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Efficiency of GameTreeSearch in Turn-based StrategyGame, by using Abstraction of Legal Moves

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There are researches on game tree search or machine learning applied to chess, shogi, or Go as parts of AI research. With the advance of such researches and the increase in computational resources, a chess program DEEPBLUE won against the human chess champion in 1997. Also in shogi, some advanced AI techniques enabled computer programs to gain competitiveness comparable to professional players and sufficient for most amateur players.

On the other hand there are types of games with rules more complex than chess or Shogi and for which AI players competitive against human players are hardly obtained by the conventional techniques. One example is turn-based strategy games in which players can move multiple pieces in a turn, even though these games are categorized as a finite two-person zero-sum game with perfect information, like chess or shogi.

Additionally there are not many open-sources programs of turn-based strategy games for researchers, unlike what can be found for other types of games such as BWAPI for StarCraft, Bonanza for shogi or Poje for Puyo-Puyo. Moreover a general framework of rules of turn-based strategy games for researchers is not determined yet. Thus, in this study we try to solve the two problems that there are no platforms or no general frameworks for the rules and that computer players are still not competitive enough.

At first, we listed 25 game features from existing strategy games and grouped the types of the games. After that, we picked 17 representative existing strategy games out and used cluster analysis on the 13 game features. In the analysis we observed that the group of turn-based strategy games (without other complex factors as stated below) is located halfway between the group of chess or shogi and the groups of more complicated strategy games, for example the strategy games being real-time, imperfect-information or adopting RPG-like systems. As a result we decided to design a framework for a simplified turn-based strategy game as the next target of chess or shogi, in which the ruleset consists of the principal rules of turn-based strategy games but does not contain more complex rules shown in already existing games.

For our purpose, we simplified the rules of "Fami-com Wars DS2 'Advance Wars Days Of Ruin'" that is sophisticated enough and contains many essential factors that most existing turn-based strategy games have in common. We set the rules according to 6 policies that should guarantee the soundness in researches using the platform, and make the researches reproducible.

Secondly, we implemented the research platform. We took more seriously into account the appropriateness for research than the entertainment of the game itself. The system provides several options for research. For example, there are three types of games possible, human versus human, human versus AI, and AI versus AI games. Options for manipulating game records are available, like save, load and review. Besides we provide the libraries for AI developers on the platform. This platform is named "TUBSTAP" an acronym for TUrN-Based-STrategy-Academic-Package and is available through the website of the JAIST Ikeda laboratory. Some laboratories of other universities or technical colleges have already started to use this platform for game AI researches.

In addition to the implementation of the platform, we tried to improve the algorithm of AI players on turn-based strategy games. The AI players sometimes seem to take foolish actions in existing strategy games like "Dai-senryaku" or "Fami-com wars". One of the reasons is that the number of possible actions in each turn is quite larger than other games and the alpha-beta search or the Monte-Carlo tree search algorithms do not

work well, unlike chess, shogi or Go games. But there are many similar piece moves in such games. For example the moves of retreating from the opponent's pieces are not the same but the differences seldom affect the situations. Thus, we tried to group some types of piece moves and limit the number of possible moves in the game tree search. We applied the method to the AI player in "TUBSTAP" and all piece moves are divided into two groups, the moves of retreating from or approaching to the opponent's pieces. Additionally, we did comparative experiments on 4 ways of grouping the piece moves. As a result, in one setting the UCT search with the grouping won against the UCT search without the grouping with a win rate of 63.1%.