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Rule-Based Role Analysis of Game Characters Using Tags about Characteristics for Strategy Estimation by Game AI

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***Abstract*—The performance of imperfect information game AI is often inferior to perfect information game AI. This is due to the difficulty of strategy estimation. In order for game AIs to select a better action, it is necessary to correctly understand the strategy of the opponent. This paper proposes a rule-based analytical method for strategy estimation by utilizing tags about characteristics of game characters in an imperfect information game, Pokémon. The method makes it possible to estimate the strategy more accurately, and it can be expected to enhance imperfect information game AI. We perform strategy estimation by game AI using the method and evaluate its accuracy.**

I. Introduction

For analog games such as Go, Shogi, Chess, etc., there are professional players who perform them competitively, and the development of game AIs related to such games is actively carried out. These games are called "Perfect Information Game," whose players can watch all information on the game situation. Perfect information game AI can choose behaviors properly and win a game against humans because such a game AI has higher computing power than humans.

Shogi, which is one of perfect information games, has been studied about game AI for a long time. H. Iida [1] devised a strategy necessary for game AIs to play as strong as professional players' level and examined the algorithm to implement a strategy in game AIs, from the perspective of Shogi professional player and AI researcher. K. Hoki [2] proposed "Bonanza" which is a shogi AI made in a unique way at that time, and described the method of move selection using full width search and the automatic generation of evaluation function parameters. Especially, the automatic generation of evaluation function parameters is called "Bonanza method," and many of Shogi AIs developed after Bonanza were introduced this method.

On the other hand, imperfect information game AI whose players cannot watch some information is not very strong. As a reason for that, in perfect information games, it is premised that the actions considered to be the best are mutually chosen, whereas in imperfect information games, it is impossible to judge whether or not the opponent's choice is the best. For example, a game AI for an imperfect information game selects an action on the assumption that the opponent player always selects the best action. However, if the opponent selects an action that is not the best, the action selection of game AI may not be the best too. The difficulty of tactics unique to such imperfect information games is one of factors that make it difficult to improve the performance of imperfect information game AI.

In these days, playing video games competitively, called "e-sports," is getting in fashion. But there are many imperfect information games among video games. Established tactics of video games are hard to be fixed, because changes in the trend of tactics in video games are more fluid than analog games, and also because of the difficulty of tactics unique to imperfect information games. For these reasons, a game AI of a video game which uses imperfect informaton is not very good in performance.

In this paper, we propose an analystic method to make a game AI refine the strategy estimation. Human players estimate their opponent's strategy from limited information. The proposed method utilizes tags about characteristics of game characters in an imperfect information game. These tags contain information that is considered to be used by human players to determine the strategy. Therefore, it is expected that our proposed game AI will be able to estimate strategies closer to human players. We perform strategy estimation like human players by game AI using this method, and evaluate its accuracy.

Researches on imperfect information game AI have been actively carried out in recent years, but there are rarely high performance game AIs. N. Kobayashi et al. [3] have suggested a method to guess the current hand from the opponents' past choice in the imperfect information game "contract bridge." However, in the research, it is assumed that the best action is always selected, so the research cannot deal with the difficulty of tactics unique to such imperfect information games. C. Kato et al. [4] have proposed a method for speeding up the search for tactical selection of the game AI. However, the research

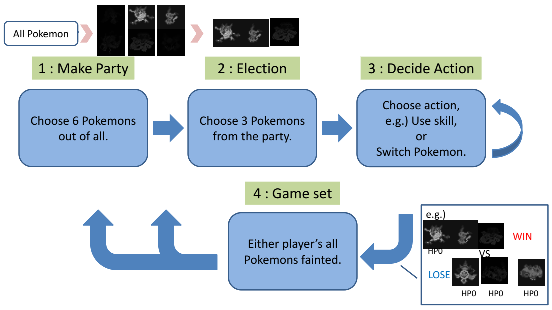

Fig. 1. The flow of battle in Pokémon.

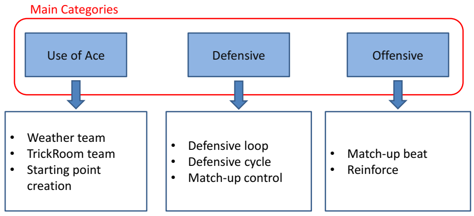

Fig. 2. Strategy categories in Pokémon.

only experimented battle between game AIs, therefore the research was not able to show that a possiblity of a game AI to win human players.

The remainder of this paper is organized as follows. Section II explains the video game, Pokémon, to be used in this research. Section III proposed an analysis method for the strategy estimation of imperfect information game AI. Section IV shows the results of two kinds of evaluation experiments. Finally, Section V concludes this paper.

II. Explanation of the Video Game to be Used in this Research

In this research, we selected the "Pokémon" series as a target to invent a game AI. Pokémon series is played all over the world, hence the online battles are frequent. Characters called "Pokémon" appearing in the game have the following characteristics.

- **Status** : it consists of *Hit Points*, *Attack*, *Defence*, *Special Attack*, *Special Defence*, and *Speed*.
- **Types** : they have effective or weakness, e.g., "*Water is effective for Fire*," "*Fire is effective for Grass*." Each character has one or two type(s).
- **Skills** : damage the opponent, reinforce oneself, or weaken the opponent, etc. Each character has at most four skills.

These characteristics are different depending on the kind of Pokémon. In a battle, by taking these characteristics into account, we decide the action of Pokémon and aim to make the opponent Pokémon's HP (Hit Points) 0. The flow of a battle in Pokémon is shown in Fig. 1. For the first preparation, a player selects 6 Pokémons from among all ones and builds a party. When actually playing a battle, players check the opponent's built party each other and select 3 Pokémons that they use for the battle from their party. At this time, a human player estimates the strategy of the opponent roughly. When the battle begins, each player instructs a Pokémon to attack or switch with the other Pokémon every turn. A Pokémon whose HP has become 0 cannot continue to battle. We repeat to instruct a Pokémon to do an action until all the Pokémons elected by either player cannot participate in the battle.

In choosing an action during the battle, a human player refers to the strategy estimated when s/he selected 3 Pokémons. Human players estimate strategies from fragmentary information and use them for the battle. If the proposed game AI is able to estimate the strategy in the same way, there is a possibility to recognize the intention of the opponent's action.

III. Analysis Method

In this section, we propose a method for a game AI to estimate the opponent's strategy from the opponent's party that can be referred to as information. Each Pokémon has status and usable skills determined according to its kind, and we can guess the role of each Pokémon. The proposed method gives role information to each Pokémon as a tag and estimates the strategy from tags included in the opponent's party.

A. Obtaining role information

We use the database [5] to get the role information of Pokémons. In this database, we can browse the status trends of each Pokémon and the skills that may be used. Using these information, we assign **role tags** as follows.

- **Status tag** : it is a tag about the status of Pokémon. It consists of offensive performance, defensive performance, and speed. Each tag is independent, for example, both tags are given to Pokémon which has excellent offensive performance and defensive performance. Also, speed tags are given depending on the speed status from "slow," "middle," and "fast."
- **Feature Skill tag** : it is a tag about skills of Pokémon. If a Pokémon can use skills with a distinctive effect, it affects its role. We define such skills as "feature skill" and give a tag based on the feature of the skills. This paper uses the set of the feature skills based on the first author's prior knowledge. Feature skills are classified into four categories.
  - Speed management : skills to help speed of party.
  - Assist : skills to assist action of attacker.
  - Reinforce : skills to strengthen offensive performance of one's own.
  - Protect : skills to strengthen defensive performance of one's own or recover oneself.

If a Pokémon has some feature skills, multiple tags based on skills are given to the Pokémon.

B. Strategy Estimation

Strategy Estimation is carried out based on the characteristics of Pokémon revealed by tagging. The strategies in Pokémon is divided into three main categories, further which are subdivided. Strategy categories are shown in Fig. 2.

- "Use of Ace" is a strategy to assist powerful attackers.
  1 . Weather : use a powerful Pokémon under certain weather with weather changer.
  2 . TrickRoom : use a feature skill "Trick room."
  3 . Starting point : make opportunities for self-reinforcement by weakening opponents.
- "Defensive" is a strategy to aggressively change Pokémons.
  4 . Defensive loop : ignore offensive performance and use a lot of Pokémons which have high defense performance.
  5 . Defensive cycle : a strategy with a little consciousness of offensive performance than "Defensive loop."
  6 . Match-up control : an intermediate strategy between "Defensive" and "Offensive."
- "Offensive" is a strategy emphasizing attack power.
  7 . Match-up beat : continue attacking without switches.
  8 . Reinforce : try self-reinforcement without assist.

Fig. 3 shows an example of the flow of strategy estimation by the proposed game AI. When a party is input, the game AI refers to the database and assigns role tags using status information and skill information of each Pokémon. For example, "Mawile," which is a kind of Pokémon, has high attack, but the speed is low. So "Mawile" is tagged with "Attacker" and "Low Speed." Further, "Mawile" can use "Sword dance" that is a feature skill. The skill tags "Mawile" as "Self-Reinforce." This process is performed for each Pokémon of the input party. Then, the game AI estimates the strategy from the role tags. In the Fig. 3, the four strategies "TrickRoom," "Starting point," "Match-up beat," and "Reinforce" were estimated because these strategies satisfied rules.

IV. Evaluation Experiment

We confirmed whether the proposed method can correctly estimate the strategies by using two evaluation experiments.

A. Matching rate between Human and game AI

In the first experiment, we evaluate how close the strategy estimation by the proposed game AI is to human players. Humans' strategy estimation is based on the questionnaire results of 13 persons who frequently play Pokémon online battle. Respondents estimated the strategies for ten different parties that built with 6 Pokémons, e.g., "Please select which strategies seem to be used in a party?" If the game AI can estimate the same strategy as many human players, it can be said that human-like estimation is done by the game AI.

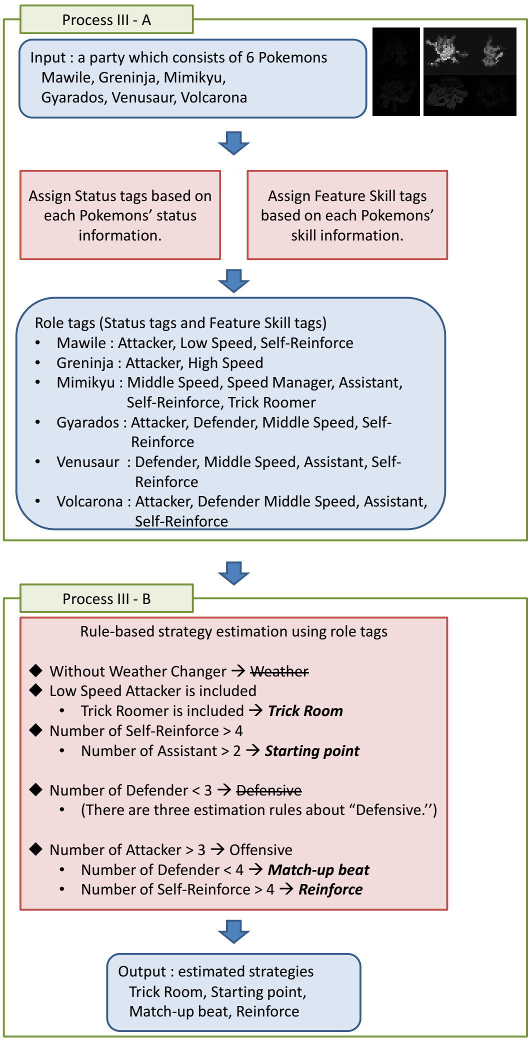

Fig. 3. An example of Strategy Estimation.

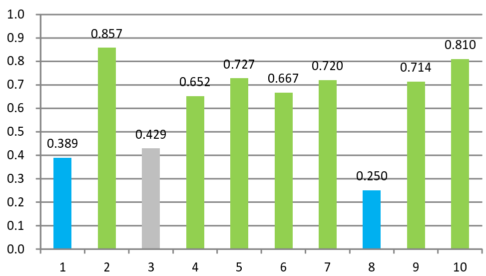

Fig. 4. Matching rate between Human and game AI.

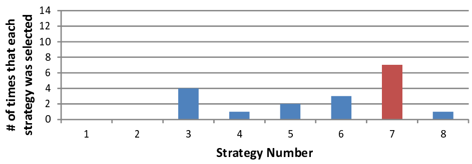

Fig. 5. The results of Question 1.
(A party : Metagross, Greninja, Mimikyu,
Thundurus, Aerodactyl, Suicune.)

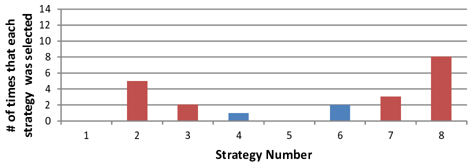

Fig. 6. The results of Question 2.
(A party : Mawile, Greninja, Mimikyu,
Gyarados, Venusaur, Volcarona.)

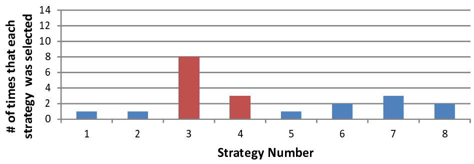

Fig. 7. The results of Question 3.
(A party : Hippowdon, Salamence, Porygon2,
Aegislash, Breloom, Glalie.)

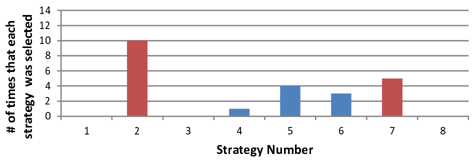

Fig. 8. The results of Question 4.
(A party : Cresselia, Mawile, Tapu-bulu,
Heatran, Greninja, Gengar.)

Fig. 4 shows the matching rate of strategy estimation of humans and the proposed game AI. Because a respondent selects all the strategies that seem to be correct for each

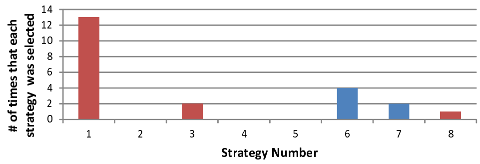

Fig. 9. The results of Question 5.
(A party : Politoad, Swampert, Kartana,
Salamence, Mimikyu, Aegislash.)

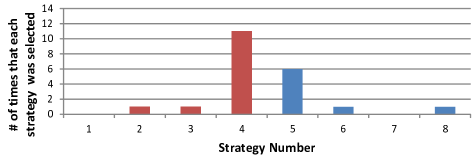

Fig. 10. The results of Question 6.
(A party : Mimikyu, Salamence, Porygon2,
Gliscor, Skarmory, Toxapex.)

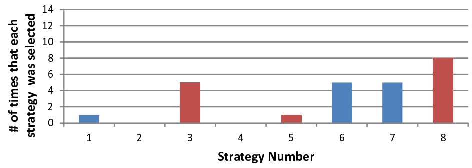

Fig. 11. The results of Question 7.
(A party : Metagross, Tyranitar, Serperior,
Tapu-fini, Landorus, Volcarona.)

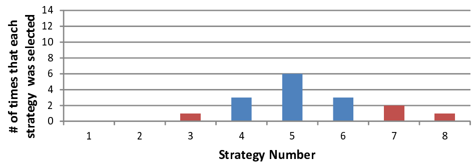

Fig. 12. The results of Question 8.
(A party : Hydreigon, Aegislash, Azumarill,
Venusaur, Incineroar, Celesteela.)

party shown to her/him, the number of responses for each question does not equal to each other. The evaluation is made by the ratio of the number of responses of the strategy whose estimation matched between humans and the proposed game

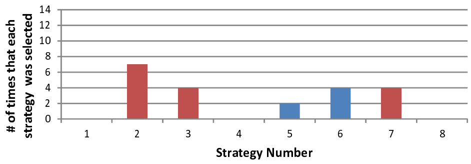

Fig. 13. The results of Question 9.
(A party : Tapu-bulu, Empoleon, Mawile, Chandelure, Garchomp, Pheromosa.)

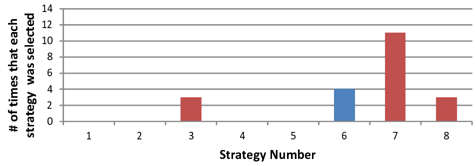

Fig. 14. The results of Question 10.
(A party : Kangskhan, Thundurus, Landorus, Mimikyu, Volcarona, Greninja.)

AI for each question.

In some of the questions, the matching rate is less than 40%, but over half of the questions the matching rate exceeds 60%. Fig. 5 to 14 show the results of each question and the estimation by game AI. Red bars indicate that the estimation matched between the game AI and humans. In each question, the strategies included in "Use of Ace" and "Offensive" often co-occur with each other, while the strategies included in "Defensive" tend to hardly co-occur with strategies of the other categories. Looking at the results, the strategies included in "Use of Ace" and "Offensive" are almost similar to human estimation. Further when these strategies are co-occurring, similar trends are found in the estimation result by game AI. Hence, it can be said that game AI's estimation close to humans has been done for these strategies. On the other hand, in Questions 1 and 8 with low estimation accuracy, there are several strategies included in "Defensive." Moreover, even with other questions, the accuracy of "Defensive" is not high, so it can be seen the strategy estimation rules that are set in this research are not sufficient. "Defensive" strategies are less affected by feature skills, this is one of the reasons that accuracy of "Defensive" strategies is lower than the other two categories.

B. Recall and precision of strategy selection by humans

In the experiment in the previous subsection, we compared the proposed game AI's strategy estimation with humans' strategy estimation. Meanwhile, here we evaluate whether the strategy actually chosen by humans can be estimated correctly by the proposed game AI. We prepared the set of correct answers that consists of strategies associated with a party built by human players. When the game AI makes an estimation of the strategy for a party built by a human player, its strategy estimation is confirmed if the same strategy intended by the human player is selected by the game AI. The results of strategy estimation for 12 parties are shown in Table I.

Bold letters represent correctly presumed strategies. As with the first evaluation experiment, the estimation of the strategies belonging to "Defensive" did not go well. However, there were only two cases where the estimation failed completely, while in other cases at least one strategy was estimated correctly. Therefore, it is possible to estimate the strategy of a human player it is possible for a game AI to estimate the strategy of a human player by rule-based analytical methods.

TABLE I
RECALL AND PRECISION OF STRATEGY SELECTION BY HUMAN.

	Selected strategy	AI's estimation
1	**Match-up control**	TrickRoom, Starting point, **Match-up control**
2	Weather, **Starting point**, Match-up control	**Starting point**, Defensive cycle, Reinforce
3	Weather, **TrickRoom**, **Starting point**	**TrickRoom**, **Starting point**
4	**Weather**, **Starting point**, Match-up beat	**Weather**, **Starting point**, Defensive cycle, Reinforce
5	**Weather**, Reinforce	**Weather**, Starting point
6	**TrickRoom**, **Starting point**	**TrickRoom**, **Starting point**
7	Starting point	Match-up beat
8	Weather, **TrickRoom**, **Match-up beat**	**TrickRoom**, Starting point, **Match-up beat**, Reinforce
9	**Weather**, Reinforce	**Weather**, Defensive cycle
10	Defensive cycle	TrickRoom, Starting point, Defensive loop
11	**Weather**, **TrickRoom**	**Weather**, **TrickRoom**, Starting point,Defensive loop
12	Weather, **Starting point**, **Reinforce**	TrickRoom, **Starting point** Defensive cycle, **Reinforce**
	Recall = 0.6153846	Precision = 0.4705882

V. CONCLUSION

Although this paper showed that there is some usefulness in the rule-based analytical method for the strategy estimation by the game AI, it was also revealed that the rule setting was insufficient. By setting the rules that can accurately estimate "Defensive" strategies, further improvement in the accuracy can be expected.

In the evaluation experiments, the recall exceeded 60%, but the precision fell below 50%. This is due to the fact that if it is judged that there is a possibility that a certain strategy is included, it is output as an estimation result without comparing it with other strategies. If we can select a strategy highly likely to be used by the opponent, the estimation method will be more accurate.

In this paper, we proposed an rule-based analytical method for the purpose of estimating the opponent's strategy, but we can use this method to deepen the understanding of our strategy. In the previous paper [6], we proposed a party creation method using Community Extraction. It is possible to improve the accuracy of party creation by deepening strategy comprehension degree.

In addition, we implemented strategy estimation because we thought that strategy estimation is important for improving the strength of game AI. However, we could not yet show the importance of the strategy estimation based on the results of actual battle. Therefore, as a future work, we need to investigate the effect of the strategy estimation by calculating the winning percentage of proposed game AI.

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