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Book reviews

The Thinking Computer: Mind Inside Matter

By B. Raphael. 1976. San Francisco: W. H. Freeman and Co. 322+xiii pp. Paperback $6.95, Hardcover $12.95.

Most of the topics which have been associated with "artificial intelligence" are mentioned in this book. The author includes descriptions of general computer hardware and software, lots of illustrations, chapter summaries, lists of suggested readings and an index in 322 smallish pages. Thus, the depth of treatment of individual topics is generally limited. Roughly 40% of the material is related to problem-solving in the narrow, mathematical, game, theorem sense and 40% to the broader, perception, robots sense. Searching (trees, graphs) and theorem proving have relatively large coverage, very similar to that of Nilsson's book (1971).

The stated aim of the book is to attempt to explain why workers in A.I. are trying to make computers intelligent; and to indicate progress so far, directions of research, obstacles to further progress, as well as the importance of the field. It is also intended as an attempt to clear up confusion, to stimulate the reader, to fill the gap between superficiality and technicality, to answer various questions, and to clear away some misleading myths. The author believes that any reader with a good high school education should be able to enjoy the book; that it could be used as a text in a new elementary college course, as supplementary reading for some standard courses and perhaps be of interest to the general public. There is probably some truth in all of these beliefs, as well as some success in most of its aims and intentions.

Those who might be looking for more than highlights will probably be dissatisfied, for the text contains many superficialities, over generalizations, non-sequiturs and vague pseudo-definitions. The following two examples are typical, and, if not seriously disturbing, are at least disappointing.

> "A common grouping in a location—called the *word length*—is eight bits whose indicators can be arranged in 256 different ways." (page 8)

and:

> "We shall use the word 'knowledge' to refer to what used to be called 'information': to mean, roughly speaking, the data that must be transmitted through a communication channel in order to convey a message, not in all its detail but well enough for the receiver to understand its meaning." (page 47).

The author then states that he will be careful not to give "knowledge" a precise technical definition, and, although there are 13 references to knowledge in the index, this occurrence is not referenced, nor does it seem to be applied. The suggested readings are just that, and are not adequately keyed to the text to enable the reader to pursue directly an object or term mentioned.

In both style and contents it resembles an A.I. film, and, if used in a course with a competent instructor, it would probably be harmless, possibly stimulating and useful. In less favorable circumstances it might well create more confusion than it would eliminate.

Reference

NILSSON, N. J. (1971). *Problem Solving Methods in Artificial Intelligence.* New York: McGraw-Hill.

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The World Computer Chess Championship

By J. E. Hayes and David N. L. Levy. 1976. Edinburgh: Edinburgh University Press. 105 pp. £3.75.

As background for the review of this book I quote from an unsuccessful application for a grant in 1972:

> "One of the best fields for research in machine intelligence is the programming of the game

of chess. . . . The various aspects of the intellect, such as pattern perception, concept formation, hypothesis formulation including generalization, problem-solving and planning, imagination, creativity, and the handling of descriptions, all have an important place in chess. Chess has the further advantage over the general manipulation of language that the vocabulary required is of the order of only a few hundred words instead of about 20,000, so that the task of handling natural language in chess is not prohibitively large.

Chess programs to date all depend heavily on evaluation functions in which the emphasis is on mobility. This is especially important in the opening and middle game, but in the endgame the use of planning and of descriptions come more to the fore, and it is here that existing programs are weakest. . . .

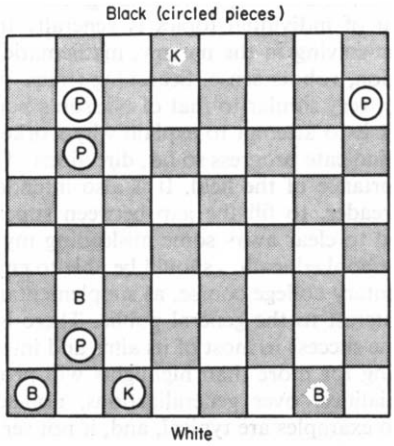

FIG. 1. White to play and win.

For its entertainment value, Fig. 1 gives an endgame composition by Naiderashvili, in which White is to play and win (in an unspecified number of moves). No existing chess program would have any chance of solving this problem. (Still true in 1976.) Its solution shows very clearly that several aspects of the intellect mentioned above must be incorporated into a highly efficient computer program."

Since the ultra-intelligence machine is the last invention that Man need make, and since a computer program of Grandmaster strength would bring us within an ace of that invention, it follows that chess programming is potentially the most important field for scientific research. But, according to a survey reported on pages 7 and 8 of the book under review, only 5 out of 42 people thought chess-programming was worth supporting by the tax-payer. I can't imagine a crowd of alumni singing their Alma Mater after a chess match. Therefore, since we live in a democracy, and because granting foundations are scared of Senator Proxmire's sarcasm, the financial support is negligible in comparison with that for athletics. This might also help to explain why the Russians won the first large-scale international tournament between chess programs. This tournament was held under the auspices of the International Federation for Information Processing in August 1974.

The book under review gives a full account of the games of this tournament, together with interesting related matters. The chapter headings are (1) A short history of computer chess, (2) The Stockholm championship, (3) Concepts and mechanisms of computer chess, (4) Glossary of chess and computer chess terms, (5) Notes on the computer programs, (6) Chess thinking; followed by a Bibliography, and two appendices. Chapter 2, of 44 pages, is by the International Chess Master David N. L. Levy, and the other chapters are by Jean E. Hayes. Levy is an experienced chess writer and Jean Hayes is editor of *Firbush News* and was once editor of the magazine *Girl*, so the style is excellent, with several witty patches. But there are a few obscurities in the detailed accounts of the specific programs (supplied by the programmers) and this is to be expected because many masters of high-level computer languages have been too busy to master any natural languages. I found no errors in the notes on the games (apart from misprints on pages 32 and 46).

There were thirteen competitors (programs) in the tournament, and four rounds. KAISSA (Institute of Control Science, U.S.S.R), won the tournament (and a gold medal) with four points, and CHESS 4.0 (Northwestern University, Illinois), RIBBIT (Waterloo, Canada), and CHAOS (Blue Bell, Pennsylvania) were second, third and fourth, with three points each. A table is given of the number of man-years devoted to each program, and we can deduce that the correlation coefficient between these efforts and the ranks in the tournament is about −0·7, naturally negative. There is also some positive correlation between success and length of program.

Judging by the accounts of the programs, they do not contain many ideas that have not already appeared in print, but there is a big difference between an idea and its implementation. One of the most ambitious and interesting techniques is "the method of analogies" in the KAISSA write-up. This attempts to group chess positions into categories so as to cut down search time.

All the programs make use of the "alpha-beta" method, a characterization of which, by American Chess Master Charles Kalme, is given on page 63: "a method by which a program can discard a bad move without having to search continuations to find out just how bad it is". It does not seem to be generally realized that *this alpha-beta method could be applied to tree-searches in general, and specifically to automated medical diagnosis.* This is one potential spin-off from chess programming.

A technique not used by any of the programs, and which has been pioneered by Donald Michie, is the use of Advice Tables. These resemble the useful but dull Decision Tables employed especially in Industrial Planning.

The Rules of the tournament are given on pages 12 and 13. These do not state how the games were supervised. Although computers, unlike athletes, cannot take drugs, it may be tempting for the programmers to go into synergy with the computer! Hence careful supervision is required by a member of the IBM (International Brotherhood of Magicians), or else the programs should be supplied to the judges, together with any parameters used for the generation of pseudo-random numbers. The latter method has the disadvantage that the programmers might wish to keep the details of their programs to themselves.

It is also not stated whether a computer is allowed to "think" on its opponent's time. If this is permitted it would affect the optimal computer strategy which in any case should allow for the state of the chess clocks. When the computer gets short of time it should carry out less exhaustive analysis. That computers do so is supported by the statistics, for seven games were "lost on the clock" and in all these cases the loser already had a lost game on the board.

The tournament consisted of 24 games, and was followed by an interesting friendly exhibition game between KAISSA and CHESS 4·0, since these two programs had not previously met. This game was a hard-fought draw, and I think CHESS 4·0 was a little unlucky not to win. modulo computer chess. My independent account of this game was given in *Firbush News-5*. The game finished with very few men left on the board, which is what would happen in a real war instead of a war-game. Levy says of one of CHESS's moves "How can America's strongest program make an oversight like this?" This reminded me of a chess event in Russia when the spectators began to shout "We paid good rubles to watch chess like this!"

All the games are interestingly reported. CHAOS make a good positional sacrifice against CHESS 4·0 and Levy says "As far as I know this is the first example of a (good) positional sacrifice being made by a computer program". In a comment on one game he says "The culmination of Black's Q-side strategy—his rook has trapped itself", with the exclamation mark quietly omitted. On page 20 he says "Black knows he is winning". Computer's Lib. would prefer the pronoun "it". Some of the bad moves are left unexplained.

I thoroughly enjoyed reading the whole book and found little to disagree with. But the number of possible games of chess is much greater than the figure 10^{120} given on page 55. This is more like the number of possible *well-played* games. (See my "Five-year plan for automatic chess", p. 108.)

Jean Hayes says on page 59 "No-one as far as we know has ever suggested a forced win for Black!" Many years ago I did make such a suggestion as an intellectual joke. It runs as follows: The first player to move a pawn weakens his pawn structure. Therefore best play goes 1 N-B3, N-B3, 2 N-B3, N-B3 and now White must either weaken his pawn structure or put a knight out of play, after which Black plays P-K4 and is two moves ahead in development!

In Appendix 1, Hans Berliner reports a game he played against CHESS 4·0, giving odds of a queen, and not losing too badly. It contains, in the analysis a good example of what Berliner calls the "Horizon effect". In Appendix 2, a report is given of the famous bet made in 1968, between Levy and others, including Donald Michie, that no program will beat Levy in a match before 31 August, 1978. The time is running out fast. Michie has expressed the fear that much chess is played with the right hemisphere of the brain, and so is inaccessible to exact analysis. Certainly the brain is in a sense a pushdown store; we push habitual thoughts down at least to the preconscious level. A good programmer needs to be good at introspection, and might even need to dig into the unconscious mind of the grandmaster.

The World Computer Championship in Stockholm was a historic occasion and it merited this excellent write-up by Hayes and Levy.

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