

Identifying Key Elements of Successful Behavior in a Video Game of Tennis

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Abstract

The game which we pick up for these past dozens of years becomes more interesting. The factor includes the improvement of graphic and the game hardware of the game, but it is thought that the evolution of the AI is a big factor. There are various forms and kind in AI. We focus Rule-Base AI [1]. We want to investigate the secret getting a point from an opponent more in video game of tennis.

1 Introduction

AI is utilized to most things of the game. It is distributed between three kinds in AI utilized by a game. It is character AI controlling NPC (non-player character) that we treat. In addition, there is navigation AI providing the information for the game to progress in the progress of the game and meta AI coordinating, character AI, meta AI. And character AI has plural technique. The technique of the character AI which we focus is Rule-based AI.

The structure of the rule-based AI is very simple. As for the rule, a condition and behavior are sets. If meet condition and get execute behavior, Rule would be applied. The rule base AI is called alias expert system. This technique was developed in 1965 [2]. This system begins to be used for commercial from 1970s. A system to diagnose blood disorder called Mycin [3] in 1972 was developed. This system recommends a drug and medical law. Squeeze bacteria with the possibility from question sequence that can answer *yes* or *no* and some kind of sentences from doctor. Although it was not made practical use, there was 65% of legitimacy. The expert system is used now in the field of enterprise as BRMS (Business Rule Management System).

There are some reasons why we took this approach. One is to be create system relatively in a short term. Machine learning have been a focus of constant attention needs a large quantity of data and to work to collect the statistics from there and decide behavior. Therefore, the cost takes the time, too. Because a human being makes knowledge and a standard for it to be determined by NPC, the rule-based technique is easy to wrestle and is easy to repeat the trial manufacture. The other is that the management of the program is simple. Because the rule may encode it by

which order, can perform work changing the system later flexibly.

2 Method

At first it necessary to explain tool we use at experiment and develop. We use game machine is World of Tennis (see Fig. 1) developed in Unity3D [4]. A player on this game should perform the following operation sequentially. Serve and Recovery movement, Returning a serve or a shot [5]. A player performs these operations by such as a tap or the flick. The AI performs these operations in own equally, too. We consider how AI performs in Video Game of Tennis through these operations to create great a shot and recovery.

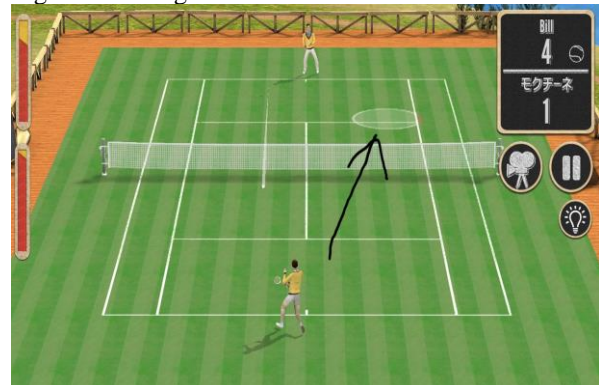
Fig. 1 Word of Tennis



Talk about Returning a serve or shot.

In this phase, decide next shot target point. (see Fig. 2)

Fig. 2 Returning a serve or shot Phase



In this phase, the player can tap anywhere on the opponent's half of the court to set the target point for the next shot. The player in Fig. 2 will shot on inside of a circle.

A condition and behavior are sets as we already spoke it. For example, AI hit ball to opponent coat in the left side if opponent hit ball to AI side coat in the right side. This is rule. In this case, "opponent hit ball to AI side coat in the right side" is rule and "AI hit ball to opponent coat in the left side".

The information to treat as a condition is as follows. One is information of the positions of the opponent. The reason is very simple. We will be going to hit the ball to the left side of the coat mostly if can relegate opponent to right-side end of the coat. Advantage of the Rule-base is able to mimic a method that a person judges and take action. Thus, the positional information of the opponent will become be important hand when AI determine behavior. The other is position of the AI. It is Important judgment materials to shoot ball which course. For example, it is easy to shoot with angle from the edge of coat than center of the coat. Also, the same is true of drop shot (shoot ball at near the net). It can decrease time until 2 bounces by shooting from near the net. By grasping own position, the effective shot become better.

In the next place, about Recovery movement (see Fig. 3).

Fig. 3 Recovery Movement Phase



In this phase, moving somewhere on own half of the coat before the opponent's shot. the player can tap anywhere on the own half court. The player in Fig.3 will move to inside of red circle.

We explain importance of Recovery movement first. It means both offensive and defensive. Defensive action

is to continue rally. For example, if AI is close to edge of the coat, advisable behavior is to move center of the coat quickly. Offensive action to seize point effectively. Typical example is net play. It is to move near the net and hit a ball on the volley. A player in this game make a mistake if they have no preparations to hit ball and manage to give opponent chance of the attack. This movement make it possible to get point strategic and create great defense.

The information to treat as a condition is as follows. One is information of own position. Consider a position of the recovery by position which hit ball at previous point. The other is distance between the positions of the opponent and ball position that AI hit ball on the opponent coat. For example, if far more than uniformity, recovery position is near the net.

2.1 Conflict resolution

We made some rules based on these ways of thinking. The rule-based system should face problem. It is conflict of Rule. The problem happen when hit some rule that same condition but not same behavior. It is necessary to let AI decide which rule. We tried some idea to solve it.

- (1) Complete random
- (2) Weighting
- (3) Association with the former rule

(1) When the competition of the rule happened, completely choose which rule choose in random.

(2) Take weight on rule and choose rule with more weight. If AI get point, take weight rule used as getting point.

(3) It is random as with (1). But fix probability to be chosen effective rule from former rule.

We implemented three idea and test. The method of the test match other AI (coach AI [6]) in tie-breaks (game of the 7-point taking first) 10 times and asses from result test.

3 Result

Table.1 is test result. First score is match score. Second score is getting score (no out and net). Third score is missed score.

(1)

The result is very widely. AI win and lose sometimes. In addition, point difference not stable. This method is random. Therefore, chosen rule could not create stable behavior.

(2)

In the method, behavior and score are comparably stable as match progresses. It became able to take a point away from the same opponent. However, it tended to increase that movement became monotonous at after the latter half of the match. AI use same rule under the influence of weight.

(3)

In comparison with (2), it is lacking in stability of the score. But could success to increase avenue to get point. (1) and (2) don't have method thinking behavior by 2 rule combination. Accordingly, it was able to be close to behavior of real tennis player.

4 Conclusion

In this paper, search key element of successful behavior in video game of tennis. We find out adaptation to an opponent and stratagem through experiment. It can take a point effectively by choosing the rule that is effective for an opponent. It can implement this by using a weight charge account. Also, it is difficult for the tennis to take a point by one shot. It is necessary to hit it to the severe course to take a point by one shot. But It involve taking risk net and out. Thus, the distribution of the course becomes important. We implemented it to make a stratagem in two rules by the experiment. If increase combination of rules and refer to score in the match and other element, can take more stratagem.

We implemented many rules and condition divergence for this study. Problem of Rule-base AI is programmer need to code these processing one by one. However, this

problem reduces divergence if can understand target essence and will become able to obtain a similar result. It will be necessary to think about the logic that the future problem simplifies a cord more, and can smoothen processing.

Reference

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- [5] M. Mozgovoy. Context-Awareness and Anticipation in a Tennis Video Game AI System. *Proceedings of the 2018 IEEE International Conference on Systems, Man, and Cybernetics*, Miyazaki, Japan, 2018.
- [6] M. Mozgovoy, M. Purgina, I. Umarov. Believable Self-Learning AI for World of Tennis. *IEEE Computational Intelligence in Games*, Santorini, Greece, 2016, pp. 247-253.

Table 1. Match results (rule-based AI vs Coach AI)

Match No. / Method	1	2	3	4	5	6	7	8	9	10
(1)	7-5 3-2 3-4	7-3 5-1 2-2	5-7 4-3 4-1	7-2 4-1 1-3	5-7 2-4 3-3	7-4 3-3 1-4	7-5 5-3 2-2	3-7 2-4 3-1	7-4 4-2 2-3	7-2 6-1 1-1
(2)	7-4 4-2 2-3	7-3 5-2 1-2	7-5 4-3 1-1	7-6 5-3 3-3	7-6 4-3 3-3	7-3 5-2 1-2	7-4 5-2 2-2	7-5 4-2 3-3	7-4 5-2 2-2	7-2 5-1 1-2
(3)	7-5 5-2 3-2	7-6 5-3 3-2	5-7 4-4 3-1	6-7 5-3 4-2	7-5 5-3 2-2	7-4 4-3 1-3	7-6 5-3 3-3	7-4 5-2 2-2	7-5 4-3 2-3	7-5 3-4 1-4

Fig.2 Decision Shot and Recovery Diagram

