

A Team

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1 Introduction

Soccer has the problem of the extremely high complexity. This complexity can be considered a problem of the search space. When the player decides the action from the situation of the world, quite many choices exist and it is impossible to search for all the choices. This search space problem is essence of the problem in soccer.

Genetic Programming(GP) is an effective technique for such a search space problem (e.g. Traveling Salesman Problem). We applied GP to the Soccer Server System, and tried to acquire the effective action patterns and its parameters. It is assumed that GP is applied to the low-level skills and the high-level behavior separately. This paper describes only the application of GP to the low-level skill part.

2 Genetic Programming(GP)

GP is a kind of Genetic Algorithm(GA), which is the evolutionary computing method[3]. GA is an optimization method that imitate the process of the evolution of the living thing. The population of the virtual living thing is generated in the computer. The selection and the reproduction are repeated until the best solution is obtained.

In GA, the chromosome of individual is expressed by the bit string. On the other hand, in GP, the chromosome of individual is expressed by the tree structure. This tree structure is equivalent to S-expression in LISP. Therefore, GP is suitable for the function identification, the acquisition of best IF-THEN rule, and so on.

GP generate the optimized solution automatically by repeating the generation change. However, when GP is applied to the Soccer Server System, it is difficult to optimize all control rule of the player by the tree structure of one individual. The high-level behavior for soccer player requires the low-level skills for soccer player. If we optimize the low-level skills and the high-level behavior simultaneously, many same structural sub-trees are needed in the tree structure and uselessness is caused in the optimization process.

Therefore, according to the action level of the player, it is necessary to apply GP to each level individually.

3 Application of GP to low-level skills

We applied GP to low-level skills, ‘kick’ and ‘dribble’.

At first, we tried to optimize dribble by using only basic commands(kick, turn, dash). However, even if hundreds of generations passed, the improvement of the fitness of individual was not seen at all. By this experiment, it turned out that it was difficult to optimize the processing structure and the parameter simultaneously even if it was basic action like the dribble. Then, first of all, the problem was simplified to the optimization of the kick, which is more basic action than dribble.

In the optimization of the kick action, the necessary is only optimization of the parameter of the kick command. This can be considered a problem of the function identification. The parameters used as an environmental input are distance to the ball, direction to the ball, velocity of the ball, distance to the target and direction to the target. The number of types of the value that the node returns is four(power, angle, Boolean value and real number). A final distance difference between the ball and the target position was used for the criterion of the fitness of the individual.

The optimization experiment was done by the above-mentioned setting. The transition of the fitness of the result is shown in Figure 1. Consequently, an excellent function to calculate the best parameter from an environmental input was acquired.

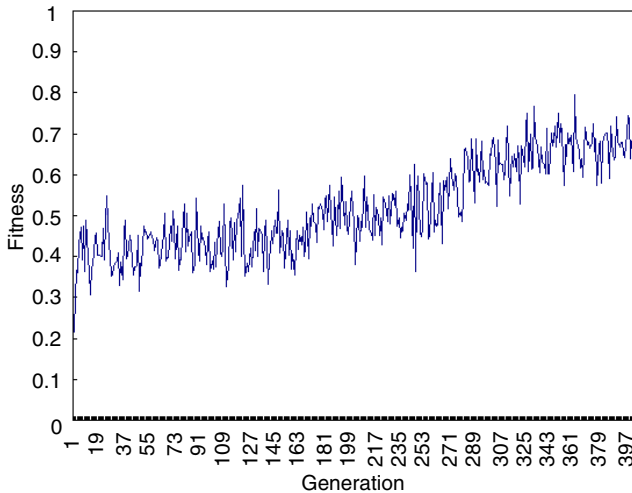


Fig. 1. Transition of Fitness : Kick

Next, the optimization experiment of the dribble was done by using the result of optimized kick parameter function. In this experiment, if the ball is within

kickable area, the player kicks ball to a temporary target. If not, the player dashes to ball or turns to ball(if necessary). Because the parameter of the kick has already been optimized, the necessary for dribble is optimization of dash power and temporary dribble target. The time took to reach the target was newly set as a criterion of the fitness of the individual. Other setting is the same as the case of the kick. After several hours of experiment, a roughly excellent result was obtained. The transition of the fitness of the result is shown in Figure 2. However, because this experiment is done in the environment where obstacle player does not exist, its effectiveness might be low.

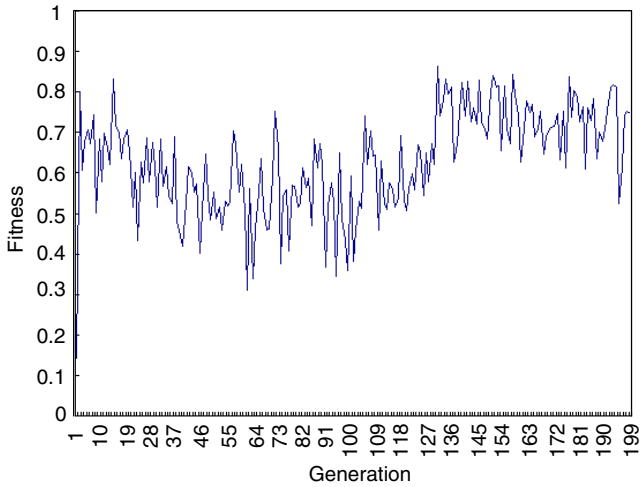


Fig. 2. Transition of Fitness : Dribble

4 Application of GP to high-level behavior

In high-level behavior, the action of a soccer player is classified. These classified actions are basic actions as a soccer player. For Example, pass, shoot, dribble, and so on. After acquiring the low-level skills, basic actions can be easily composed by combining them. Basic actions here include the passing to specific teammate, the shot, and the dribble to a specified position, etc.

Now, it is possible only to experiment in very limited the game situation(e.g. 3 vs. 3), and the result is not enough. Therefore, the result of the experiment has not been used in the actual competition yet.

5 Conclusion

The application of GP to the Soccer Server System was effective to develop low-level skills. However, in high-level behavior, that effectiveness cannot be shown yet. In competition of RoboCup2000, because making a high-level behavior was insufficient, the result was a total defeat. In the future, it is scheduled to acquire a high-level behavior with GP, and to verify its effectiveness.

6 Team Development

Team Leader: Hidehisa Akiyama

Team Members:

- Hidehisa Akiyama
 - Tokyo Institute of Technology
 - Japan
 - graduate student
 - did attend the competition

Web page No Web page

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