AI in the sphere of game development remains indubitable, enriching the gaming milieu with layers of complexity, immersion, and replay value. Collectively, these academic discourses advocate for the relentless advancement of AI technology to surmount its present limitations whilst capitalising on its potential to engender a paradigm shift in the gaming industry.

The rapid integration of AI in the gaming industry has ushered in a new era of complex and immersive gaming experiences. However, this technological advancement raises significant ethical concerns that must be addressed to safeguard player welfare and ensure fair play. One of the primary ethical challenges is the potential for AI to manipulate player emotions to enhance engagement, which, while increasing game immersion, can also lead to addictive behaviours or negative psychological impacts (Melhárt et al., 2023). This manipulation necessitates a careful ethical review to balance engagement with the mental health of players. Additionally, the vast amount of personal data collected by AI systems for enhancing gaming experiences introduces privacy concerns. Ensuring that data is handled responsibly, with clear communication to players about data use and securing their consent, is essential for maintaining trust and adhering to privacy standards (Jobin, Ienca &Vayena, 2019).

At the heart of a critical analysis of AI's application within the gaming industry though, the first-class citizen should be the question of "who benefits?" This timeless inquiry, which is also fundamental to Critical Theory, challenges us to scrutinise not just the technological advancements, but the socio-economic implications behind them. It prompts an examination of how corporations may leverage AI to streamline operations while potentially sidelining the human cost, thus obscuring the realities faced by their workforce from the consumers. Such an approach unveils the dual-edged nature of innovation, serving as a prelude to exploring specific instances where the pursuit of technological advancement may overshadow ethical considerations and worker welfare.

There have been recent examples of such cases. For instance; people may talk about a recent controversy surrounding an AI startup that promoted its technology as using sophisticated AI algorithms to generate highly detailed 3D images; which, in turn, could be used as assets for use in digital game production. However, investigations revealed that instead of relying solely on using AI, the company extensively used human workers, who were manually creating the majority of the images rather than AI (Sadler, 2023). In another similar case, a game company which supposedly used AI for the creation of many game assets during development later revealed that, as far as voice acting was concerned, AI was used to only "modify" and augment actual performance from human actors to greater effect. In the end, however, these actors themselves were found to be unlisted in the credits section of contributors to the game (Wilde, 2023). Therefore, at this point, it should be considered that in the human creation of assets, artists may be exploited in different ways ranging from being underpaid to remaining uncredited and it should be questioned how the use of generative AI may play a role in such situations. For one thing, it should be noted that in generating content, AI mostly relies upon its training data and all this training data has, in the first place, been generated by humans. It is therefore no surprise that AI-generated content may be considered design plagiarism, which has been demonstrated in the case of Palworld, whose game assets generated by AI have been found to bear a striking and controversial resemblance to the design of the popular franchise Pokémon (Zolotarenko, 2024). Last but not least, the use of generative AI has been suggested in the creation of not only visual assets; but also for in-game non-player character dialogues or complex narratives that are typical in roleplaying games. These seem to be efforts to remove the need for human intervention in the creation of elements in a game that especially cater to the narrative and simulationist gamer types. However, there are doubts on whether AI can handle these highly complex tasks as well as a human could; or, more importantly, whether it should (Acovino & Intagliata, 2024).

6. The Future of Artificial Intelligence in Games and Ethics

Everyone agrees that AI and deep learning will revolutionise all aspects of games and game development. In just a few years, the number of games that incorporate AI-based development will increase, and even with the emergence of a new consumer profile, the competitiveness of developers or studios that fail to catch the locomotive will decrease. It is inevitable that AI will develop with games in terms of both reducing the cost and improving the playing experience. At an early stage, game designers can mention that Text2speech (TTS) systems, known as speech synthesisers, will become widespread. These systems make it possible to create realistic and emotional voices for game characters by giving text input. AI-based TTS systems use AI techniques such as deep learning and NLP to produce more natural and human-like voice synthesis, taking into account the intonation, stress, speed and other language features of the text.

As the use of such tools becomes more widespread, it will be possible for studios to manage their budgets economically and minimise or eliminate at least some outputs in game production, which involves high profit-cost balance and risk. On the other hand, NPC chatbots that cover the entire game universe and have access to a large game knowledge base, boss fights that are not scripted in advance and adapt to the player's style, cheat detection systems that detect game hacks, aimbots and wallhacks and ensure that games remain fair, competitive and fun will shape the future of the game industry thanks to AI (Alarcon, 2018).

Deep learning is one of the types of AI as mentioned before, and Deep Neural Network (DNN) models, which are inspired by nerve cells in the human brain, can also help paint the future. Deep Neural Network models can improve their functionality over time by mimicking these networks, learning from data and updating their connections. DNN will contribute to the dimensioning of the industry, such as creating the movements and animations of characters or adding reality to the game world by simulating the movements of objects in the real world, improving and optimising data processing processes. As a result of all this, AI will free designers and artists from mundane and repetitive tasks. Development teams will be able to iterate much more on all aspects of games, improve the core elements of their games, and find that elusive fun factor that makes good games great.

Fumito Ueda's 'The Last Guardian', which tells a story based on the friendship between Trico, a giant bird-like creature, and a child, might be a good choice for exemplification. The game, which is interesting in terms of its design consisting of various environments such as ruined castles and vast forests, strong story and social mechanics, may be able to take the game experience to another dimension by improving its social mechanics through AI. In the game where the player controls the child character, she wakes up in a ruined building with Trico and then tries to get rid of the place she is in. However, she has not met Trico, who is chained and wounded, before and she has no idea why she is there. In order to free Trico from captivity, you must first be able to get close to him. While the game deals with themes such as love, trust and sacrifice, she must avoid sudden movements and try various ways to win Trico. While even the current version of the game presents some difficulties in manipulating the character, AI could add much more meaning to the social mechanics of this game. While the friendship between the child and Trico strengthens over time in the current game, the decisions she makes with AI can shake Trico's trust and move the game to another story and difficulty. AI may recognise your ability to persuade him, making the situation more difficult and forcing you to look for different ways to ride on Trico's back. An AI algorithm that she will be talking about a lot in the future is VAE (Variational Autoencoder), which is an AI algorithm that is used to learn players' preferences and play styles, and offers players more appropriate difficulty levels, enemy types and missions (Heikkilä, 2023).

Such AI systems that automatically learn players' play styles and preferences and adapt the game accordingly will sustain user motivation. Again, with narrative support, AI is also used to offer stories and branching missions that change according to player choices and actions and to create special content that recognises players and is specific to their preferences and characters. With the advancement of these technologies and studies, gaming experiences will become more realistic and personalised, and the ethical and social implications of the use of AI will be discussed.

Although discussions on the privacy of personal data of the use of AI have been popular recently, the most interesting one is the concern that AI characters in games behave like real people or exhibit human-like emotions, allowing players to empathise and establish an emotional bond with the characters. If the game developers elaborate a little more, equipping AI characters with unreal emotions may cause players to create false perceptions that negatively affect their relationships with real people and distort their perception of reality. In addition, the behaviour of AI characters that may lead to emotional manipulation or moral debates is considered to be one of the threats beyond ethics. Since the emotional reactions and social interactions of AI-controlled characters can affect players' psychological well-being, human relationships and societal norms, developer control over this issue needs to be carefully considered and adapted (Srivastava, 2023).

7. Discussion

As computer technology continued to develop, the video gaming industry has also evolved into a multi-billion dollar industry (Dillon, 2011). From an industrial standpoint, games therefore ended up becoming commercial projects with much greater potential of gain or loss, leading game designers towards efforts to come up with similar modelling structures that would better guarantee success and help them avoid financial ruin. It is thus no wonder to encounter player typology studies in academia dedicated solely towards video gamers, such as Trojan Player Typology. The Trojan typology, much like GNS, identifies six distinct player types in video games: (1) Story-driven (Play to experience stories in the game world and learn about character backstories), (2) Completionist (play to explore all elements of a game fully), (3) Escapist (play to escape from real life), (4) Competitor (play to win the game and behave in ways that contribute to victory), (5) Smarty-pants (play to improve intellect and enhance intelligence) and (6) Socialiser (play to build and maintain social relationships) (Kahn et al., 2015). Researchers have used this typology to develop a model of video game play, highlighting what aspects of motivation are related to satisfaction; realising that the greatest predictor of video game satisfaction was story-driven motivation (Patzer, Chaparro & Keebler, 2020). Therefore, ongoing research efforts that are trying to explain what it is that exactly makes games entertaining tell us that the narrative, which is an artistic output of human creativity that falls under the domain of aesthetics, is very important in player satisfaction. However, aesthetic creation may be listed among the highest-order cognitive skills and as such, it is also very difficult, if not impossible, to explain why, for instance, War and Peace by Tolstoy is such a greatly appreciated work of art. Moreover, even in games that do not seem to prioritise narrative, such as a massive online first-person shooter in the case of Battlefield: Bad Company 2, there may be times when game designers themselves may not be able to explain what made their game successful or entertaining (Yin-Poole, 2014). Therefore, the real problem here is this: if what renders games entertaining is the highest level of cognitive effort shown by humans and if at times designers and developers are not even sure what makes a game successful; how could they fully rely upon AI's help in this extremely ill-structured domain to achieve games that are beyond mediocrity? It should be therefore understood that in its current state, AI could better support the development of games that cater to, say, a completionist or competitor gamer much easier than it does games that cater to story-driven or socialiser players.

On the other hand, the complex notion of AI is frequently misunderstood and misrepresented, particularly in the business and startup ecosystems. This misrepresentation is evident in how startups describe their use of AI technologies. A significant analysis of European startups revealed that a substantial proportion of companies labelled as "AI startups" do not actively engage in AI-driven or AI-related activities (Schulze, 2019). This misuse of the term AI has been identified as a strategy by startups to attract investments and enhance their marketability. The findings from the report raise questions about how the term AI has become a blanket phrase for startups looking to attract investments, suggesting a dilution of the term's meaning and a potential misalignment between claimed capabilities and actual technological deployment.

AI's potential to perpetuate existing biases presents anotha er ethical challenge. If AI systems are trained on biased data, these biases can be reflected in in-game dynamics, potentially leading to unfair PXs (O'Neil, 2020). To combat this, developers must implement robust ethical frameworks that guide AI development and usage within games, focusing on fairness, transparency, and accountability. Regular ethical audits and the adoption of transparent AI systems can help identify and mitigate biases, ensuring that AI-driven innovations contribute positively to the gaming experience without compromising ethical standards. Thus, while AI can significantly enhance the technical capabilities of games, its deployment must be managed carefully to align with ethical considerations that protect and respect both individual players and the broader gaming community (Melhárt et al., 2023; Jobin, Ienca &Vayena, 2019; O'Neil, 2020).

Last but not least; although the industry has not entirely understood and formulated what makes a game entertaining; it sure has had great opportunities for analyzing what makes a game engaging and even addictive. This notion may be understood by the emergence of games in the smartphone market; the homogeneity of which, as compared to PC or console games, often stems from a strong commercial impetus to maximise profitability. Mobile games indeed tend to follow a formulaic approach with repetitive mechanics and themes to ensure steady user engagement and revenue through in-app purchases and advertising. This trend is driven by the lower entry barriers and the broader demographic of casual gamers on mobile platforms, who may be less demanding regarding novelty and depth than traditional PC or console gamers. Unlike PC or console games, which can afford to invest in complex narratives and innovative gameplay due to higher development budgets and a more dedicated gaming audience, mobile games focus on simplicity and addictiveness. The academic discourse, although not directly addressing the homogeneity, acknowledges the significant impact of these games on various demographics, suggesting an underlying motive of profitability that could be shaping the landscape of mobile gaming (Delos Santos & Cornillez, 2020). It should therefore also be asked: may AI be used in a fashion that helps amplify user engagement in the search for profit maximisation, making addictive elements in video games even more viciously addictive?

To sum up, the ways AI may be used in more rewarding gaming experiences may also be approached from an ethical standpoint. The question is who may benefit from using AI – the consumer or the manufacturer – and how this might be, bear repeating.

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