

Analysis of the State-of-art Implementations for Artificial Intelligence in Gaming

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Abstract. As a matter of fact, Artificial Intelligence (AI) stands out as a crucial area of interest, seeing significant integration across diverse sectors. The gaming industry's evolution has further escalated the integration of AI, leading to an increased necessity for sophisticated game AI systems. These systems, crafted to emulate the cognitive actions and decision-making abilities of humans, enable the automation of game creation and dynamic game management. In order to give a better account of the application of AI in the game field, this study will introduce the following contents. First of all, this study will introduce what is AI, the second is to introduce the three kinds of application scenarios of AI in the game field; the third is to make a prediction on the future fusion of AI and the game industry. According to the analysis, the current features as well as limitations and prospect will be demonstrated at the same time. Overall, these results shed light on guiding further exploration of AI in gaming.

Keywords: Artificial Intelligence, Gaming, in your paper.

1. Introduction

In the realm of modern technological advancements, artificial intelligence (AI) stands out as a crucial area of interest, seeing significant integration across diverse sectors [1]. The gaming industry's evolution has further escalated the integration of AI, leading to an increased necessity for sophisticated game AI systems. These systems, crafted to emulate the cognitive actions and decision-making abilities of humans, enable the automation of game creation and dynamic game management [2]. Tailored AI frameworks and algorithms, known as game AI engines, serve to enhance the efficiency of game production processes. Interactions with virtual characters, powered by advancements in voice recognition and natural language understanding, are pivotal in enriching the gaming experience and augmenting the interaction between the game environment and its players [2-4].

From gaming's inception, AI has been an integral component, manifest in classics like Mario and Contra as well as modern titles such as King and Chicken. Initially, game AI's role was to expand the game's narrative and fulfill players' quest for success. However, today's AI competes adeptly with the most skilled human players across numerous titles, a feat made possible by enhanced computational capabilities and algorithmic advancements [5]. The basic structure of such AI can often be traced to the Finite State Machine (FSM), a conceptual framework encapsulating a limited set of conditions and the transitions and interactions within these states. This framework serves to map out an entity's state transitions over time and its reactions to external stimuli. Essentially, it's a strategic construct to predefine all conceivable scenarios and engineer appropriate responses for AI execution, as seen in the Non-Player Characters (NPCs) in various games [6-8].

Currently with the continuous development of artificial intelligence, the connection between the game field and AI has become closer, and the current application of artificial intelligence in the game mainly has the following three kinds of three application scenarios, one is the AI intelligent game engine; the second is the neural network algorithm; the third is the AI operating system. In order to give a better account of the application of AI in the game field, this time this paper will introduce the following contents: one is to introduce what is AI, the second is to introduce the three kinds of application scenarios of AI in the game field; the third is to make a prediction on the future fusion of AI and the game industry; and the fourth is to summarize.

2. Basic Descriptions

Since the inception, artificial intelligence has become increasingly mature in theory and technology, and the field of application has been expanding, and its application in gaming is extremely broad. For players, the expansion of games in terms of gameplay and development can bring about a multitude of more interesting and more refined games; it will also make the experience more special, personalized, and evocative. For the industry as a whole, more innovations and technological advances will drive the industry to flourish and become more benign.

3. AI Intelligent Game Engine

Game AI engines have transformed development workflows by offering robust platforms that simplify algorithmic complexity, thus making game design more accessible. These engines are instrumental in automating the design pipeline, from easing the creation burden with intelligent map generation to the dynamic crafting of NPC behaviors. The industry acknowledges three primary categories of game AI engines that are in widespread use today: those specialized for rendering intricate AI-driven game environments, those that focus on the autonomous generation of NPC personalities, and comprehensive game development engines that serve as an all-encompassing toolkit for game creation [9].

Game screen design needs to constantly clarify the role of AI in various fields. The main structure of the game engine consists of three layers, i.e., the high, middle as well as low level interface. Specifically, the high-level interface's primary function is to facilitate a user's strategic command over in-game character behavior, including combat and movement tactics through adaptable algorithmic patterns. It interfaces with the foundational animation and processing layers to expedite the rendering of gameplay visuals. By optimizing these interlayer interactions, the system is designed to execute sophisticated maneuvers within the game, thereby elevating the user experience to a premium standard. The role of the bottom layer interface is to control the character's animation and basic movements and provide physical calculation and 3D rendering and other functions, but the function of the bottom layer interface can only manipulate the character's direction and position, and can't carry out the jumping action, which need to be accomplished by the middle layer interface. The Fig 1 and Fig. 2 show the rendering of the image.

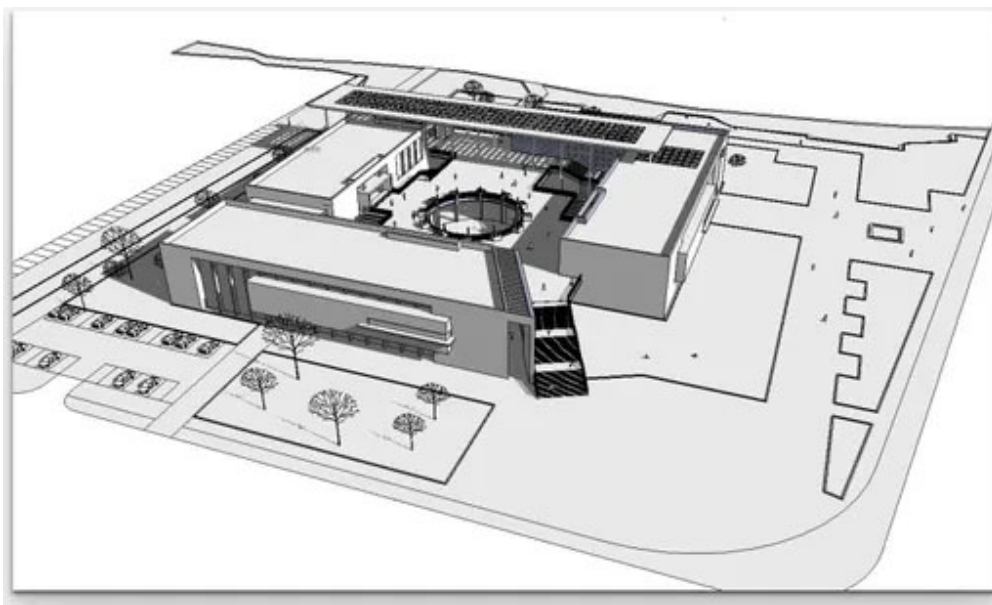


Figure 1. Image before rendering.



Figure 2. Image after rendering.

4. Neural network algorithms

To enhance the intelligence of NPCs, the gaming industry employs four predominant AI strategies: Finite State Machines (FSMs), Monte Carlo Decision Trees (MCDTs), Neural Networks, and Genetic Algorithms. FSMs, being the traditional choice, are expertly crafted, pre-set algorithms extensively used in earlier games. On the other hand, MCDTs evaluate outcomes through a series of potential future states, not just the present, resulting in more dynamic and custom gameplay experiences. Although this adds depth to player interaction, it comes with higher complexity and costs, along with a lack of adaptability since MCDT-based NPCs do not possess the capability to learn from and adapt to a player's repetitive patterns or strategies [10]. Fig. 3 shows a Monte Carlo decision tree.

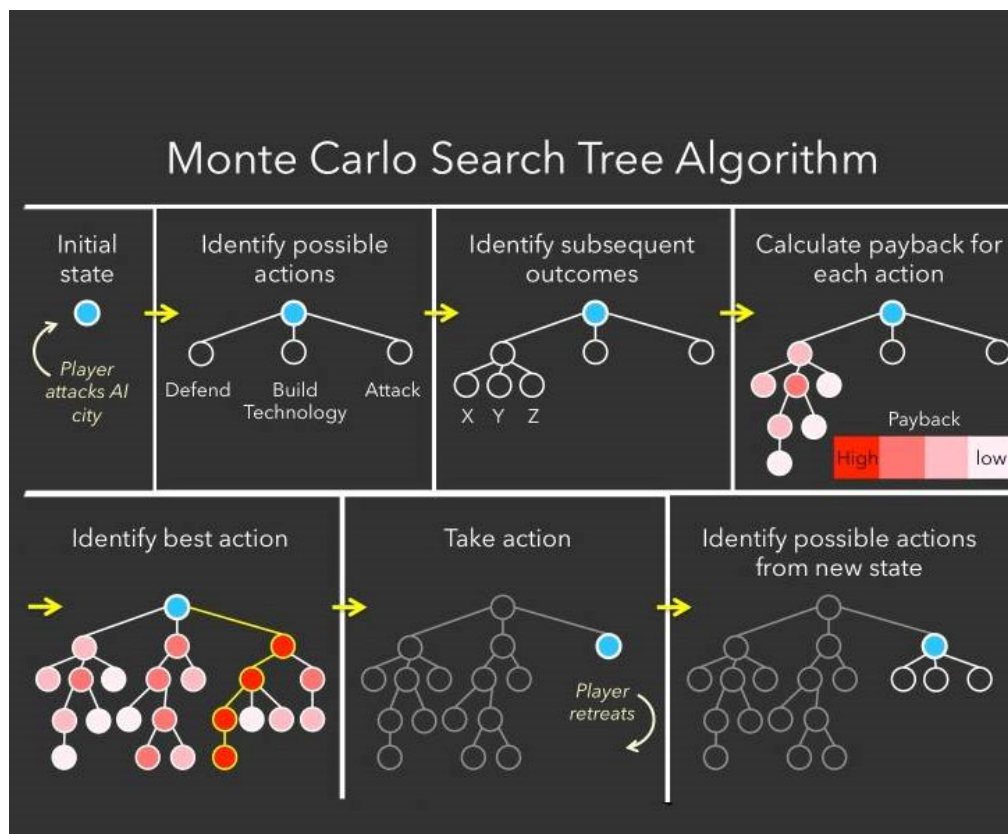


Figure 3. A sketch of Monte Carlo decision tree.

Neural Networks and Genetic Algorithms have been deployed to address the challenges of machine learning in game development. NPCs powered by neural networks often exhibit 'non-linear' and 'non-deterministic' behaviors, introducing significant challenges in game stability and maintenance as their unpredictability escalates with ongoing learning, complicating the debugging process in the game's later stages. Conversely, Genetic Algorithms embody a methodology for decision-making that mirrors the principles of evolutionary survival, with the system continuously evolving towards optimal gameplay tactics. This adaptive mechanism allows in-game adversaries to evolve over time, learning from previous defeats to counteract a player's tactics more effectively. Consequently, the more adept a gamer becomes, the more formidable the opponents generated by these algorithms turn out, creating a never-ending escalation of challenge. In the console game SHMUP, the game developers put in place enemies that utilize genetic algorithms. They had the player fight off the AI of an enemy that had evolved over many generations, and when that generation was defeated again, the genetic algorithm ranked the AI and used them to create a new generation of enemies to fight the player. Genetic algorithms have been used in the famous evolutionary strategy games Spore and the Monster series.

5. AI operating system

The adoption of Artificial Intelligence (AI) in gaming has surged, tracing back to its conceptual forerunner, the Robotics Operating System (ROS), introduced by Stanford University in the latter part of the 1960s. An AI operating system encompasses the capabilities of a standard operating system, enhanced with features like voice recognition, computer vision, motor system integration, and cognitive-behavioral modeling. Such systems in the gaming context have the novel ability to interpret player input directly, transitioning the industry from traditional button-based inputs to a more fluid and intuitive analog interaction paradigm [11, 12].

AI's incorporation into gaming not only revolutionizes the sector but also propels advancements in practical technologies. Gaming provides a precise and controlled testing ground for real-world applications, with racing games, for instance, contributing valuable insights for the development of autonomous driving technologies. AI's reach has extended beyond gaming into sectors including healthcare, education, and finance, predicting its future as an essential component across multiple domains.

In conclusion, the theoretical predecessor of the AI operating system is the robot operating system, and its application in gaming has become more and more extensive. the application of AI has expanded from the gaming industry to other fields.

6. Future Prospects

Every studio is beginning to assign a dedicated programming team to AI. Designing games in the early stages of game development. They spend more resources and time building diverse, competent and well-behaved non-player characters (NPCs). More developers are using high quality AI design to make their games stand out in an increasingly competitive market. The ideal goal is to keep the player immersed in the game at all times. On this basis, game will be more interactive. It might give rise to a whole new type of game.

7. Conclusion

To sum up, through the game show one can see that game AI is developing rapidly in the direction of higher quality, more adapted to the needs of players, and bringing extraordinary experience to players. Perhaps the ideal and greatly anthropomorphized game AI one is looking forward to will soon be realized, and add more joy and color to our lives. As a matter of fact, game AI will also add a very important part to human research in artificial intelligence. Overall, these results offer a guideline for implementation of AI techniques in gaming.

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