A Guide to Expert Systems

Donald A. Waterman

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Series Foreword

In recent years, research in the field of artificial intelligence has had many important successes. Among the most significant of these has been the development of powerful new computer systems known as "expert" or "knowledge-based" systems. These programs are designed to represent and apply factual knowledge of specific areas of expertise to solve problems. For example, collaborative efforts by human experts and system developers have resulted in systems which diagnose diseases, configure computer systems, and prospect for minerals at performance levels equal to or surpassing human expertise. The potential power of systems which can replicate expensive or rare human knowledge has led to a worldwide effort to extend and apply this technology.

The Teknowledge Series in Knowledge Engineering is a collaborative effort by Teknowledge Inc., an editorial board of knowledge system engineers, and Addison-Wesley to aid in this effort through book publication. Through this series we hope to provide an effective channel for informing and educating people interested in understanding and implementing this technology. We will be defining needed works, encouraging their development, and editorially managing their publication. Our intended audience includes practicing knowledge engineers, students and scientists in related disciplines, and technical managers assessing the potential of these systems. Readers with criticisms or suggestions for needed books are urged to contact the managing editor or a member of the editorial board.

Over time, the knowledge engineering field will have an impact on all areas of human activity where knowledge provides the power for solving important problems. We can foresee two beneficial effects. The first and most obvious will be the development of knowledge systems that replicate and autonomously apply human expertise. For these systems, knowledge engineering will provide the technology for converting

human knowledge into industrial power. The second benefit may be less obvious. As an inevitable side effect, knowledge engineering will catalyze a global effort to collect, codify, exchange, and exploit applicable forms of human knowledge. In this way, knowledge engineering will accelerate the development, clarification, and expansion of human knowledge itself. If this series contributes to these exciting developments we will have achieved our aims.

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Preface

This book describes the purpose, structure, and applications of expert systems.

Expert systems are sophisticated computer programs that manipulate knowledge to solve problems efficiently and effectively in a narrow problem area. Like real human experts, these systems use symbolic logic and heuristics—rules of thumb—to find solutions. And like real experts, they make mistakes but have the capacity to learn from their errors. However, this artificial expertise has some advantages over human expertise: It is permanent, consistent, easy to transfer and document, and cheaper. In sum, by linking the power of computers to the richness of human experience, expert systems enhance the value of expert knowledge by making it readily and widely accessible.

The book is designed to meet the needs of a variety of audiences:

- Data processing managers responsible for evaluating or starting an expert system project
- Students with or without programming experience who want an introduction to the basic concepts in the expert systems area
- Professionals who wonder if expert systems can be useful in their fields
- Experienced systems programmers without experience in artificial intelligence who are given the task of building an expert system, and
- High-level managers who want to know what expert systems can do for their companies.

I have organized the discussion to mirror the interests and technical background of each audience. Section I provides a general introduction to expert systems and assumes no computer experience. Section II

is especially relevant for readers who want a more detailed examination of the components of expert systems and the tools available to build them. Sections III and IV address the concerns of those charged with deciding whether and how to implement an expert system. Section V surveys expert system work today, makes some predictions for the future, and lists sources for readers who want more information. Section VI presents a catalog of expert systems and tools for those interested in a broad view of work in this area.

A number of people have contributed significantly to the development of this book. The assistance of these people is gratefully acknowledged: Mary Vaiana, for help with the reorganization and rewriting of the text; Jody Paul, for help with the compilation of the catalog sections; Janet DeLand, for editing and proofreading the text; Susan Pond for proofreading; and Dean Schlobohm and Diane Butera for their comments on early versions of the manuscript. Special thanks to Rick Hayes-Roth and Teknowledge for their comments on the final draft.

Santa Monica, California D.W.

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SECTION ONE

Introduction to Expert Systems

In this section, we provide an overview of expert systems. We define them by examining their basic structure, their uses, and their differences from conventional computer programs. We conclude our overview by looking in some detail at an expert system at work: PROSPECTOR, a system designed to aid exploration geologists.

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