BioTechnology

An Indian Journal

Analysis of artificial intelligence in computer game

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ABSTRACT

Artificial Intelligence (AI) mainly means to utilize electronic and mechanical devices to substitute and imitate some human intelligence. With the development of science and technology, the application of AI in computer games is increasingly wide, which greatly encourages the development of computer games. This paper studies the application of AI in computer games. The author classifies AI technology on the basis of its functional distinction, performance distinction and behavior distinction in computer games and illustrates its function and operating principle in computer games. Moreover, the author enumerates the major AI technologies used in computer games and makes a brief discussion about their functions and advantages and disadvantages in games. In addition, the author analyzes the design principle of AI system in computer games. Then based on work experience and related research results, the development trend of AI technology in computer games is discussed.

KEYWORDS

Computer games; Artificial intelligence (AI); Operating principle; Technology.

INTRODUCTION

Since the invention of computer games in 1971, it has been popular among most people. With the increasing growth of science and technology, the anthropomorphic characterization in computer games has been more vivid. Nowadays, computer games have imitated most of scenes of human's daily life. Furthermore, these vivid scenes can be reflected in human brains directly through many mankinds' senses, impacting people's life strongly. Currently, with the rapid development of computer games in China, the application of AI in computer games has spread more widely, and the game's attraction has increased a lot[1].

COMPUTER GAMES AND AI

The functional classification of AI in computer games

According to the functional distinction of AI in computer games, AI can be divided into Individual Intelligence and Social Intelligence. Individual Intelligence is mainly applied to control the behaviors of virtual characters in games, which are called Non Player Characters (NPR, which refers to partners, enemies and other non player characters). In order to make the simulation of NPC to be more vivid, AI technology must be adopted to control characters to behave like their identities. Social Intelligence is generally used to control and decide the motional changes of some system's groups or environment in computer games, for instance, the troop movement, the battle reasoning, the judgment of battle and so on in strategy games. The core programs of most computer games have utilized AI technology, increasing the reality of game environment and reasoning the characters' behaviors in games, which greatly improve the attraction of games and arouse the players' interests.

The performance classification of AI in computer games

AI also can be divided into Qualitative AI and Non-qualitative AI according to the performance distinction of AI in computer games. Qualitative AI is predictable and deterministic. Simple pursuit algorithm applied in Qualitative AI system is a classic qualitative example. The advantage of Qualitative AI system mainly lies in its simple structure but having high efficiency. Moreover, its programming is very simple, without complicated algorithms, only concentrating logic structures in the computer game. On the other hand, its disadvantages are that programmers have to think over all scenes in the game before developing it and work out clearly plots and behaviors of characters in the game. The learning development of NPC in the game will be restrained, which is easy for players to find out, resulting in decreasing greatly the interest of the game. The performance of non-qualitative AI system in computer games is unpredictable and irregular in some degree. For example, NPC in strategy games can learn players' strategies, which is set by neural network technology and genetic algorithm. The main advantage of non-qualitative system is that there is no need for game developers working out game scenes and characters' behaviors in advance during the progress of development. The learning ability of NPC can be enhanced effectively by applying non-qualitative AI system so that players cannot predict specifically the learning development of NPC. However, the disadvantage is that it is difficult in system debugging and testing[2].

On the basis of behavior distinction of AI in computer games, it can be divided into Roaming AI, Behavior AI and Strategy AI.

THE OPERATING PRINCIPLE OF AI SYSTEM IN COMPUTER GAMES

The structure of AI system in computer games is shown as Figure 1, the structure of AI system in computer games is similar with human brain's organization, consisting of perceptible input, memory storage, analytical reasoning and decision-making behavior output.
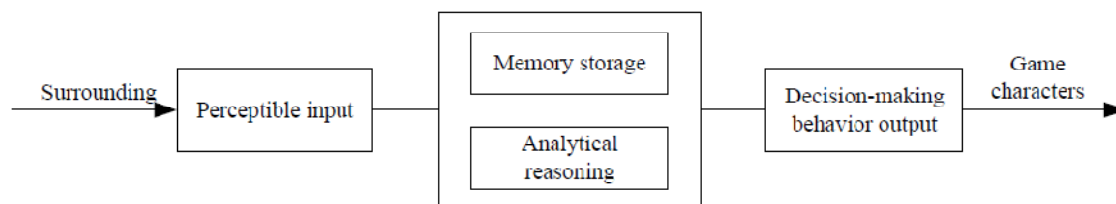
Figure 1: The structure of AI system in computer games

Perceptible input

The system mainly used to perceive the surroundings and get information, then further analyze and reason the information. There is an instance in strategy games. Perceptible input can perceive the data of military power in each player's territory, landform information, different arm's features and military establishments, as shown in Figure 2.

Figure 2: War zone panoramic map of a strategy game

Memory storage

The system mainly used to collect and organize all information, knowledge and data perceived from the perceptible input system, then memorize and present in an appropriate way in the computer, for instance, the routes of each environment in games, the orientation and location of NPC[3].

Analytical reasoning

The system is the center of the whole AI system. Through analyzing and contrasting information and data in the perceptible input system and memory storage system, it makes reasonable decisions and sequences decisions utilizing ranking method. For instance, in the strategy games, game characters usually adopt following three principles in turn: principle of proximity attacking, principle of leftover blood target attacking and principle of DCmax, which means game characters attack the nearest enemy at first, then the target having little leftover blood and choose the final target with the max damage power.

Decision-making behavior output

The role of this system is to feed all decisions and operations made by computer programs back to the game, making the characters in the game behavior accordingly. On the process of developing games, AI is finally represented by all kinds of movements, behaviors and responses in the games, which makes game players experience the intelligence of the game, as shown in Figure 3.

Figure 3: AI in starcraft

AI TECHNOLOGY IN COMPUTER GAMES

Every technological application is relatively fixed in computer games. AI is composed of many intelligent technologies. Currently, the main AI technologies are as follows:

Script language

The main function of script language is to control the mode of AI in the games, the essence of which is a kind of interpreted language. Using script language in computer games can help NPC to do the modeling, drive the story development of the games and realize the automation of some characters in the games[4].

Finite-state machine (FSM)

FSM includes a certain amount of "states" and "transition" among "states". They combine together to form a directed graph, which can only lie in a specific state at every definite moment. In computer games, FSM mostly manages the scenes of games or controls the single object in the games.

Fuzzy logic

Fuzzy logic presents the degree of objects' belonging in the container by the real-value. Its expressiveness is more detailed and plentiful than the traditional logic, so it has better ability of reasoning. In computer games, fuzzy logic is mainly utilized in strategy decision, filtering input information and computing players' health status and emotional variation[5].

Decision tree

Similar with IF-THEN judgment, decision tree is mostly used to predict, sort and learn game information in computer games.

Neural network

Neural network is the synthesis of a series of machine learning algorithms based on the biological brains and the neural connection structures in the neural system. Its major function is to predict, sort and learn game information, recognize game mode and control the behaviors of game characters[6].

Genetic algorithm

The main function of genetic algorithm is to simulate the process of biological evolution, which means rationally select and hybridize all algorithms, parameters and programs in game system and randomly crossover and mutate them. Its key function in computer games is not only to improve and learn the games, but also to develop strategies and improve NPC's behaviors.

In addition, AI technology in computer games also includes case-based reasoning, situation calculus, searching method and machine learning. The results of utilizing the above AI technologies are different. Compared with other AI technologies, fuzzy logic and script language are relatively mature, while the study and application of the advanced AI technology such as machine learning and genetic algorithm are still at an early stage. Related researches have found that the relatively simple technologies such as decision tree and FSM among the applications of AI technology in computer games have already been widely used[7].

THE DESIGN PRINCIPLE OF AI IN COMPUTER GAMES

Designing AI in computer games is for coping with some difficulties in the games, such as simulating some character's behaviors; the military attack, defense, path selection and landform analysis in strategy games. Because these behaviors have mankind's features, during the process of designing AI in computer games, the following principles must be adhered to.

Principle of progressive design based on game player's personal experience

On the process of designing AI in computer games, the player's ideas shall be considered as the basis of design. The game characters' behaviors and operations shall be designed from the player's point of view to construct a normal running system. Then, let the characters set in games confront with players. Meanwhile, improve AI in computer games by recycling the following procedures in turn: ⓐ what "mistakes" did the game characters make? ⓑ how did human beings do? ⓒ what kind of information led the game characters to make "mistakes"? ⓓ improve AI in computer games. After continuous trials and repeated modifications, AI in computer games must be improved and become much more real and natural[8].

Principle of improving AI in computer games to have better flexibility and openness

Taking the strategy game as an example, when a game character is designed to attack by using AI in computer games, the following basic principles shall be kept to: ⓐ if there is only one enemy nearby, the enemy will be the attacking target; ⓑ if there are several enemies nearby, the weakest enemy will be the attacking target; ⓒ after attacking, game

characters shall have considered the hostility from the enemies and the fight back. AI in computer games can order and carry out the above three basic principles on the basis of each game character's features to ensure the game character's decision behavior. If the game character has strong attacking power, the order of operation of three basic principles will be ▯→▯→▯. If the character wants to avoid attacking at the same time by too many enemies, the order will be ▯→▯→▯. The reason of doing this is that after attacking even if the game character succeeded killing enemies, it would be attacked by other enemies nearby in next round. Therefore, when it comes to this situation, the character will not make the attacking decision.

The balance of AI in computer games

There are two aspects about the balance of AI in computer games. First is the balance between the reality and entertainment of the computer games. Second is the balance between entertainment and challenge of the computer games. First and foremost, AI in computer games needs to be realistic, ensuring the balance between reality and entertainment. For instance, in the basketball computer game, if an offensive player is heavily defended, it is possible for him to behave offensive moves even fouls because of impatience, which must be penalized. This kind of condition which the real basketball game has must have according reflection. Moreover, AI in computer games shall ensure the balance between game entertainment and challenge. Because most of players play computer games for relaxation, during playing games, players hope that NPCs in games are more realistic and make some mistakes such as dropping the weapons and missing shoots. It can not only make the games more interesting and easy, but also be found some different fun by players in the games. If game characters have too high intelligence, making no mistake, the players will lose the interest to play.

Distinguishing social intelligence and individual intelligence

AI in computer games shall distinguish social intelligence and individual intelligence. For example, in the football computer game, when one team begins offensiveness, all behaviors of the player with the ball will be controlled by AI such as shooting, passing and running with ball. If only individual intelligence is designed on the process of developing the game, the player with the ball will not pass the ball, which loses the teamwork meaning of the football game. However, if only social intelligence is designed, the players in one team will pass the ball constantly without shooting or running with the ball, which loses the athletic meaning of it. As a result, the most rational situation is that every player in either team is able to analyze the game's situation and facts. After analyzing, AI can adjust promptly every player's behaviors so that the football computer game is more realistic. Team games lay more emphasis on the design and development of social intelligence, which gives game characters the overall thinking and judgment ability in different groups and scenes.

THE CONCISENESS OF AI IN COMPUTER GAMES

The conciseness of AI in computer games means to apply resources as less as possible to create an illusion of the game AI with high level. On the process of utilizing game AI, the larger calculation and the more complicated algorithm, the more pressure computer processor has, which will result in decreasing the refresh frequency of animation frame in games. Meanwhile, it will directly influence the playability of the computer games and the activity of AI. Therefore, during the course of designing and developing computer games, different technologies can be applied to simulate based on the distinction of game characters. For the characters with relatively simple behaviors, the simple AI technology can be adopted. For the minor characters with a certain degree of intelligence, different modes can be set based on the distinction of function, and add a few random factors to interfere. For the important characters with relatively high intelligence, the designers can utilize FSM, with the help of conditional logic and state backtracking to control the transfer of state. For the most important characters, all available AI technologies can be used.

THE DEVELOPMENT TREND OF AI TECHNOLOGY IN COMPUTER GAMES

The extensibility of AI in computer games

In recent years, the popular game AI in computer games is usually based on principle. Nevertheless, the most attractive thing for game players is to improve the overall AI in computer games according to players' own favorites. It can effectively solve the problem of game characters' mechanization thoughts because of the low level of game AI. As a result, extensible game AI technology is for sure to become the main trend in the future. Currently, there are many kinds of games having succeeded to utilize the extensible game AI technology in Chinese game market, which shows that AI technology has potential to extend in the development of computer games. With the constant development of AI technology, game players can freely amend and define game AI totally according to their own favorites.

The improvement of simulation of game characters' learning ability

Game characters' learning ability in computer games mainly means that characters are gradually grown up with the increase of experience. This kind of learning ability of AI is obtained by adopting the machine learning technology. In recent years, the method to imitate learning of most games is to classify and compare the current and experienced situation in order to obtain the higher intelligence level of decision behaviors. With the increasing development and growth of Chinese game industry and the constant trying and improvement of new AI technology, more and more complicated machine learning

technology will be gradually applied in computer games, which effectively encourages the enhancement of the learning ability of AI in computer games.

CONCLUSION

Recently, China has initially developed an overall computer games industry. Under the circumstances of the upgrading performance of computer hardware and much more vivid imaging presented by graphic imaging, the audiovisual effects have developed greatly. The center of computer games development has also changed fundamentally. As a powerful technology to effectively enhance the effect of game experience, to arouse players' interests and to extend the life of games, AI technology has received more and more attention in Chinese game industry.

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