Innovative Application of Genetic Algorithms in the Computer Games

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Abstract: The traditional methods to solve the computer games problem are to use various search algorithms on the game search tree and to combine the situation evaluation to generate the corresponding methods. The paper introduces the innovative genetic algorithms to the computer games based on the traditional methods. Through the operations for the search tree such as selection, crossover and mutation, the better search tree can be gotten from the better solutions. At the same time, the application of the evaluation functions can produce the best steps in the current situation. The advanced and modified genetic algorithms are proved to be practical and applicative by experimentations and tests of computer games.

Key Words: Computer Games, Genetic Algorithm, Search Tree, Search Algorithms

1 INTRODUCTION

The artificial intelligence is a rapid developing and comprehensive science. Its central task is to study how to make the computer to do those things which can only be done by the human intelligence in the past. There are so many research fields and the computer games could be one of them. The computer games are a complete knowledge games in which both sides of the games at any time fully understand the situation and the state. The chess games and the cards games belong to this computer games.

The typical methods of the complete knowledge games are by searching the search game tree to decide which step to take. The standard computer games have the four parts:

(1) The state representation.

(2) The candidate movement generation.

(3) The searching methods.

(4) The situation evaluation function

The artificial intelligence of machine games is reflected in the computer through the search algorithm based on the situation evaluation function to find an optimal walk method from all legitimate candidates walking method, and the search algorithm to make the choice.

2 GAME TREE SEARCH ALGORITHMS

The traditional method to solve the problem of the search tree is a game machine. To play chess machine as an example, the first step is to define a tree rooted tree, in a situation of a node on behalf of the board, in a situation of sub node is the situation step can be reached. In the process of playing chess every step is called a response to the move, from the current state of the game (the root node), to identify all possible sub nodes should, from each of all to deal with, find out the corresponding to each response until the final constituting a tree, called the search tree. Find the most favorable branch in the search tree through the valuation and select the starting point of the branch as a response plan.

2.1 The Min-Max Search Algorithm

The Surakarta chess is a two-player eating game which comes from Java Island in Indonesia. The chess board is composed of 6*6 squares and 8 circular arcs on the corner. There are 36 crossing points in total in the chess board. These crossing points are named the chess points. The players have two different color pieces, and each with 12 medals, commonly used color to black and white pieces. At the beginning, the pawn in the bottom line of the 2 rows. The chess board and the chess pieces are shown in the figure 1 as following.

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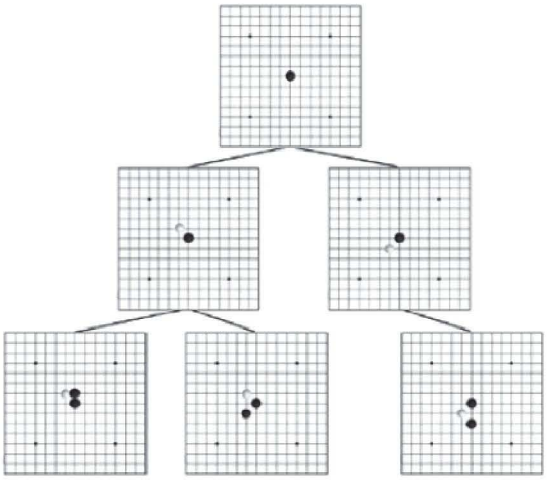

Fig. 1: The mini-max search tree

The two sides take turns chess, every move a pawn, in addition to eat outside, only for each piece along the vertical or diagonal direction around a grid, only to a vacancy. When eating the other pieces, must go through at least one full arc, and no pawn in the path of the eating. Eat up all the other pieces of the side to win, or in time limit game, the remaining pieces of a party to win.

2.2 The Alpha-Beta Pruning Search Algorithm

The Alpha-Beta pruning algorithm is the most famous optimization method and improvement measure. The common situation often encounters when the search engine is searching in the game. After the Alpha-Beta pruning is applied in the search engine, the number of the search nodes reduces from 11 million to 1.49 million. So the optimization and improvement effect is very obvious exactly.

Although the Alpha-Beta pruning search algorithm has been improved, it has large data redundancy and low efficiency. Based on the maximum and minimum values, the Alpha-Beta pruning technique is proposed. That is, as long as there is a good move, other unnecessary response branches in the game tree can be cut off, thus greatly reducing the scope of search.

In practice, the search efficiency of Alpha-Beta pruning technology is still not ideal. On this basis, the improved algorithms such as search node ordering and opening optimization are proposed. But these improved algorithms can not fundamentally solve the exponential complexity of the search tree.

3 GENETIC ALGORITHM AND COMPUTER GAMES

In order to further improve the efficiency, genetic algorithm is introduced into machine game.

3.1 The Basic Knowledge of Genetic Algorithm

In 1975, Professor John H. Holland and his colleagues at the University of Michigan in the United States studied the theory and method of genetic algorithm. After a comprehensive and systematic discussion by Goldberg, they laid the theoretical and application foundation of modern genetic algorithm.

The genetic algorithm is a non numerical parallel stochastic optimization algorithm, which introduces the "survival of the fittest" mechanism of biological evolution into the algorithm. Using population search technology, the population represents a group of problem solutions. By applying a series of genetic operations such as selection, crossover and variation to the current population, a new generation of population is generated, and the population gradually evolves to a state containing approximate optimal solutions.

As a new global optimization search algorithm, it is simple, universal, robust, and suitable for parallel processing and wide range of application. It is especially suitable for dealing with complex nonlinear problems which are not well solved by traditional search algorithm.

3.2 The Search Algorithm from Genetic Algorithm to Computer Games

In the search of the game tree, the corresponding positions are binary coded, and the positions of the players are randomly arranged to get a corresponding string. Each playing string contains the playing process of both sides. In this way, n coping strings are generated. In the genetic process, those favorable coping strings are selected as the optimization goal to get the initial population.

At last, the starting point of the string with the largest fitness function is chosen as the solution of the problem. This algorithm can focus on the high-performance part of the search and can quickly find the best way.

3.3 The Optimize Situation Evaluation Function in Genetic Algorithm

In the machine game, the situation evaluation function determines the level of the game program to a large extent. When using genetic algorithm to optimize the estimation, we can use some famous chess scores or play chess with other game programs to see how much the probability of winning when using a certain set of parameters is to be tested.

After several tests, we can get a better estimate. The traditional algorithm can only maintain a group of better parameters. Genetic algorithm is a parallel optimization algorithm, which can maintain several groups of better parameters at the same time. By adding a new group of

parameters to it, and then comparing with several groups of old parameters, the worst group is removed from it.

The genetic algorithm is applied to the game tree, through the selection, crossover, mutation and other operations of the search tree, the game path which may contain the optimal solution is obtained, and the best action is evaluated.

4 IMPROVED STRATEGY AND INNOVATIVE APPLICATION

The standard genetic algorithm uses binary coding. The advantages of this coding method are fine gene expression, long problem coding, which is conducive to solving combinatorial optimization problems. However, this method is not flexible enough, and needs mapping from coding domain to problem domain, and the intermediate process is complex.

The genetic algorithm can also use tree coding, which is more flexible to solve the problem of large change of coding length. And the machine game itself is the process of searching the tree structure. If we can directly operate the game tree, we can simplify the coding process and improve the efficiency of the game.

The game tree is regarded as the population of genetic operation, and all the sub trees from root node to leaf node in the game tree are individuals in the population. According to the optimization objective design evaluation function, the fitness function value of each individual in the population is calculated, and the initial population is determined according to the fitness function value, so that individuals with strong adaptability (large fitness function value) can get more cross and genetic opportunities and generate new offspring individuals. Through repeated iterations, satisfactory solutions can be obtained.

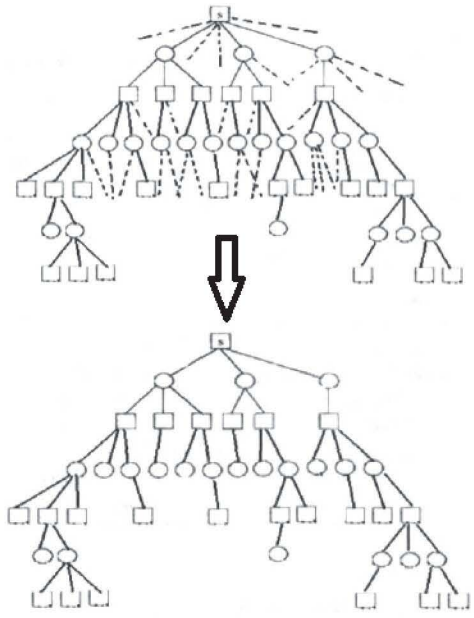

Fig. 2: The research tree simplified

5 EXPERIMENTAL DATA AND RESULT ANALYSIS

To take Connect5 as an example, this paper discusses the realization of each link in genetic algorithm.

(1) Generation of initial population.

During the simplification period, a 15×15 checkerboard is used, which has 255 points in total. In order to determine the game tree in a certain situation, the current position of chess can be listed first.

In Connect5, except for the position where the chess has been played, the remaining positions are all chess positions. There are different ways to deal with different positions of chess, and they are regarded as the population of genetic operation.

Before and after the start of the game, the game tree obtained is extremely large and complex, so it is difficult to analyze and operate it. Many of the positions are meaningless for forming five children, so we can reduce the redundancy of the game tree through constraints.

(2) Selective population.

In order to reduce the size of the game tree, we can select the lower part of the current state as the playing point according to the rules of Connect5. For example, if the minimum distance between the surrounding pieces of a position is greater than 4, it will be excluded; for the first party, it will also be excluded from the forbidden positions such as "three three three", "four four four", "long even".

(3) Crossover and mutation.

Through crossover and mutation, the existing game tree will be changed greatly, and a new path will be generated, but not all the new paths will produce a good path. The subtree obtained by crossing and mutation may be a worse response process, or even an illegal action. For the above subtree, we can prune according to the constraint rules to remove the unreasonable branches. The evaluation function is used to estimate each subtree after pruning, find the best response path, and then get the best action method in the current situation.

6 CONCLUSION

The selection, crossover and mutation of genetic algorithm can be directly applied to the search tree of both sides of the game, which can simplify the complex coding process and has certain significance for the design of the game system.

There are many applications of genetic algorithm in machine game. If genetic algorithm is applied to the opening database of game system, through machine learning, chess game analysis, summary and learning, according to different actions, different opening can be

generated, then the performance of game system can be further improved.

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