Book Review

**Machine Intelligence 1.** By N. L. Collins and D. Michie.

**Machine Intelligence 2.** By E. Dale and D. Michie.

**Machine Intelligence 3.** By D. Michie.

In the general scientific community, research in Artificial Intelligence is often thought of as the creation of elaborate toys. This attitude arises, in part, from a tendency within the field to emphasize the performance of programs rather than the principles underlying them. European workers, perhaps because of a scarcity of tempting powerful machines, have tended to concentrate more on fundamentals. Some of their best work has appeared in the Machine Intelligence (MI) series.

Starting in 1965, the Machine Intelligence workshop has been held annually in Edinburgh, Scotland. The proceedings of the first three workshops are reviewed here; the proceedings of the 1968 workshop (MI4) will be published this year (the fifth workshop will be held at Stanford early this year). Although it started as a local showcase, the Machine Intelligence workshop is becoming an important international event.

The three MI volumes in print have all been divided into the same five subject areas: Abstract Foundations, Automatic Theorem Proving, Heuristic Programming, Programming Languages, and Methods and Models of Cognitive Processing. We will discuss each of these areas, concentrating on the more recent work.

Several of the papers on Abstract Foundations are concerned with the representation of programs as graphs, usually for the purpose of proving that programs halt or are equivalent. This work has been largely superseded by the results of Floyd and Manna (1969) and would be of interest to specialists only. The paper by Patterson in MI3 contains a number of new unsolvability results on program schemata. The other foundation papers concern themselves with formal descriptions of programming constructs; these contain no significant results, only representations which may lead to them. The study of data structures by Lasky and of automata models of compilers by Florentin (both in MI3) both seem to be potentially useful.

The work on Automatic Theorem Proving is the long suit of the Machine Intelligence series; with the forthcoming Volume 4, the series clearly becomes the leading periodical covering the field. Almost of all the work follows the ideas of J. A. Robinson in using the Herbrand formulation and some resolution strategy. A theorem is proved by showing that the set of clauses (in prenex conjunctive normal form) consisting of the axioms and the negation of the theorem is unsatisfiable in all models. There are a number of different strategies for combining (resolving) clauses to successively reduce the class of models which might satisfy
the set of clauses. Darlington in MI2 and Luckham in MI3 describe experiments with various resolution strategies and suggest some improvements. Papers by Meltzer, Luckham and J. A. Robinson in MI3 are concerned with a better formulation of the problem of mechanical theorem proving. The Robinson paper presents the notion of semantic trees which has been very fruitful.

One major problem in any automatic theorem proving system is the treatment of equality. If the axioms of equality are included in the usual way, the program will produce many extraneous clauses. Several papers in MI3 suggest possible treatments of equality and the Darlington paper makes a specific suggestion that is one of several receiving attention.

The sections on Heuristic Programming (also called Machine Learning) contain relatively few papers of theoretical value. There are a number of discussions of particular games and some speculative papers, which will not be discussed here. One result of the work on game-playing programs has been the consideration of the general problem of graph searching; the papers by Michie, Burstall, and Doran in MI1 and MI2 provide a good introduction and some results in this area. In MI3, Michie, Fleming and Oldfield present some results on automatic, human, and combined efforts on the travelling salesman problem. Also in MI3 are a long paper by Amarel describing how he was able to devise successively better representations for the "missionaries and cannibals" problem and a paper by Varshavsky describe some theoretical and experimental work on collections on finite automata which is currently being done in the Soviet Union.

The sections on Programming Languages contain very little material that is not available elsewhere. There are several papers on POP-2, a language developed at Edinburgh for artificial intelligence applications. The language is in the tradition of LISP, but provides more convenient syntax and a variety of data structures. One of the bases for POP-2 was the work of Landin and Strachey on \( \lambda \)-calculus formulation of semantics. This point of view is used in MI3 by Park and Burstall in considering data structures and search trees, respectively.

The sections on Cognitive Processes: Methods and Models contain much less information than would a comparable collection of American papers. There is, however, an important pair of papers on automatic parsing by Bratley and Dakin in MI2 and by Thorne, Bratley, and Dewar in MI3. Several attempts at automatic parsing of natural language sentences using elaborate phrase structure or transformational grammars have had disappointing results. The formal linguistic models have also been unsatisfactory as a model of human performance. Of the many attempts by workers in Artificial Intelligence to reformulate the parsing problem, the ones described by Thorne et al. is perhaps the most interesting.

The dictionary has listings for only those words (closed class words) with syntactic functions, e.g., prepositions, conjunctions, certain verbs, and suffixes. All other words are considered open class and can, \textit{a priori}, be used as any part of speech. Other interesting features include a finite-state base component and the generation of a "deep structure" in a single pass. There are immense theoretical and practical problems remaining with this formulation, but it deserves and is receiving wide attention.
There are a number of other interesting papers of an experimental or expository nature in the MI series. The forthcoming journal of artificial intelligence will hopefully provide somewhat broader coverage, but in the interim, the Machine Intelligence series has provided an excellent service to the field.

REFERENCE


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