

BOOK REVIEWS

LOGICS FOR ARTIFICIAL INTELLIGENCE, by Raymond Turner.
Chichester: Ellis Horwood, (1985) pp. 178

One of the most exciting recent trends in computer science is the application of philosophical work in logic and epistemology to problems in AI (artificial intelligence). AI research is nothing if not eclectic in inspiration, and much use has been made of philosophy. The book under review is a case in point, for it surveys non-standard logic with an eye to its use in two key areas of AI: the representation of knowledge and the design of "inference engines".

Turner's book begins with a brief discussion of what "non-standard" logics are. (The term "non-standard" is preferable to the term "deviant", which is still used by many philosophers). Non-standard logics include: modal, temporal, many-valued, epistemic, intuitionistic, and other recent systems. As Turner notes, while non-standard logics have been investigated by philosophers and logicians since the 1930's at least, it was only in the late 1960's that McCarthy and others began to exploit those resources, in AI.

In the second chapter, Turner takes up the topic of modal logic, and its descendant temporal logic. He describes how the syntax of modal logic, interpreted in terms of possible worlds, can be re-interpreted in a way more useful to computer scientists, viz., as states of an underlying machine. He then explains how the basic concepts of dynamic logic can be defined. He finishes the chapter by briefly discussing Moore's recent modal logic of knowledge and action, which may be of use in AI.

In chapter 3, many-valued logic is reviewed. Turner focuses on the three-valued logics of Kleene, Lukasiewicz, and Bochvar. (Kleene's logic was developed to accommodate undecided mathematical statements, so has a third truth value "u" for "undecided". Lukasiewicz's logic was developed to accommodate future contingents, so has a third truth value "i" for "indeterminate". Bochvar's logic was developed to accommodate semantic paradoxes, so has a third truth-value "m" for "meaningless".) The chapter finishes by tying in the three-valued systems of Bochvar and Kleene with non-monotonic reasoning.

In chapter 4, Turner discusses Martin-Lof's intuitionist logic. He rightly notes the importance of Bishop's work in the mid-1960's, which showed that many of the results of classical mathematics can be obtained

BOOK REVIEWS

intuitionistically. He devotes some detail to an exposition of Martin-Lof's theory of types, and shows how to reinterpret it as a kind of programming language. Roughly, he reinterprets an intuitionistic judgement $a \in A$, i.e., that a is a construction which proves A , as meaning that a is a program which achieves task specification A . He reviews an example (due to Nordstrom and Smith) of an intuitionist programming language. The result is quite attractive: at once, you have a specification language, a (purely functional) programming language, *and* a formal device for deriving programs from their specifications (thus verifying the adequacy of the programs).

Chapter 5 covers non-monotonic logics, i.e., logical systems in which the addition of new information (axioms) can invalidate old information (theorems). Non-monotonic logic is of great interest in AI. Turner reviews the nonmonotonic system of McDermott and Doyle, which is a type of modal logic. He also reviews the markedly different approach to nonmonotonic inference of Gabbay, which bases nonmonotonic logic on intuitionism. The chapter ends with a brief discussion of Moore's autoepistemic logic.

Chapter 6 is devoted to yet another variant of modal logic, viz., temporal logic. Turner reviews the temporal semantics of modal operations, and reviews various axiom systems. He then focusses on two particular temporal logics, McDermott's system (which has an event-based ontology) and Allen's (which has an interval based ontology). Turner gives some very useful criticisms of both systems. He concludes the chapter by discussing the work by Manna, Pnueli, and others applying temporal logic to the specification and verification of concurrent programs.

In chapter 7, fuzzy logic and its application to expert systems is discussed. His discussion, of course, focusses on the work of Zadeh, who virtually created the subject. Chapter 8 briefly discusses many-sorted logic, and prospects for the future use of non-standard logic in AI.

Turner's book has a number of good features. It is clearly written at a level accessible to undergraduate math and Computer Science students. It has a good bibliography at the end of each chapter. Most importantly, it fills a large need for an up-to-date survey of a rapidly expanding field.

However, Turner's book also has some drawbacks. It overlooks some very promising recent areas of nonstandard logic, such as relevance logics and nonassertion logics (i.e., question logics, logics of imperatives, and dialogue logics). Worse yet, it is *too* much an overview: it is so sketchy in many places that it only informs the reader of the

BOOK REVIEWS

existence — but not the real nature — of a particular subdomain. This is a book that leaves one hungry.

Gary Jason

**Department of Information & Computer Science
University of California, Irvine
Irvine, California 92717
U.S.A.**