# Towards strong solutions

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## TOWARDS STRONG SOLUTIONS

Many researchers are attracted by the idea to develop a method that is able to solve a game. When one investigates this research aim more closely two possible approaches come to the fore. First, there are the game-playing researchers who love the game and would like to know everything about it. They usually have expert knowledge of that specific game and aim at developing a game-dependent method that solves their game. Second, there are the AI specialists, well-known for their deep understanding of the knowledge-and-search approaches as practised in the game-playing community. They know that they have a powerful tool at their disposal, and they search for an application domain, typically a game not yet solved.

Solving a game is something like revealing a mystery. However, in everyday research terminology it is nothing more than determining a property with regard to the outcome of the game. In his thesis Victor Allis distinguished three types of game solutions: ultra-weak, weak and strong. An ultra-weak solution means that the game-theoretic value of the initial position of the game has been established (e.g., Hex is a win for the first player). A weak solution means that for the initial position a strategy has been determined to obtain at least the game-theoretic value (e.g., the winning strategy for Go-moku and Renju). A strong solution means that for all legal positions a strategy has been determined to obtain the game theoretic value (e.g., the chess endgame databases).

The current issue of the Journal deals with solving games as can be read from Tristan Cazenave's contribution, Alexander Nosovsky's call for solutions, and Eugene Nalimov's brief scientific biography. This is the place to warn the reader explicitly that (1) different games may have the same name and (2) the same game may have different names. We provide two examples and encourage our readers from now on to read all related articles with this warning in mind. According to Lasker (1934) the Japanese game of Go-moku has two restrictions (see

p. 47 of this issue) but in the Western world the latter have disappeared. The Japanese version is now called Renju, and Go-moku has ousted the correct name of Five in a Row. Moreover, there are many other names, mostly country dependent (see again p. 47). Other appearances of at least two names for the same game are the couple: Phutball and Philosopher's Football, as well as Atari-Go and Ponnuki-Go.

Tristan Cazenave is a researcher who clearly belongs to the group of scientists that possess a powerful tool and are searching for an appropriate application domain. In the past Cazenave developed the technique of Abstract Proof Search (APS) and he has recently extended the technique to Gradual Abstract Proof Search (GAPS). To see how powerful it is, he went to the world of "small games", i.e., games that are pocket editions of the original game. This well-known technique was used to solve Domineering and is applied in Othello (solving 6x6 Othello) as well as in the domain of chess and checkers (endgame databases). Cazenave has now solved two versions of Phutball, namely for a 9x9 and an 11x11 grid. The original game, invented by Conway, is usually played on a 19x15 grid (or on a 19x19 Go Board). So, there is still some way to go. Nevertheless the performance deserves our admiration.

Cazenave's technique allowed him to solve some smaller versions of the game Atari-Go, too. There he solved 6x6 Atari-Go with a crosscut. The "official" definition of Atari-Go is for 9x9 or even 19x19 boards (without a crosscut). Assuming it is possible to go down this road, there will certainly be a very long way to go. Personal communication with colleague researcher Erik van der Werf revealed the latter's research activities in the domain of Ponnuki-Go. Van der Werf, independently, has solved the plain 5x5 version and all 6x6 versions with a symmetrical centre, a crosscut being among them.

Cazenave's technique used for solving these games is a generalisation of threat-space search, a technique where at any time the opponent has only a limited set of replies. Hence, the search algorithm represents the application of a single-agent search to two-player games. Victor Allis called an analogous generalisation Dependency-Based Search, a name which has never been adopted by other researchers, though it describes in general terms remarkably well the method how to solve a game. The essence is twofold: for the knowledge expert it is the true application of what the expert knows, and for the search expert it is a straightforward doubling of the search depth.

Reviewing the current state of the art, your Editor concludes that two different tasks remain for the game researchers. First, to continue the process of solving "little brother" games such as 13x13 Phutball, 6x6 Atari-Go without crosscut and 6-piece chess endgames with Pawns, etc. as advocated by Cazenave and Nalimov. Second, to start extensive research on "solving" all legal positions of a game, such as Nosovsky calls for with respect to Renju. The latter can be tested in problem-solving competitions. Although the future of this Journal is not specifically bounded to solving games, as is proved by the current contributions on Alpha-Beta-Conspiracy Number Search and Transposition Tables, we wholeheartedly encourage researchers to report on their domain-dependent optimisations since we consider them as a major step towards a deeper understanding of the intricacies of a game.

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