REVIEW

CONTROLLED CONSPIRACY NUMBER SEARCH

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Ph.D. thesis University of Paderborn
(in German) 140 pp.
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Reviewed by Dap Hartmann

To reduce the exponential growth of the game tree, virtually all strong chess programs use the α–β algorithm (or similar algorithms, such as *NegaScout*) as an enhancement to the *MiniMax* search. For well-ordered trees, the reduction in the search effort generally exceeds 90%, while the outcome of the search remains unaltered. However, the major shortcoming of this type of tree searching is that it provides no information about the reliability of the scores which are propagated up towards the root. As these scores ultimately decide which of the legal moves is the best move to play, it seems somewhat careless not to have a measure of their reliability. Moreover, generally only the precise score (evaluation) of the best move is known; the score of the other moves is merely 'lower'.

In 1988, David McAllester (1988) published a paper on an ingenious new algorithm which establishes a reliable best move: *Conspiracy Number Search* (CNS). A *Conspiracy Number* (CN) is a measure for the number of leaf nodes that must change their value for the score at the root of the search tree to change. A move for which the score ultimately hinges on just a single leaf node, is critically dependent on the correctness of this one particular call to the evaluation function. So, obviously, a higher conspiracy number indicates a more stable, more reliable move.

Implementations of CNS in chess programs (for example, by Schaeffer (1989) and by Van der Meulen (1990)) exhibit solid playing strength and stability in tactical positions, but there is also a price to pay. It is difficult to control the expansion of the search tree, and at every node a vector of CN values must be maintained. The size of these vectors greatly depends on the resolution (graininess) of the evaluation function. And, as with every best-first search, the entire search tree must be stored in memory.

In his thesis, Ulf Lorenz attempts to overcome some of these problems, in particular the rapid expansion of the search tree. He developed the so-called *Controlled Conspiracy Number Search* (CCNS), which uses target-oriented searching to confine the expansion. The algorithm is carefully described in the 40 pages of Chapter 2. In the next chapter, the CCNS algorithm is parallelized. The achieved efficiency for 160 processors is about 30%, and the question remains whether this figure can be improved upon. Chapter 4 analyzes the propagation in a game tree of errors due to an imperfect evaluation function. The (appropriate) conclusion is that the use of Conspiracy Numbers is highly desirable. An important concept throughout this thesis is that of 'leafnode disjunct strategies'. Two strategies are said to be 'leafnode disjunct' when they share no common leaf nodes. They may, however, share internal nodes.

How well does a chess program using CCNS perform? The algorithm was implemented in the 'world-class chess program' CONNERS (single-processor version; the multi-processor parallel version is preceded by 'P.'). Lorenz presents a table comparing CONNERS (using CCNS) with various other chess programs in the BT2630 test. But, as all these programs ran on different computer platforms and at various clock rates, a comparison is not very meaningful. The only tentative conclusion that may be drawn from this experimént, is that the single-processor version of CONNERS (using CCNS) performs as well (pseudo-Elo = 2402) as some of the best commercial chess programs (FRITZ, HIARCS). The pseudo-Elo rating for P.CONNERS peaks at 2589 points, when using 79 processors. Doubling that number of CPUs did not further improve the score. One should also keep in mind that BT2630 is basically a tactical (albeit very difficulty) test. A similarly rather meaningless statistic was obtained from a test match of 100 games against CHEIRON'97 (which achieved the lowest score in the BT2630 test). CONNERS (with CCNS) lost this match by 6 points. Running on hardware consisting of 160 Pentium II-450 MHz processors, P.CONNERS won the 10th Grandmaster Tournament (Category 11) in Lippstad (2000) with a score of +6=3–2. An impressive result (Lorenz, 2000).

Clear descriptions and abundant examples make this thesis a pleasure to read. Unfortunately, the title is the only English sentence in the entire work. Not even an English summary is provided. This is a pity. I believe that the German educational system has revised its ordinance that a thesis must be presented in the German language. This silly rule has considerably disadvantaged German scientists in the past, as they had to rewrite their work in English to make it accessible to a world-wide audience. If I am not mistaken, and this rule was indeed abolished, I cannot understand why anyone would persist in presenting their scientific research in German. I therefor strongly encourage Ulf Lorenz to transform this fine Ph.D. thesis into articles for the *ICGA Journal*. That is not a trivial undertaking, but other people in the field deserve to learn the intricacies of *Controlled Conspiracy Number Search*.

References

Lorenz, U. (2000). P.CONNERS Wins the 10^{th} Grandmaster Tournament in Lippstadt (Germany). *ICGA Journal*, Vol. 23, No.3, pp. 189-191.

McAllester, D.A. (1988). Conspiracy Numbers for Min-Max Search. *Artificial Intelligence*, Vol. 35, pp. 287-310. ISSN 0004-3702.

Meulen, M. van der (1990). Conspiracy-Number Search. *ICCA Journal*, Vol. 13, No. 1, pp. 3-14.

Schaeffer, J. (1989). Conspiracy Numbers. *Artificial Intelligence*, Vol. 43, No. 1, pp. 67-84. ISSN 0004-3702.

Photo by Jeff Rollason

Players and Spectators at the CMG Sixth Computer Olympiad.
Maastricht, The Netherlands, August 18-23, 2001.