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# The Impact of AI on Video Games: Enhancing NPC Interactions, Player Experience, and Environmental Design

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**Abstract:**

Artificial Intelligence (AI) has had a profound and significant impact on contemporary society, encompassing various fields, including entertainment and gaming. With the continuous advancement and innovation of AI technology, its application in video games is bringing about revolutionary changes that fundamentally alter the player experience, making it more authentic and vivid. Players are not only able to enjoy a higher level of interaction but also experience a richer emotional engagement and immersion within virtual worlds. This paper will explore how AI shapes the future of gaming through its applications in non-player characters (NPCs), the construction of game worlds, and the analysis of player behavior. Furthermore, the article will discuss the cost challenges associated with developing efficient AI systems, as well as the limitations that current technology has yet to overcome. In summary, this paper provides a comprehensive overview of the pivotal role AI plays in transforming the landscape of modern video games and offers insights into future development trends, aiming to provide readers with a deeper understanding and reflection on the subject.

**Keywords:** Non-playable characters, artificial intelligent, procedural world generation,

## 1. Introduction

The earliest structure of artificial intelligence starts from Warren McCulloch and Walter Pitt's paper on neural networks, and it was officially acknowledged by people in 1956 when the word AI was invented by John McCarthy, Marvin Minsky, Nathaniel Rochester, and Claude Shannon. It reached its golden age between 1950 and 1970, and eventually it became a big factor in modern society.

In the 21st century, AI quietly sneaks into people's daily life and provides them convenience. They gradually shift their ability into other fields like entertainment and education. Video games, as another product that starts thriving from the 21st century, are also profoundly impacted by AI. AI can provide a more immersive and interactive world than before. Among these, video games have emerged as a significant

cultural and technological phenomenon, experiencing explosive growth in recent years [1]. They not only provide entertainment but also serve as platforms for social interaction and creative expression. The application of artificial intelligence in the gaming sector has fundamentally transformed the way we interact with virtual worlds, making the gaming experience more immersive and dynamic. The advancements in AI technology have enabled game developers to create more complex and realistic non-player characters (NPCs). Traditional NPCs often exhibit simple behavior patterns, with player interactions typically limited to a few predetermined options. However, as AI technology continues to progress, the intelligence level of NPCs is steadily increasing. In addition to the intelligence of NPCs, artificial intelligence plays a crucial role in enhancing player experience. AI can analyze players' gaming habits and preferences to offer personalized game recommendations and challenges. This personalized experience not only increases player engagement but also stimulates their desire for exploration. Moreover, the application of artificial intelligence in environmental construction offers new possibilities for enhancing the immersion and realism of games. Using AI technology, game developers can create more complex and detailed game environments. These environments are not only visually more appealing but also exhibit significant improvements in interactivity and dynamism.

Despite its advantages, AI faces several significant challenges. The development of AI is often costly and unaffordable for many developers, as creating a system tailored to a specific project requires substantial time and financial investment, along with ongoing considerations for computational power and resources. Additionally, the exploration of AI's impact on NPCs, player experience, and enhanced environmental construction remains insufficient. AI lacks true creativity and cannot surprise players, as its outputs are entirely dependent on human-created databases, something that is stationary and always unchanged. For example, when players first interact with a character in Cyberpunk 2077 on the street, they will feel fresh and interesting, but after they repeat these interactions a few times, players will immediately get bored and realized that it's limits. Besides its creativity, AI's adaptability is also concerning. There were cases for game developers to contain a large amount of data to achieve a more realistic AI, but the amount of work is huge, and usually the effect is superficial compared to its expectations.

This paper aims to explore the impact of artificial intelligence on the future of video games, focusing on three key aspects: NPCs, player experience, and enhanced environmental construction. These are the three main subjects that AI cast impacts on, and they are also few of the most important factors that make a player experience an authentic gameplay experience. To examining these aspects, this paper tends explain how AI's innovation reshape game developing experience and redefine the border between reality and games.

Big Body:

## 2. Application of AI Technology on Game NPC

### 2.1 NPC's Diversity and Adaptability

Baldur's Gate: Dark Alliance is a game published on PlayStation 2 in 2001. This game is famous for its rich and diverse NPC's dialogue. After players finish their first mission, they will meet their first NPC, the vendor. Players can experience 10 kinds of different and interesting dialogue when they interact with him. After the 15$^{th}$ time, his monologue will become repeating and boring [2].

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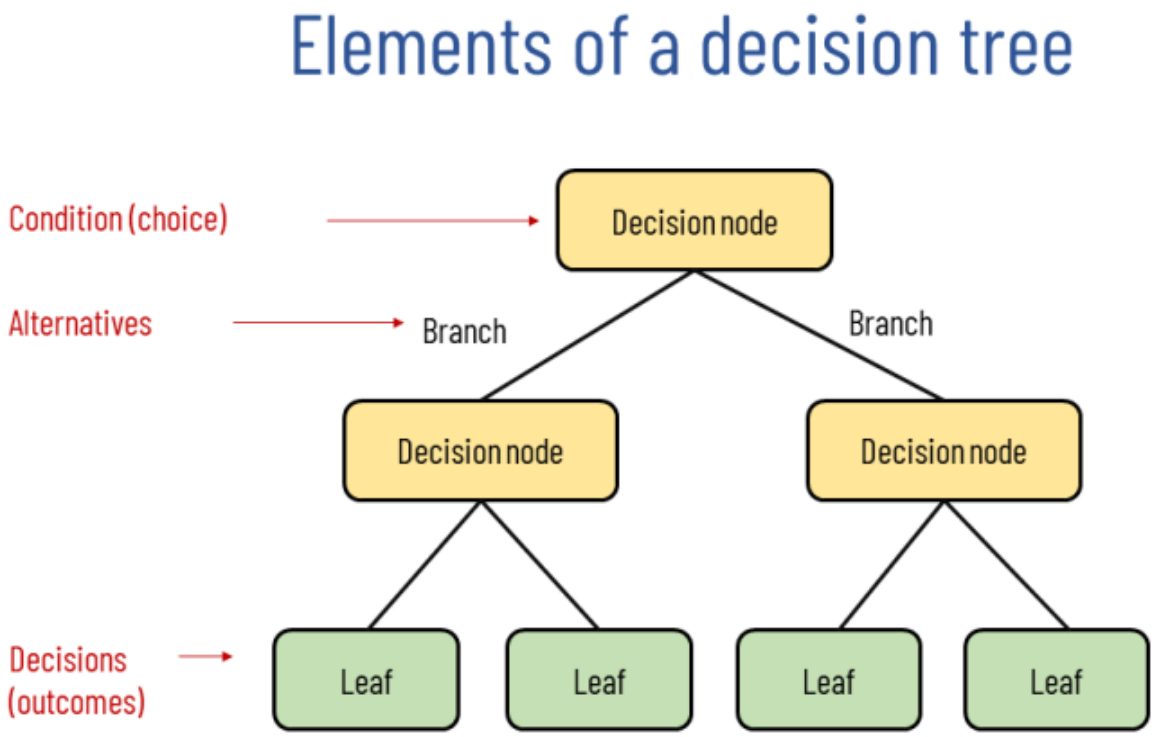


**Fig. 1 Decision tree [3]**

This reflects a limitation in traditional game design, where the dialogue content of NPCs is fixed and lacks sufficient dynamic variation to maintain player interest. To overcome this limitation, modern game development has introduced artificial intelligence technology, particularly in the intelligent behavior design of NPCs (Fig.1). A new type of memory mechanism model known as the "Memory Warehouse" mimics the functioning of the human brain, creating two important memory components for AI: long-term memory and short-term memory. This design allows NPCs to retain new information and interact with players in a more natural manner, while also advocating for a memory updating system that allows NPCs to forget some old memories. Such a design helps maintain the freshness of NPC dialogue, reduces repetition, and ultimately enhances the player's gaming experience [4].

In game design, a decision tree approach can be used to describe the behavior logic of NPCs. For example, in "Baldur's Gate: Dark Alliance," the merchant's behavior can be modeled as a decision tree. The root node of the decision tree could represent the player's first interaction with the merchant, with subsequent branches representing different dialogue options. As the player interacts more with the merchant, the structure of the decision tree becomes increasingly complex, incorporating adjustments to the dialogue based on the player's actions and choices [5]. The goal of this memory updating system is to maintain a balance between long-term memory, short-term memory, and forgetting. In this way, NPCs can dynamically adjust their dialogue based on the player's behavior and game progress, even developing different storylines according to the player's choices and actions. This intelligent design not only enhances the realism of the game but also provides players with a more personalized interactive experience (Fig.2).

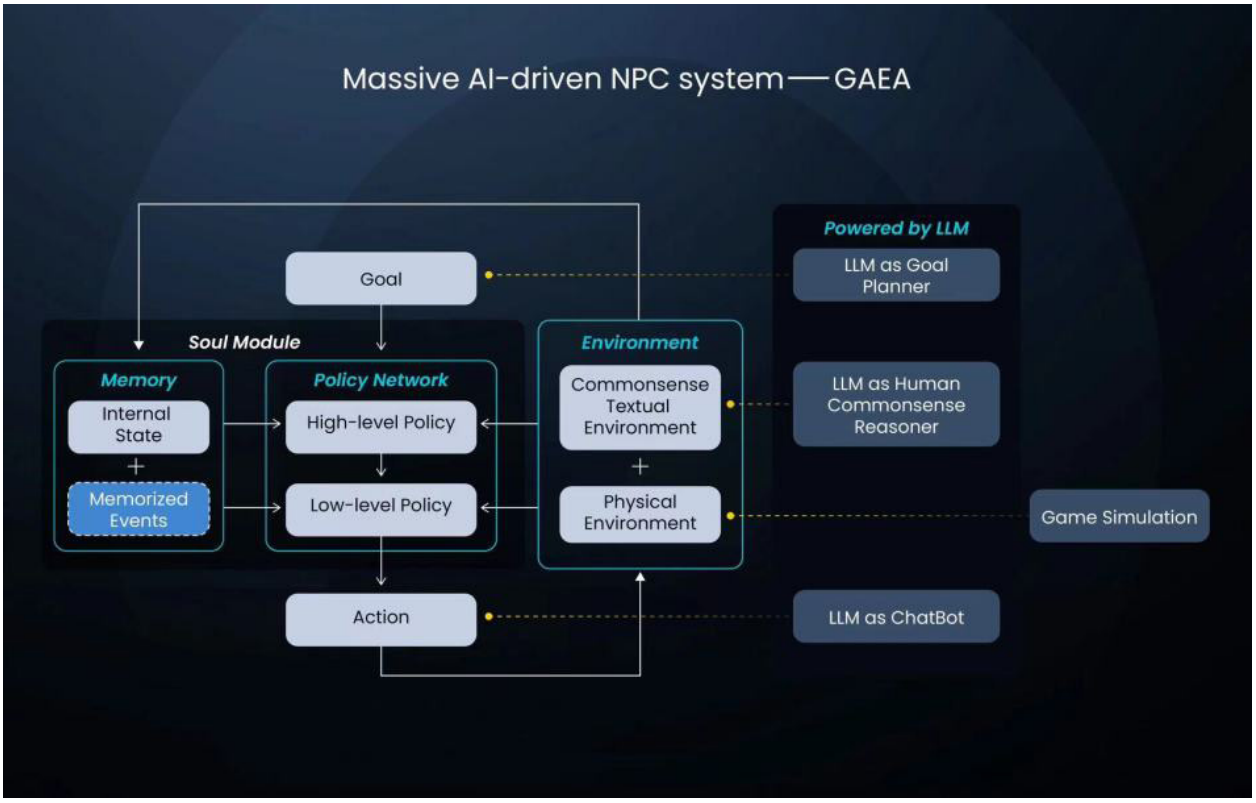


**Fig. 2 Massive AI Driven NPC System [6].**

## 2.2 Emotion and Personality Simulation

AI, as a machine that operates according to specific coded instructions, is inherently incapable of generating genuine emotions. However, an innovative approach involves the application of virtual agents within NPCs in video games, endowing them with a system that allows them to understand and respond to various emotional states based on relationships, emotional contexts, and environmental dynamics. To achieve this, developers can leverage affective analysis algorithms and affective computing frameworks to imbue NPCs with lifelike qualities, thereby creating a more immersive gaming experience.

By integrating advanced frameworks such as FAtiMA (Fearnot Affective Mind Architecture) and ERiSA (Emotionally Realistic Social Game Agent), NPCs can not only identify the categories of players' dialogues but also apply appropriate emotional responses accordingly. Additionally, ERiSA considers the personality traits and relational networks of NPCs, offering the most suitable behaviors and responses for each interaction. Despite AI's fundamental inability to detect emotions authentically, the construction of specialized systems can guide AI to mimic human emotional communication [1].

The Affective Analysis Algorithm serves as a critical component, acting like a nuanced interpreter of emotional content. This process unfolds from a macro to a micro level: initially, the algorithm categorizes received statements into positive, negative, or neutral expressions; subsequently, it further analyzes the specific emotional elements contained within, such as joy, anger, or sadness. Finally, by meticulously dissecting the emotional nuances of each term, the algorithm discerns the subjectivity or objectivity of statements, thus generating more accurate interpretations of emotional content. This multi-layered emotional parsing mechanism enables NPCs to interact with players in a more human-like manner, thereby fostering a richer and more engaging game world [7].

## 2.3 NPC Automatic Generation

Containing a large variety of NPCs with different characteristics and traits in the game is a huge task for game developers. It a time-consuming job, and it is hard to meet the expectations. AI, with its intelligent generator, can help developers compose different NPCs based on the assets database that it contains, making a more efficient and convenient game developing environment.

Procedure Content Generation is a system that automatically generates maps, levels, textures, and most importantly, NPCs. When generating NPCs, one thing to keep in mind is that each NPC obtains a different culture and ethnicity. PCG achieves this though few steps. First, it

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focuses on the NPC's appearance, body size, face, skin color, hair style, etc. Next, it generates its personality, characteristic traits, and speaking habits. To achieve a better and more complex NPC model, PCG utilize a machine learning model, which review previous models, and update to create better NPCs. Other techniques like genetic algorithm and Dynamic NPC Relationship provide an intricate relationship web to the character and applies more natural response toward players [8].

Video games such as Cyberpunk 2077 and Elder Scroll utilized this system and create various crowds wandering in the city. Each character looks different to the next one. The artists need to provide the base model for each component of their body, like hairs or faces. AI can create characters based on their surroundings, and their culture.

This design plans to give players a more realistic environment. While most of them aren't realistic enough, they can only repeat certain lines of dialogue. A true realistic world should be randomly generated people speaking entirely random dialogues, and they should also reply to platers like an actual human. These challenging tasks require a large amount of time and patience, so this is where AI comes into play. AI can calculate faster than humans and give immediate responses after players speak. Besides speaking, AI can also control NPCs to interact more naturally than human edited NPCs.

# 3. Game Environment and Content Making

## 3.1 World and Detail Interior Generation

Creating both aesthetically pleasing and functional game worlds is a challenge that game developers often grapple with. To address these challenges, designers have increasingly turned to advanced technologies and strategies, such as procedural generation and intelligent content placement. Procedural generation can be likened to an indefatigable architect who randomly generates various game elements according to specific rules, from simple landscapes and terrains to complex architectural structures, and even compelling narrative arcs. Imagine each time you start the game, it's like stepping into a completely new world where mountains, rivers, and forests are different every time. This experience is undeniably thrilling, as it provides infinite possibilities and makes each gaming session a fresh adventure.

Intelligent content placement acts more like a wise director who dynamically adjusts the positioning and distribution of in-game elements based on the game's progress. The goal is to maintain a reasonable difficulty curve that is neither too easy nor too difficult. For example, when a player advances through a role-playing game, the enemies they encounter become progressively stronger, ensuring the combat remains challenging while avoiding the risk of players becoming disinterested due to ease.

The application of these technologies not only enhances the player experience but also significantly reduces the workload for developers. In the past, constructing a game world required extensive manual labor, from terrain design to item placement, all of which needed meticulous refinement. Today, procedural generation and intelligent content placement can automate much of this foundational work, allowing developers to focus more on core gameplay mechanics and innovative features.

## 2.2 Adaptive Environments Interaction

Constructing the map is not enough, AI is still needs to add features and details to the map to make it seem realistic. Everything on the map should follow physical laws. When the player's character is walking on a lawn, players should be able to see the grass swaying and moving in the breeze. AI developers need to adapt new systems such as dynamic simulation and real-time decision-making to the AI's system.

Map generation is one big element in a game. It decides where the player should explore. A well-developed map can provide players with a unique experience, and a sense of achievement after they finish the map, but a single map will make the players get bored quickly. Even though game developers created roguelike maps, allowing more variations on map choice, its essence is still a collection of pre-built maps shuffled and put together. On the other hand, AI can create totally random maps that are bigger in size, and more variations. AIs don't have pre-designed scenarios in their database, so they won't stick with traditional art and structure. This also leads to a problem: The maps are entirely random, so the player might encounter bugs during their gameplay experience. Hence, it's important how game developers set up AI's basic operating method.

# 4. Player's Behavior Analysis and Recommendation

## 4.1 Profile and Classification

Each player explores the game world in their own unique way, and their battles within the virtual realms are distinctive. These differences lead to varied reactions and behaviors when faced with similar situations, resulting in different groups having their own standards for evaluating

game experiences. To enhance the overall gaming experience for players, AI needs to build a system that caters to diverse needs. This process involves the creation, segmentation, and recommendation of content based on player profiling, behavior analysis, and engagement tracking.

The Bartle Taxonomy of Player Types categorizes players into four primary types: Achievers, Explorers, Socializers, and Killers. The first two traits are more prominent in single-player games where players individually explore unknown worlds; the latter two are more evident in multiplayer competitive environments such as League of Legends or Counterstrike: Global Offensive [9].

For example, Ubisoft's Tom Clancy's Ghost Recon Wildlands updates content and narrative in real-time based on player interactions within the virtual world. NPCs adjust their aim skills according to the player's past performance. The game offers a non-linear mission structure, allowing players to choose their mission order freely. Ubisoft also tailors' enemy strategies based on the player's preferred weapon type and combat style.

In competitive games like League of Legends or PUBG, the system not only stores player profiles but also matches opponents based on their performance. If a player's actual ability exceeds their current rank, they will quickly rise through the ranks to face stronger opponents; conversely, they may be adjusted to a lower rank to encounter easier opponents.

### 4.2 Personalized Content

Recall when Spotify launched "Discover Weekly" in 2015, showcasing the power of personalized recommendations. This feature creates customized playlists based on users' listening habits. A similar logic can be applied to games-while players may share similar preferences, everyone has a unique pattern of behavior. This is why, in the gaming industry, there is a need for a more refined approach to identify unusual behaviors.

This unique approach includes several aspects: personalized recommendation. predictive content generation, and branched storylines. AI driven personalized recommendation for players, like what is mentioned in paragraph 1, programs like Spotify published such system to focus on their customers' own interest and favor. This type of system is also applicable to games. Some common applications that also utilized this strategy include steam and epic, which sell products based on the tags from their customers' played games. Another personalized content is from games like Red Dead Redemption 2 and World of Warcraft where players face unique and different content based on their previous interactions. If the player maintains a good fame during the game, then those NPCs will have a friendly relationship with the main character. There will be treats and rewards during the gameplay. In contrast, if a player chooses to do something bad and become notorious, then those NPCs will fight against the player's character and provide more battle scenes.

The last feature that it provides is a vivid branched storyline, where the player can become totally immersive in the story and take deep consideration of every choice they created. One representative game of this kind is Detroit: Become Human. This game focuses on telling the story based on the player's actual thoughts and emotions, every character in the game is possible to die, and every single choice matters.

### 4.3 Difficulty Adjustment

Requirements for difficulty are different for different people. Some elderly people and young kids prefer easier games and focus their experience on the game's story. While other people, like teenagers and gamer's like challenges, they always pick the hardest mode to win the game. However, a lot of games don't provide players too much choice, or even no choice, to pick their own difficulty because it requires a lot of time to adjust the data. AI, with its excellent calculation abilities, has become the best choice for data moderator. With its calculation abilities, it can easily adjust the best difficulty for different players and provide a more convenient environment for game developers to develop games.

DDA, which stands for dynamic difficulty adjustment, is a term that refers to real time adjustment to games' difficulty based on players' performance. When AI detected the players' performance, PCG (procedure content generation) starts generating easier or harder mobs and traps. After that, adaptive AI records this data into its database and saves it for the next game[10].

Some games like Left 4 Dead adopted this system, and it updates the difficulty synchronously. Based on the number of times that the player died, it automatically generates the mobs closer or farther. Its innovative use of AI director creates a more comfortable gameplay environment for the players. Besides the position of the mob, L4D2 also provides a variety of mobs that are more powerful and intelligent. These components create a more intense and fun gameplay experience for players (Fig.3).

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**Fig. 3 Left 4 Dead 2 Mob List [11].**

### 4.4 Cheating Detection and Prevention

Fair competition is the foundation of the gaming world. As technology advances, particularly with the development of AI, game developers are employing various methods to ensure that every player can enjoy a fair gaming experience. After all, nothing ruins the fun of a game more than discovering someone is cheating. AI plays a critical role here. It can analyze players' behavioral patterns to detect potential cheating activities. For example, if a player suddenly exhibits superhuman shooting accuracy or incredibly fast reaction times, these could be signs of using cheat tools. By continuously monitoring such behaviors, game companies can take swift actions to prevent unfair competition.

One of the most effective methods to prevent cheating is its ability to detect cheating tools. A commonly used anti-cheating system is Punkbuster, a widely used system in various fps games, like PUBG. This system automatically detects outside interferences and unauthorized mods [12].

## 5. Coclusion

This paper explored the influence of video games through a few key points: NPC behavior, game world generation, and players personalized experience. It analyzed how AI enhances NPC diversity and adaptability, and allowing characters to evolve based on player's decision and interaction. Another function that is mentioned is AI's ability in personalizing player experiences, which highlights how AI varied its content, difficulty, and challenges based on the player profiles. In addition, the paper addressed AI's application in environmental construction, especially emphasizing its capacity to generate randomized game worlds through procedural generation. The paper post concerns that while AI significantly enhances gameplay experience, it still faces challenges like its insufficiency in creativity. As for right now, AI cannot totally replicate human emotions or create unpredictable dynamic environments without an extensive amount of database. Despite these limitations, AI remains a revolutionary impact in the gaming industry, with continuous advancements promising to overcome current existing obstacles. Looking forward, further research and development in AI technologies are essential to fully unlock their potential, enabling a new era of more interactive, personalized, and lifelike gaming experiences.

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