

Title	指導碁を行う囲碁プログラムのための悪手検出と想定図を用いた説明
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Description of a Bad Move Detection and Explanation System for Teaching Games with a Go Program

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One goal of research in games is to create a computer player able to entertain human players. In order to achieve this goal, the computer program must be sufficiently strong to play at the same level as human players, so a lot of research has been done first in the direction of a strong computer program for many different games.

For example, in the case of Chess or Shogi, which are two-player zero-sum games, computer players reached the professional level. Even for the game of Go, which state-space complexity is very high and for which it is hard to design state evaluation functions, a strong computer player was achieved in 2016 by using Monte-Carlo Tree Search and deep-learning technique. The strength of this computer player was shown to be almost equal to human professional players. The strength of Go programs is now sufficient for almost all human common players, thus the original goal of game research, i.e. creating an entertaining computer player, is now a possible goal, even for the game of Go.

In this research, we aim at producing a computer player able to perform “Go-teaching games” (Shidou-Go in Japanese, shidou means coaching or teaching). Such computer player would be quite useful for human players, to improve their ability at the game of Go. Go-teaching games are usually played between one relatively strong player as an instructor and a weaker

player as a student. This kind of training is rare in other games such as Mahjong but popular and important in the case of Go. There are many styles of Go-teaching games. Advice from the stronger player can be given during the game itself or only after the game. Also, the instructor can coach only one student at once, or sometimes three or more students at once. In any case, it is known to be effective to follow such training repeatedly and regularly for improving the skills at playing Go.

Nowadays, almost all Go-teaching games are performed by high rank human players. However, it should be noted that strong players are not necessarily able to guide well all players. It is required for the coaching to be effective that adequate moves and adequate comments are chosen, depending on the student level. Especially, in the case of Go-teaching games among the same family members, it is often reported that the stronger player becomes emotional and cannot be a good teacher. To get a good-quality lesson, hiring professional instructors is one possible way. However the price for such professional instructors is usually expensive, for example the official price of the Nihon-Kiin (Japan Go Association) is 3600 Yen for one game, even when the student is a paid member of the Nihon-Kiin. It is not a price that all players can afford easily for learning. Thus, for a wider spreading of the game of Go, it is valuable to create computer players able to conduct Go-teaching games.

As the first step of this research, we have attended some lessons in a local Go club and Nihon-kiin, and investigated by interviews which kind of lessons are done by human instructors and which points are important. Mainly two styles of lessons are done. One is a lecture for many students like the ones done in high-schools for usual school topics, and the other is Go-teaching games. In the case of a lecture, some Go problems are shown by the instructor, the students try to solve them, and the instructor show the answer and explain the reasons. In the case of Go-teaching games, it has been found that many things should be considered for doing a good lesson, such as "estimating students' level", "playing gently, producing a good game", "avoiding unnatural moves for producing a good game", or "using various strategies". Such points have already been tried in the case of "Settai-Go" research, where the computer player tries to entertain the human player. The only difference is that Go-teaching games also require

an "explanation of the bad moves" that were played by the student player.

We have also investigated the case of textbooks of Go. There are many styles, but it was found that a large part of the textbooks has a similar style. A problem is shown on one page, and the next page shows the answer and explanation by using some figures, which represent the "correct answer and expected result", the "correct answer and another variation", or the "bad move and expected result". By summarizing and analyzing the result of this investigation, we have reached a conclusion that we should implement a function to do an "explanation of the bad moves played" after entertaining games. The implementation needs the following steps: 1) detecting bad moves, 2) making an explanation on why it is bad, 3) making an explanation on the consequence, and 4) making some figures especially about the "correct answer and expected result".

Next, we decided the range of bad moves dealt in our research. There are many possible definitions of "bad move", for example all moves except the best move defined by a min-max algorithm can be called bad moves. But usually, only moves which produce very bad results, or which produce bad results quite surely, are called bad moves. Of course we should be careful to the level of the players. A move losing 2 points should be called a bad move among professional players, but should not be called that among beginners. In many cases, bad moves can be categorized in some groups depending on the reasons why they are bad. We made a list of the groups after investigation, and considered how they can be defined and categorized not by natural language but by a computer program. It was found that some of them are difficult to detect or categorize by simple rules, so this difficult category of bad moves will not be addressed in this research.

Detection of bad moves can be done by comparing the winning ratio of a move to the winning ratio of the best move, by using a standard computer Go program. After that, they are categorized by some rules and the reason why it is bad is explained by using some natural language template, like "A11 Nobi was bad. This is far from the battle field". Also, the consequence of the bad move is explained, like "by white F2 Cut, your stones are killed". Finally, the correct answer and the expected result is shown like "Here F2 Tsugi was better. After 5 moves it is clear that your stones are alive." For this purpose, we found that some functions of

a standard Go program could be used, and that some extensions of them were also required. For example, the "ownership" is a common statistics of recent Go programs. It can be used to evaluate the strength of each stone, and whether it is likely to be alive or to be killed. Another example is how to create explicative figures about a specific area of the board. It is possible to limit the computation of "the best move" to a target board area, so that "the best move in this area" is computed. The contribution of this research is to investigate and summarize the list of required elements for Go-teaching games, and to show how to implement these elements by using standard computer Go programs.