Developing Pokemon AI for Finding Comfortable Settings

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Abstract This paper explores an innovative way to find a comfortable setting of video games. Pokemon is chosen as benchmark and game refinement measure is employed for the assessment. The number of Pokemon that one trainer can carry (i.e., setting with $n=6$) has never been changed after the first episode of Pokemon was released in 1996. Pokemon battle is simulated and various AIs are developed for the experiments. The results show that the original setting is the best for many players of various levels.

Keywords Pokemon, Pokemon AI, Game refinement theory, Entertainment, Settings of video games

1. Introduction

Nowadays, there are many video games. Some are so popular but others are not so. There are many reasons behind this fact, e.g., its story, graphics etc. In practical sense, one of the most important points is the setting of some variables in the game. Its setting may often considerably affect the entertaining aspect which leads the game to be exciting or boring. That is the reason why we believe that each setting of video game has its own reasons behind this, and therefore finding a comfortable setting can be significantly important to maximize the entertainment in playing the game considered. Thus, this paper proposes an innovative approach to find a comfortable setting of video games.

In this study, we use the game of Pokemon, one of the most popular video games [3]. We focus on Pokemon battle which is the core part of Pokemon game. Actually, there are many factors to be considered in Pokemon battle. Some of them have been added, deleted or changed in order to improve the quality of Pokemon battle such as abilities, some moves, the number of types and so on. However, a few factors are still same after the first episode of Pokemon was released in 1996. Among them, the number of Pokemon ($n=6$) that one trainer can carry has never been changed.

Therefore, we use a measure which is derived from the game refinement theory [4] [9] to find comfortable settings of Pokemon game. We simulate Pokemon battles and its AIs in order to gather the data. However, it is hard to create a perfect human-like AI. Instead, we create different types of AIs to estimate the real human's behaviour. We then figure out a reasonable model of game refinement for Pokemon game.

The structure of this paper is as follows. We first briefly introduce Pokemon and explain how to simulate the game and its AIs. Then, we explain how to apply game refinement theory to Pokemon battle and experiments are performed. Finally, the results obtained are discussed and concluding remarks are given.

2. Pokemon Battle and AI

This section presents Pokemon-related matters such as its overview, outline of Pokemon battle and our Pokemon AIs.

2.1 Overview of Pokemon

Pokemon [2] is a series of games developed by Game Freak and Creatures Inc. First released in 1996 in Japan for the Game Boy, the main series of role-playing video games (RPG) has continued on each generation of handheld Nintendo consoles, including Game Boy Color, Game Boy Advance, Nintendo DS and Nintendo 3DS [1]. Pokemon is the most successful computer game ever made, the top globally selling trading-card game of all time and one of the most successful children's television programs ever broadcast [10].

2.2 Pokemon battle simulator

The goal of Pokemon game [5] is to win the badges of gyms and become the champion of the league. For this purpose, one has to win every battle in the game. In this study, we focus on each battle. The goal of Pokemon battle is to fight until the opponent has no Pokemon remained. One Pokemon will be fainted if its HP (hit points or health points) [6] reaches zero.

Normally, each player will be called as a trainer because the duty of a player is to train his or her Pokemon to be powerful enough to clear the game. Each trainer can bring up six Pokemons and each Pokemon can remember four moves. Each Pokemon has six kinds of stats composed of HP, attack, defense, special attack, special defense and speed. There are eighteen types of Pokemon and one Pokemon can be only one or two types such as Pikachu which is an electric type or Golem which is both rock type and ground type. The effectiveness of each move depends on the type of move and type of Pokemon that received move.

One possible way to collect many data of Pokemon battle which have been performed by human players is given by online Pokemon battle simulator [8]. These data have been used to analyze the entertainment impact with a focus on battle [7]. However, in this study we need to change the number of Pokemons that one trainer can carry in order to find a comfortable setting. Therefore, we simulate the Pokemon battle game by simplifying many factors in the game.

2.3 Pokemon battle AI

For the experiments we propose four different types of Pokemon battle AI: Random AI, Attack AI, Smart-Attack AI and Smart-Defense AI. The details are given below.

Random AI will choose at random every possible choice including the move and the change of Pokemons.

Attack AI will choose a move that makes the highest damage from the currently used Pokemon. It will not change the currently used Pokemon.

Smart-Attack AI checks at first whether or not the currently used Pokemon has a move that wins the opponent's type. If yes, it selects the best move that makes the highest damage from the moves that currently used Pokemon has. If not, it checks whether or not it has other Pokemons that have a move that wins the opponent's type. If yes, it changes the currently used Pokemon with the Pokemon that has a move that makes the highest damage to the opponent. If not, it has to select the move that makes the highest damage from the currently used Pokemon inevitably.

Likewise, Smart-Defense AI does the same as Smart-Attack AI. However, the difference is that Smart-Attack AI checks type from its moves while Smart-Defense AI checks type from Pokemon. So, Smart-Attack AI would make higher damage because the damage is based on the move. However, Smart-Defense AI is safer because if your Pokemon's type wins opponent's Pokemon's type, it is hard that your opponent can make high damage to you. This significant difference leads Smart-Attack AI can end the game faster than Smart-Defense AI.

3. Assessment of Pokemon Battle

This section first gives a short sketch of game refinement theory. We then discuss on how to apply it to Pokemon battle game. Using game refinement measures, Pokemon battles with various numbers of Pokemons are compared.

3.1 Game refinement theory

A general model of game refinement was proposed based on the concept of game progress and game information progress [9]. It bridges a gap between board games and sports games. The 'game progress' is twofold. One is game speed or scoring rate, while another one is game information progress with focus on the game outcome. Game information progress presents the degree of certainty of game's results in time or in steps.

3.2 Board games approach

Game refinement values for various board games such as chess, shogi, Go and Mah-Jong were calculate in [4]. Let B

and D be the average branching factor (number of possible options) and average game length (depth of whole game tree), respectively. Therefore, in general, R value for board game is obtained by Equation (1) and game refinement values of major board games are shown in Table 1.

$$R = \frac{\sqrt{B}}{D} \quad (1)$$

Table 1: Measures of game refinement for major board games

Game	B	D	R
Western Chess	35	80	0.074
Japanese Chess	80	115	0.078
Go	250	208	0.076
Mah Jong	10.36	49.36	0.078

3.3 Application to Pokemon battle

Pokemon battle is a turn-based game where each player has to choose what to do at his/her turn, same as board games like chess. So we can suppose Pokemon battle as a board game [7].

Hence, game-refinement theory can be applied by using the same idea as board game. Normally, we find R value by using the average possible options (say B) and game length (say D), as shown in Equation (1).

For possible options B, in Pokemon battle, they are very limited because one Pokemon can remember only four moves and player can change his/her current used Pokemon to other Pokemons that player possesses. In case of using some items such as medicine and potion, it is illegal in Pokemon contests, so we do not consider that case.

For game length D, the meaning of one turn in Pokemon battle is both players' simultaneous actions. Hence, there are two actions in one turn. So, we have to multiply *2* to this value. Finally, with this simple method, we can completely find R value as shown in Equation (2).

$$R = \frac{\sqrt{Average\_number\_of\_options}}{Average\_number\_of\_turns * 2} \quad (2)$$

4. Results and Discussion

Experiments are performed by adjusting the number of Pokemons that one trainer can carry, denoted by n. We use AI in our simulated Pokemon battle game in four algorithms, described in Section 2. For each n in each type of AI, we perform one million games. Then, we collect B and D. We then calculate game refinement values by using Equation (2) and the results are shown in Table 2.

Table 2: Measures of game refinement for Pokemon battle

n	Random AI	Attack AI	S-Atk AI	S-Dfs AI
1	0.222	0.296	0.296	0.296
2	0.124	0.173	0.169	0.160
3	0.083	0.127	0.119	0.107
4	0.060	0.103	0.093	0.079
5	0.046	0.088	0.076	0.063
6	0.037	0.077	0.065	0.052
7	0.031	0.069	0.057	0.044
8	0.026	0.063	0.051	0.039
9	0.022	0.059	0.046	0.035
10	0.020	0.055	0.043	0.032

We can roughly classify Pokemon's player in many levels such as novice, beginner, normal and expert. Novice players would play like Random AI due to the very poor knowledge, so they do not know how to choose a good move. Beginner players would play like Attack AI because they try to end the game as fast as possible by choosing the maximum damage move which is not hard to calculate. Normal player would play like Smart AI by using simple decision making as we describe. However, higher level players likes expert players would know that Pokemon battle is more complex than other levels think. So, these level players would choose many complex moves which make the game somehow long but not so long as Random AI does.

According to our previous studies, it is found that many sophisticated games have R value between *0.07-0.08* which may be suitable for normal viewers. It suggests that for the Pokemon battle $n = 5$ may be the best setting. On the other hands, it is observed in [7] that the main target of Pokemon

game is children. So its R value should be slightly lower than the sophisticated zone in order to have the appropriate level of excitement. Hence it is reasonably assumed that the appropriate R value for Pokemon battle is around *0.06-0.07*. Under the assumption, $n = 6$ is the best setting.

Moreover, $n = 5$ and $n = 7$ are also reasonable settings for some specific levels of Pokemon player. For example, if we focus on beginner's level, $n = 7$ may be nice. If we focus on expert's level, $n = 5$ may be fine.

However, when focusing on children's performance, we see that $n = 6$ has the best R value because the range is very comprehensive. It can hold an acceptable value for novice, beginner, normal and expert.

This is the answer to the research question in this study: Why the number of Pokemons that one trainer can carry is six? Because it is an appropriate number which is optimal for every level of players. This is the reason why the number six has never been changed after the first episode of Pokemon was released in 1996.

Our approach to find comfortable settings of Pokemon can be summarized as follows. We first simulate a Pokemon battle game by simplifying many factors. The simulated game should be as simple as possible, but it should be sufficiently complex in order to create a realistic simulated game. Then, we try to implement some realistic AIs for gathering data. However, it is hard to make a perfect human-like AI. Therefore, our solution is that we create some AIs which can be a lower bound and the upper bound of the human performance. Then, we try to create a human-like AI as realistic as possible. We can estimate the real human's performance based on his level by considering these AIs. Finally, a reasonable game refinement model is applied and we perform our experiment by the numerous games.

5. Conclusion

This paper proposed an innovative way to find the comfortable settings in video games. Pokemon was chosen as benchmark and game refinement measure was employed for the assessment. In the Pokemon battle game the setting ($n=6$) is most comfortable under the assumption that Pokemon is mostly played by children and comfortable zone for children is *0.06* to *0.07*. Moreover, there are other reasonable settings for some specific levels. For example, $n=5$ or $n=7$ may be a comfortable setting for experts or beginners, respectively.

It is understood that the work presented here is a simple model with no complicated factors and more studies are required. This work has some limitations such as the number of Pokemons implemented, Pokemon battle's AI and some Pokemon battle mechanics which is hard to implement are ignored. Further works may improve these points. Moreover, investigation in various domains such as Pokemon contest or another video game can be important to improve our approach.

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