CORRESPONDENCE

LIMITED COMPETITION

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In my article (Good, 1967, p. 90), I said "The more the program is based on the methods used by humans the more light it will shed on the nature of thought processes. But for the sake of a clear-cut objective I should like to write a program that wins games."

I still believe what I said then, although I have left the hard work of programming to others. But the power of "brute force" has somewhat undermined the goal of the first sentence. To serve that goal, it would be useful to introduce a new kind of competition between programs in which, for any given move, the machine is not allowed to examine more than say 100 or 1000 positions. I am not saying that such competitions should replace the current ones, but that they should be held in addition. If the machines stated the reasons for their moves, these competitions would be of great value to cognitive psychology, to AI, and to chess-players.

Reference

Good, I.J. (1967). A five-year plan for automatic chess. *Machine Intelligence II* (eds. E. Dale and D. Michie), pp. 89-118. Oliver and Boyd, Edinburgh.

LIMITED COMPUTATION I

Ray Lopez

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It was reported in the March 1993 *ICCA Journal*, p. 49, that Monroe Newborn predicted that "200 years from now, computers may be powerful enough to solve the game of chess". This statement should not be taken too seriously, in part because of the time span involved (predicting next year's advance is tricky enough) but more importantly, because of certain theoretical barriers to solving the game of chess.

For instance, using arguments based on quantum mechanics, H.J. Bremermann has conjectured that no computer, either living or artificial, can process more than 2×10^{47} bits of information per gram of its mass per second. [Bremermann, H.J. "Optimization through Evolution and Recombination" in *Self-organizing Systems* (eds. M.C. Yovits *et al.*), pp. 93-106, Spartan Books, Washington D.C., 1962].

If this is true, a computer the size of the earth (6×10^{27} g) operating continuously for a period equal to the estimated age of the earth (10^{10} years) could process fewer than 10^{93} bits. This number is considerably less than the number of possible sequences of moves in chess games of 40 moves by both sides, which has been estimated at 10^{120} [first suggested by C.E. Shannon in "Programming a Computer for Playing Chess", *Philosophical Magazine*, Vol. 41, No. 7, pp. 256-275, 1950].

LIMITED COMPUTATION II

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If a computer had to search all 10^{120} lines of play, there is no question that Ray is correct. However, my case was based on the observation that most of these lines need be followed only a short way before it becomes clear who the eventual winner will be. Exactly what "clear" is depends on who you talk to, I suppose, but the top players in the world play a very small number of different lines. To them, it is clear that most lines are bad and can be shown to be so quite quickly.

To "solve the game of chess" in the strictest mathematical sense may be feasible if it turns out that one can prove victory in a sufficient number of non-mate positions. Databases already do this for all games with five or fewer pieces, and for a number of endgames with six men. In two hundred years, much larger databases will exist. In addition, if it turns out that a number of rules can be established that are sufficient to declare non-mate positions won or lost, then it may also come to pass that the game is solved. If a Queen's advantage held for, say, ten moves can be shown always to win (I'm not sure it can be shown nor am I sure it is always the case. If not, then perhaps additional conditions may suffice to prove victory), then many lines can be cut short.

My intuition has led me to believe there may be only several trillion lines, or maybe several thousand trillion lines that need to be explored after 20 moves are made. [One trillion is 10^{12} here. — Eds.] Such figures should not be very threatening to the capabilities of computers two centuries from now. It is quite likely that the "effective branching factor" of a chess tree is less than two. With an effective branching factor of two, (and putting $2^{20} = 10^6 = 1{,}000{,}000$), then a computer would find about one trillion positions after 20 moves are made.

Perhaps my prediction was motivated by my observations over the years of how some people have consistently overestimated their human chess talent while glorifying the complexity of the game. Perhaps it is not as complex as we imagine.

INTERNET CHESS RETRIEVAL

The Editors have received a communication from Udo Sprute, Oetternbachstr. 44, D-32791 Lage, Germany (sprute@Post.Uni.Bielefeld.DE) in which he notes that a great deal of chess-relevant information is available in the public domain on Internet. The difficulty is that of retrieval of the material, be it in the forms of text files, executable files, or even interactive facilities. He notes, with the Editors, that they range from trivial texts in BASIC to chances to play the world's best interactively. The Editors recognize the problem as being acute and likely to become more pressing as time goes by. We suggest that the ICCA has a duty to assist in retrieval of the upper range of what is available but has not, so far, given due consideration to ways and means. While awaiting action at ICCA Board level, we suggest you send your constructive proposal to Udo Sprute copying any Board member by Email when you do.