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Research on Artificial Intelligence Algorithm and Its Application in Games

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***Abstract*—With the in-depth development of intelligent technology, game artificial intelligence (AI) has become the technical core of improving the playability of a game and the main selling point of game promotion, deepening the game experience realm. Modern computer games achieve the realism of games by integrating graphics, physics and artificial intelligence. It is difficult to define the meaning of realistic game experience, but generally speaking, it usually refers to the immersion of the game and the intelligence of non-player characters in the game. As the technical core of improving game playability and the selling point of many commercial games, game artificial intelligence gives players a way to interact with non-player characters in the game, and promotes the realm of game experience to a higher level. Based on this, this paper analyzes the history and present situation of artificial intelligence in game development, and puts forward the possible changes and impacts of artificial intelligence technology based on machine learning on game development in the future.**

Keywords—Artificial intelligence, Game experience, Machine learning

I. INTRODUCTION

With the rapid development of all kinds of computer game engine, especially the development of computer game industry [1]. With the significant improvement of computer hardware level, the game engine used by game designers is constantly updated. As the basis of game development, game graphics technology is updated every year. The quality of a game depends largely on graphics technology [2]. However, with the increasing perfection of graphics technology, people are no longer satisfied with the beautiful and gorgeous audio-visual experience, but instead pursue deeper game connotation [3]. Modern computer games achieve the reality of the game by integrating graphics, physics and artificial intelligence (AI) [4]. Realistic game experience is difficult to define its connotation, but generally speaking, it usually refers to the immersion of the game and the intelligence of non player characters in the game [5]. A successful game that is popular in the market must have not only gorgeous visual effects and pleasant hearing, but also highly realistic artificial intelligence control system [6].

When game developers apply AI to computer or game console games, they will make the majority of players feel that the enemy controlled by computer AI system (NPC) they face has human intelligence just like the real enemy, so that the players can leave a realistic experience [7]. Game developers need to find innovations that further alienate their own games [8]. Because game AI has not made great progress like graphics technology and physical simulation technology, it provides a space for game innovation and alienation. The application of graphics technology and physical characteristics simulation technology has been insufficient, making a game unique [9]. As the technical core of improving game playability and the selling point of many commercial games promotion, game AI gives players the way to generate behavior and emotional interaction with non player characters in the game, and promotes the realm of game experience to a higher level [10]. How to endow the non player characters with credible intelligence, so that they can more truly reflect the human like behavior, emotion, and even self-learning to adapt to the changing game environment, has become a hot spot of game research and development at home and abroad [11]. This paper analyzes the history and current situation of AI in game development, and puts forward the possible changes and influences of AI technology based on machine learning on game development in the future, including intelligent game design, intelligent iteration and subsequent development strategy generation and execution ability, highly intelligent role, dynamic adaptation and constantly changing game experience.

II. KEY TECHNOLOGIES OF GAME AI

Artificial intelligence technology is mainly based on computer. It studies the activity of transforming into artificial intelligence through electronic technology. Its overall design shows intelligence and can achieve the work that human intelligence can accomplish. Now, there is a clear difference between the type of artificial intelligence in commercial games and the type of artificial intelligence as a player playing games. One of the characteristics that distinguishes human beings from animals is the ability of learning and innovation. Animal learning mostly stays in the stage of conditioned reflex, while human learning has developed to the height of multi-dimension, rational speculation and creation and invention. Many problems in game development can be solved perfectly by traditional qualitative AI techniques such as state diagram search and regular script. The application of artificial intelligence technology in games is mainly to design immersive scenes for gamers, so that players can immerse themselves in this relatively real situation. Under normal circumstances, the computing capacity and storage capacity of the general computer cpu are very limited. Using artificial intelligence technology to program and calculate the characters in the game, the interaction between the whole game and the

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players is enhanced, and the sense of reality is also increased. The finite state machine can be used to describe the intelligent behavior of non-player characters. However, when characters need to deal with more states, the finite state machine will become very difficult to understand and maintain because of the explosive growth of scale.

In a grid-based system, the essence of path search is to use an algorithm to find the shortest path from the current node to a certain target node. Modern games are using variations of these technologies. Of course, artificial intelligence in commercial games is much more complicated than this, but most of them are different versions based on these basic principles. From the player's point of view, the advantages of learning are mainly reflected in the fact that the game can dynamically adjust the difficulty according to the player's level, so that players can get a great experience at all times, or choose different tactics independently according to the characteristics of different players. Taking Chinese chess as an example, the existing AI technology can only simply control the search depth of the state tree and evaluate the complexity of the function [12]. The explosion of state combination caused by finite state machine can be alleviated to a certain extent by using hierarchical state machine, in which the behavior of non-player characters is decomposed into several small tasks, but the hierarchical state machine still uses a large number of state transitions, which is also difficult to manage. Selection nodes without priority do not judge the conditions from the first child node every time, but from the child node executed last time. If the conditions are met, the node will continue to be executed, and if the conditions are not met, other child nodes will continue to be judged in turn. The actual driving process of NPC motion system is obtained through visual behavior analysis, and a unified visual and behavioral model is formed, as shown in Figure 1.

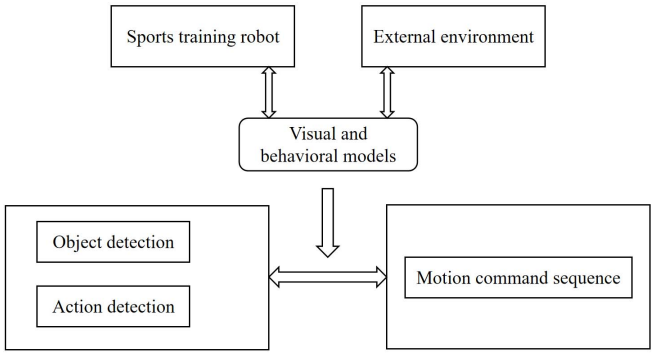

Figure 1 Vision and behavior model

The artificial intelligence technology in the game should not be too smart, at least not more than half of the player's level, otherwise the player will lose interest in the game. Therefore, when artificial intelligence technology is applied in games, on the one hand, it should limit its effectiveness and prevent players from being bruised, on the other hand, it should also increase the development and application of intelligent technology in games. Advanced artificial intelligence has better original computing ability, or the machine has to face the solution thinking, or the like, but in the game, the designer hardly pays attention to it at all. What game designers really want is for players to have a good experience. Usually, when designing games, designers want to design an experience for players. Designers want to know what players will experience when they reach this point in the game. Therefore, if an artificial intelligence is to be placed, it is expected that the artificial intelligence is predictable. When designing games, game designers need to balance the virtual game world. On the one hand, they should attract players' interest in games, and on the other hand, they should make games challenging. The design of artificial intelligence in games is complicated and difficult, which plays a very important role in the quality of games. Therefore, to design a balanced and difficult game, the application of artificial intelligence technology is very important.

III. Application of Artificial Intelligence Based on Machine Learning in Game Development

A. Intelligent game design

When making an open world environment and creating simulations and systems that are closer to realizing the complexity of the real world, large studios may challenge the limits. Making games will be much easier, and producers can make bigger games. These open-world games will become larger, and the game rules system is changeable. The rules are different every time you play, and even between different players' terminal computers. Artificial intelligence technology in games has great potential in future development. Future games can change with the changes of games. Most games rarely have great repetitions in requirements, but they can be used for reference and unified in development models. This model can be used in most games with complex situation decision and evaluation. As for the self-learning function of the model, offline learning can be used in game development, so as to extract many parameters that have great influence on decision-making, and train neural network, so that the network can learn the game experts' understanding of the game to a certain extent. At present, the role of advanced artificial intelligence is not to act as in-game artificial intelligence in games, but to replace real players to play games and test the games themselves.

When a game goes on the market, the behavior of non-players will not be arranged in advance, and the longer the game is played, the game itself can adjust itself according to the game progress, so as to better adapt to the player's progress of the game. Figure 2 is the frame of game artificial intelligence detection and tracking system using image error technology.

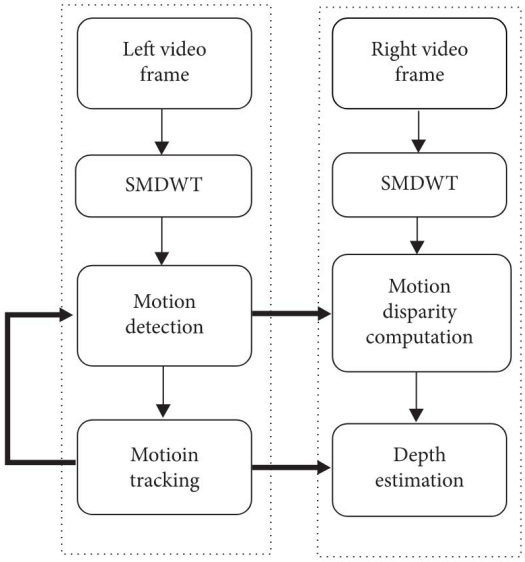

Figure 2 Game artificial intelligence detection and tracking system framework using image error technology

Game software also serves as a tool for training advanced artificial intelligence. Artificial intelligence researchers mainly regard games as a method to measure the intelligence level of software, because the virtual world with strict rules and reward system is a particularly useful environment for training certain software. Traditional breadth-first search and depth-first search are both non-heuristic. By simulating the search process with computer images, we can easily prove that non-heuristic path search is actually an exhaustive method, which searches the waypoints around the pathfinder in a fixed order until the destination waypoint is found. Weights will bring a certain tendency to randomness, but there will still be no starvation of other child nodes [13]. If the weights of all child nodes are set to the same value, the selected node becomes a completely random selected node. Machine learning is an essential data mining tool for in-game analysis, so game studios can study players' behaviors and decipher new insights to improve games over time. In fact, the finite state machine maintains a state graph, the vertices of the graph are states, the connection between vertices is a transition from one state to another, and the logic of transition is described by rules. The process of state jump can be described by behavior tree. The key to the application of advanced artificial intelligence in this field will be a real game character driven by artificial intelligence, or an overall game design artificial intelligence system, which can change, grow and react like human beings when playing.

B. Artificial intelligence routing

It is difficult to find the existing linear formula to describe the solution model of the non-qualitative AI problems in games, but these problems can be transformed into specific patterns or nonlinear mappings. A game must have a perfect process to effectively support its smooth running. A simple game can jump in a fixed mode after determining the established mode, but when encountering non-discrete conditional decision, conditional statements have limited ability. Here, we can abstract the experience of human reading competition into several parameters to train neural networks. Let the network learn these representative decisions, while the input of other non-training sample data depends on the generalization ability of neural network.

In the game, the most classic problem of path search is the game maze problem, which is also one of the difficulties in game design. Many intelligent problems, such as chess game, strategic decision-making, robot path planning, etc., can be transformed into finding the optimal path of maze. Figure 3 shows the structure of agent nodes.

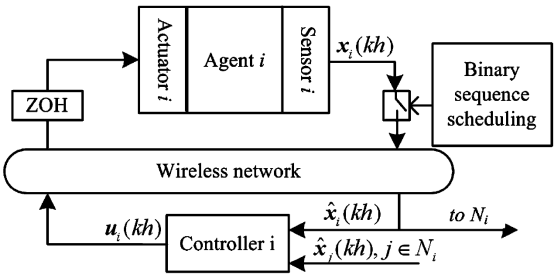

Figure 3 The structure of the agent node

With the increase of path density, the shortest path between nodes increases, as shown in Figure 4.

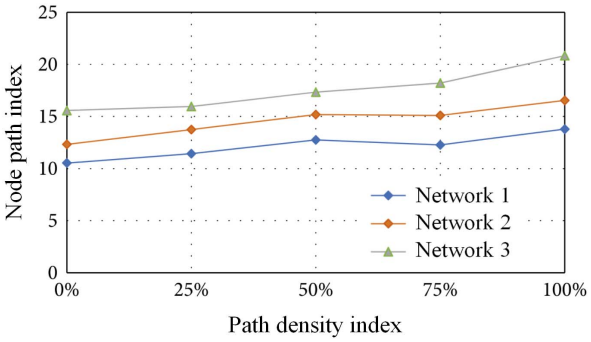

Figure 4 Path density and node path relationship

Different losses can be set for different terrains, such as swamps, hills, stairs, etc., which can set higher moving cost than flat ground. Hierarchical path search is necessary when the map is very large or when you want to cross the map to find the path. In the real world, if you want to find a village, if the path is too far, people may not know how to get there directly, but you can go to the county where the target is located first, then find the way to the township where the target is located, and finally find the destination. The most exciting element in the prospect of the future may be not only the creative role played by software in the process of constructing the art of games, but also the ever-changing and tailor-made experience created by this technology, which will never be boring to deal with only one goal at a time. As a result, only one action is executed at a time. Moreover, only the currently processed target rules are tested, thus providing a context. Rules are processed in sequence, and the first rule that meets the conditions passes control to another new target. Automated game design can make players experience many times, because the game can be redesigned and refreshed constantly.

IV. Conclusions

With the rapid development and progress of China's economy, great breakthroughs have been made in science and technology, especially in the field of artificial

intelligence, which has great potential for mining. Like today's game graphics engine, artificial intelligence engine will become an indispensable part for large-scale game development. At present, the traditional in-game artificial intelligence can still fulfill the mission entrusted by the developers, and create realistic intelligence illusion by combining with other audio-visual interactive means. Machine learning is an essential data mining tool for in-game analysis, so game studios can study players' behaviors and decipher new insights to improve games over time. It is difficult to find the existing linear formula to describe the solution model of the non-qualitative AI problems in games, but these problems can be transformed into specific patterns or nonlinear mappings. As for the self-learning function of the model, offline learning can be used in game development, so as to extract many parameters that have great influence on decision-making, and train neural network, so that the network can learn the game experts' understanding of the game to a certain extent. After the latest artificial intelligence based on machine learning is involved in game development, the future game development mode, gameplay and game experience will eventually be innovated and changed.

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