Research on Online Game Design Based on Artificial Intelligence Algorithm

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ABSTRACT

In today's online game, AI (artificial intelligence) has become a widely used technology. Because any game itself is a process of human-computer interaction, it more or less includes the use of AI. In this project, we try to combine the existing AI technology with online game design, and study a feasible online game design road based on AI algorithm. A decision-making model of game AI behavior is designed, and the proposed genetic SASarsa algorithm takes the value of exploration rate as the solution of chromosomes in the genetic process, and also represents the state in the annealing process. In the design of game AI engine, multithreading mechanism and the design pattern of producers and consumers are introduced, and the near-end strategy optimization algorithm is used to improve the search efficiency. Experiments show that reinforcement learning method can use the same reward function for similar intelligent agents, so as to achieve action decisions that conform to the game world view and set after training. It can complete the construction of game AI without reorganizing the decision structure, and improve the intelligence level of intelligent agents in the game.

KEYWORDS

AI, online game, AI engine, Genetic SASarsa algorithm, Online games

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1 INTRODUCTION

With the improvement of productivity, people spend less and less time on their work, which makes people have enough time for rest and recreation; On the other hand, the fast-paced life has invisibly increased people's pressure. With the introduction of standardized measures by relevant government departments on the game industry, the appeal of the whole society for the healthy and green development of games and the example of many people of insight in the game industry, the negative impact of games on society is gradually weakening [1]. The Internet provides an unprecedented platform for people to ask questions and communicate with each other. This brand-new communication mode has suddenly attracted many young and fashionable people, and the network industry in China has entered a high-speed development stage. At the same time, a new game mode-online game has also entered people's entertainment world. Online game industry is a new sunrise industry. After the initial formation stage and rapid development stage at the end of the 20th century and the beginning of the 21st century, the online game industry in China is now rapidly maturing from the growth stage [2]. online game industry is at the high end of industrial value chain, such as technological innovation and R&D. It is a knowledge-intensive industry with high added value and low energy consumption, with creativity as its source and close integration with information technology. AI (artificial intelligence) is a new technical science to study and develop theories, methods, technologies and application systems for simulating, extending and expanding human intelligence [3, 4]. In today's game industry, AI has become a widely used technology. Because any game itself is a process of human-computer interaction, it more or less includes the use of AI. In this project, we try to combine the existing AI technology with online game design, and study a feasible online game design road based on AI algorithm. At the same time, through the use and improvement of AI technology, we will further strengthen the role expression and environmental authenticity in the game, making the NPC in the game more intelligent and humane. This paper describes the concrete design and detailed implementation of the optimized behavior decision system, and designs the overall architecture of the AI engine.

2 RESEARCH METHOD

2.1 Game AI Behavior Decision-Making Design

The AI system of the game includes a wide range, from simple pursuit to dodge, to mobile modules, as well as more advanced neural networks and GA (genetic algorithm). AI needs to know the environmental letter, the character's own information and the external input information. Then, after making decisions based on various information, directly guiding the behavior of the role, the role itself will change, which will in turn affect its environment, and the information changed by the decision will also be fed back to AI. The decision-making part is mainly responsible for what to do [5, 6]. It is responsible for collecting all kinds of information about the environment and itself, even external input, etc., and making judgments according to its own state and goals, and planning the next behavior of the role. For example, mobile system and skill system, the input of this part is the selected behavior, and the output is the result of these behaviors. The behavior layer controls the realization of specific behaviors, which is a low level, and the

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technologies about chasing, dodging and pathfinding generally belong to this layer.

Different from stand-alone games, online game are destined to rely heavily on the game world since they came out. In this case, the designer can't completely predict the behavior of the player in the open scene, nor can he predict the conditions under which the player will interact with the objects in the game, so he can't complete the optimal feedback corresponding to all the behaviors of the player in the game. For fuzzy state machine systems, when the AI situation involves independent and concurrent systems, the model will be helpful to design separate systems that have nothing to do with each other or one-cause multi-effect systems with multiple branch choices, so that individuals controlled by AI can present a wider range of behavioral personalities. If we need to detect whether the individuals in the game are stimulated by the outside world or whether their surroundings have changed all the time, a huge amount of data will be generated. Therefore, for triggered behaviors in AI, we usually design them in an information-based way [7].

The behavior decision-making system of a game character is the brain of a character, which is responsible for the great responsibility of planning behavior for the role, and is the key factor of whether a character can be intelligent. It needs to be able to analyze the various situations of the role itself and the game environment in which the role is located, and make a reasonable response to it. The role does not exist in isolation in the environment. In most cases, it will have partners. Therefore, in addition to independently accomplishing the goal and attacking the enemy, it should also be able to show certain cooperative behavior. If there is a team or leader, it should also be able to obey the arrangement of the team or leader.

Deep reinforcement learning refers to reinforcement learning combined with deep neural network. The main difference from traditional Q-learning is that firstly, the deep convolution network+fully connected network is used as the approximation function, secondly, the sample is stored in the experience pool, and finally, the target network is used to get the TD-target separately. In most reinforcement learning, the learning process of Agent to solve sequential problems can use Markov decision-making process [8, 9], which is defined as Markov decision-making process is composed of five groups. The genetic SASarsa algorithm proposed in this paper takes the value of exploration rate as the solution of chromosomes in the genetic process and also represents the state in the annealing process. The optimal chromosome obtained after a certain number of iterations can be decoded to get the optimal exploration rate at the current moment.

The iterative formula of the state action pair value of Sarsa algorithm is as follows:

$$Q(s_t, a_t) = Q(s_t, a_t) + \alpha(r_t + \gamma Q(s_{t+1}, a_{t+1}) - Q(s_t, a_t)) \quad (1)$$

In the formula, γ is the discount factor and s_t is the state of the Agent at the current time t. After performing an action a_t, the Agent enters the next time $t+1$ and receives an immediate return r_t, and enters the statess_{t+1} and $Q(s_{t+1}, a_{t+1}), Q(s_t, a_t)$, both of which are the values of state action pairs. The performance of .Sarsa algorithm in solving some learning problems is better than the classical Q learning algorithm in reinforcement learning.

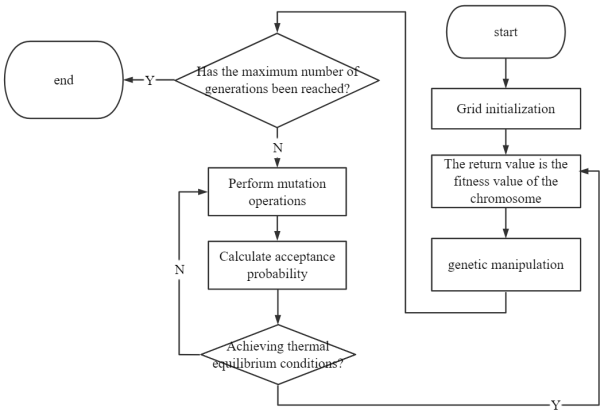

Figure 1: Algorithm training process

Both GA and SA (Simulated annealing) algorithms are heuristic random search algorithms. GA has poor local search ability, but strong ability to grasp the overall search process. The SA algorithm has strong local search ability, and can prevent the search process from falling into the local optimal solution [10]. In this paper, the compatible real coding GA and SA are organically combined. Taking the excellent individuals evolved from real coding GA as initial values, then calling the improved SA algorithm subroutine to search in detail to replace the poor individuals, and finally accelerating the cycle.

Let the optimization room of nonlinear function be entitled as the following minimization problem:

$$\begin{aligned} &\min f(x) \\ &a(j) \le x(j) \le b(j) \qquad j = 1, 2, \cdots, p \end{aligned} \quad (2)$$

Where $x = \{x(j)\}$ is the set of optimization variables, $[a(j), b(j)]$ is the change interval of$x(j)$, $p$is the number of optimization variables, and$f$ is the objective function.

Figure 1 describes the training process of genetic SASarsa algorithm on exploration rate:

2.2 Design of Game AI Engine

The NPC in the game usually only attacks the characters within its own detection range, and will not actively look for the player characters within all ranges of the scene, otherwise the player characters will be at an obvious disadvantage. Some can't be moved, such as the defense tower NPC or the mission NPC. This part of NPC that can move is either confined to an area, such as a room; Or move randomly in the scene; Or move along a fixed path. For characters controlled by players, their actions, such as forward, backward, left turn and right turn, are completely controlled by players. When attacking other characters, the player also chooses the action. The computer needs to find the path and control the role to advance to the specified point according to the path.

In some games, players can control a group, and the computer must control the actions within the group, so that the characters in the group are compact and will not collide. Decision-making is the core part of AI, which generates instructions according to the messages of the sensory system and sends them to the command

system. This part is designed by game planners, and the logic of each game is completely different. Therefore, the touch engine only provides a logical implementation mechanism and a path-finding algorithm with high universality.

The design of the framework should ensure the stability of the game developers. The most basic thing is that the games developed by using the framework can run stably for a long time at the framework layer, and try to avoid some frame layer bugs such as memory leakage caused by the use of the framework. As far as possible, each part of the code can be added or removed at any time without affecting other parts of the game. On this basis, when the game requirements change, some functions are added or deleted, the original code can be easily modified. AI needs to coordinate data calculation in the background and animation display in the foreground. For this reason, it introduces multithreading mechanism and design pattern of producers and consumers, and uses near-end strategy optimization algorithm to improve search efficiency, which is another typical application of AI in practice [11, 12].

The near-end strategy optimization algorithm adopts the Off-Policy method and adopts the mode of two strategy networks, one of which is specially used for interactive sampling, and the sampled data is used to update another set of parameters. According to the principle of importance sampling, we can get:

$$J^{\theta^k} = E_{s_t,a_t\sim\pi_{\theta^k}}\left[\frac{P_\theta\left(a_t\,|s_t\right)}{P_{\theta^k}\left(a_t\,|s_t\right)}A^{\theta^k}s_t,a_t\right] \tag{3}$$

Where $_\theta(a_t|s_t)$is the transition probability of the policy currently being updated, and θ^k is the parameter of the policy network used for interaction.

In order to limit the scope of policy update and ensure that the action probability distributions of the two policy networks are not too different, the near-end policy optimization algorithm introduces KL divergence into the objective function:

$$J_{PPO}^{\theta^k}\theta = J^{\theta^k}\theta - \beta KLP_{\theta^k}\,|s_t,P_\theta|\,s_t \tag{4}$$

Among them, β is used to adjust the constraint strength of KL divergence and ensure it to play a moderate role.

As shown in Figure 2, the AI engine includes three modules: logic, command and path planning. The individuals who put forward the path-finding request queue up to call the path planning, and the longest running time is set for the path planning module when the game is running, after which the path-finding is suspended.

On the basis of the basic functions, this paper divides the scene management module and the auxiliary toolkit module according to the analysis of the general game framework mentioned above. For the scene management module, the framework needs to have the ability to manage the elements in the current scene, the ability to manage the game hierarchy, the ability to manage different logic branches of the current game scene, the ability to manage the game interface, and the ability to provide universal AI algorithm functions.

In order to facilitate the subsequent game development, developers can use common algorithms conveniently. Based on the basic types of object modules in the framework, AI modules are designed and implemented, which are mainly responsible for providing the interface of AI algorithms and returning results.

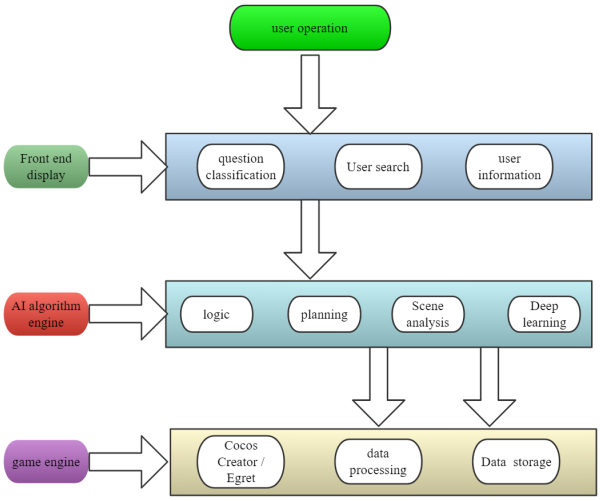

Figure 2: Structural design of game AI engine

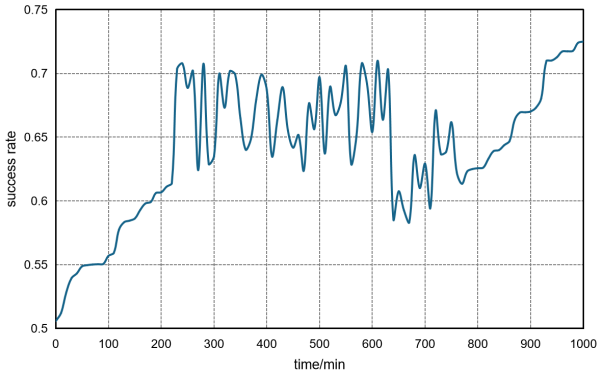

Figure 3: Game AI training results

3 RESULT ANALYSIS

In order to verify that the game AI based on reinforcement learning method proposed in this paper can simplify the use difficulty of NPC role AI system under the premise of ensuring performance and effect, this section carries out experiments on the AI algorithm designed in the previous section, in which two different game characters, hunters and prey, are defined and move in the experimental game scene with different behavior patterns. In this experiment, the damage is directly reflected in the health value of the intelligent agent. The initial health value is 100 points, and each point of damage is reduced by 1 point. When the health value is 0, death is declared.

Figure 3 shows the success rate of skill release, that is, whether AI has learned to release a cooled skill. When AI releases a skill that is being cooled or is controlled by a control skill and tries to release an uncontrolled displacement skill, the skill will fail to be released, and others will be released successfully.

From the initial success rate of 50% to about 70%, and more experimental data show that the negative benefits of adjusting the failure of skill release can change the value of the final convergent

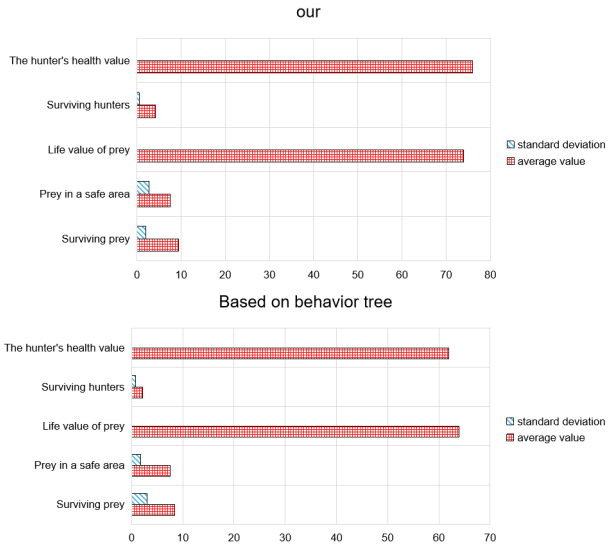

Figure 4: Simulation experiment results

success rate of skill release. The greater the negative benefits, the higher the success rate, which can reach more than 95% in the experiment. However, the diversity of skills will decrease, that is, some skills will be ignored and never released. The value of the negative return of the final skill release failure makes a trade-off between skill diversity and skill success rate.

Record the average number of surviving prey and the average and standard deviation of prey reaching the safe area in the two groups of experiments, as shown in Figure 4.

The survival rate of prey characters based on AI strategy method in this paper is 49.33%, while the survival rate of prey characters based on behavior tree method is only 38.73%. In the experiment based on the AI strategy method in this paper, the average value of the inventory quantity and remaining health of the hunter role is also higher than that based on the behavior tree method.

This experiment shows that the strategy method based on AI in this paper can better guide the behavior of prey and improve the survivability of prey characters. Compared with the method based on behavior tree, prey is more inclined to take refuge rather than attack hunters. These data show that the strategy method based on near-end strategy optimization can effectively improve the accuracy of decision-making and bring better behavior performance to intelligent agents.

Reinforcement learning method can use the same reward function for similar intelligent agents, so as to achieve the action decision that conforms to the game world view and setting after training. It can complete the construction of game AI without reorganizing the decision structure, and improve the intelligence level of intelligent agents in the game.

4 CONCLUSION

The Internet provides an unprecedented platform for people to ask questions and communicate with each other. This brand-new communication mode has suddenly attracted many young and fashionable people, and the network industry in China has entered a high-speed development stage. In this project, we try to combine the existing AI technology with online game design, and study a feasible online game design road based on AI algorithm. At the same time, through the use and improvement of AI technology, we will further strengthen the role expression and environmental authenticity in the game, making the NPC in the game more intelligent and humane. Experiments show that reinforcement learning method can use the same reward function for similar intelligent agents, so as to achieve action decisions that conform to the game world view and set after training. It can complete the construction of game AI without reorganizing the decision structure, and improve the intelligence level of intelligent agents in the game.

REFERENCES

[1] Huang Wei. Network Design and Development of 3D Warfare Games Based on Unity Engine [J]. Modern Electronic Technology, 2015, 38(23):4.
[2] Shao Invention, Li Xingde, Tang Jian, *et al.* Design and Implementation of Abacus Competitive Game System [J]. Computer Application, 2015, 35(2):3.
[3] Shi Huaxing, Dong Lijun. Research on user experience design strategy based on China's end-game products [J]. Journal of Graphics, 2016, 37(4):5.
[4] Lan Ji, Wu Yingcai. Visual analysis of game data [J]. Journal of Computer Aided Design and Graphics, 2017, 29(4):8.
[5] Du Zhihua, Lai Zhenqing. Real-time strategy card game design based on deep reinforcement learning [J]. Computer Simulation, 2022(002):039.
[6] Chen L, Sun H, Zhao W, *et al.* AI Based Gravity Compensation Algorithm and Simulation of Load End of Robotic Arm Wrist Force[J]. Mathematical Problems in Engineering, 2021, 2021(8):1-11.
[7] Tong Zhenming, Liu Zhipeng. Prediction of the next location of massively multiplayer online role-playing games [J]. Computer Science, 2018, 045(2):453-457.
[8] Chernova S, Depalma N, Breazeal C. Crowd-Sourcing Real-World Human-Robot Dialogue and Teamwork through Online Multiplayer Games[J]. Ai Magazine, 2011, 32(4):100-111.
[9] Butt A H, Ahmad H, Shafique M N. AI-Powered 'Voice Recognition Avatar': A New Way to Play Games[J]. International journal of gaming and computer-mediated simulations, 2021(3):13.
[10] Barriga N A, Stanescu M, Besoain F, *et al.* Improving RTS Game AI by Supervised Policy Learning, Tactical Search, and Deep Reinforcement Learning[J]. IEEE Computational Intelligence Magazine, 2019, 14(3):11.
[11] Eliasson O, Weidner C, Rafner J, *et al.* A man-machine mind meld for quantum computing: Can an online game that combines human brainpower with AI solve intractable problems [J]. IEEE Spectrum, 2019, 56(11):37-41.
[12] Gross, Daniel. Applications of AI technology in Online database services[J]. Online Information Review, 2013, 12(5):283-289.