Guest Editor's Introduction

Artificial intelligence for man-machine interface

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Over the past 20 years, the interactive computer system has slowly evolved from "a dumb number cruncher" to an "intelligent expert." Today, it is extending human capabilities—such as memory, intelligence, perception, language, and reasoning power—to solve problems of increasing complexity. This extension has been made possible by the technology of artificial intelligence.

Since 1970, a great deal of research has gone into developing intelligent human-machine interfaces based on such artificial intelligence technology as natural language processing, knowledge engineering, and vision. Several human-machine interfaces have emerged for applications—ranging from a simple game to life-critical missions—but they are limited in scope. Such interfaces have proven to be efficient, intelligent, automatic, and accurate, but they are not general-purpose.

A general-purpose human-machine interface can be thought of as a *knowledge information system* consisting of three subsystems: a front-end signal processor of various I/O forms, an adaptive knowledge-based system, and a reasoning- and inference-based, problem-solving system. Such an interface should act as a true companion to humans.

The Japanese fifth-generation computer system project is trying to develop such an ideal interface; however, the emerging prototype would be limited in scope. Similar efforts are underway in the US and in Europe. In addition, custom-tailored interfaces are being developed within various corporations, indicating that the importance of AI technology for building accurate, better, and (eventually) "companion" interfaces will continue to grow.

To date, no serious effort has been made to publish a comprehensive coverage of this topic in any professional journals; to my knowledge, this special issue on AI for human-machine interface is the first of its kind. Active and well-known researchers in artificial intelligence have contributed to it; the first three articles are general in nature, whereas the remaining four are applications dependent.

The first article by Frederick Hayes-Roth presents an excellent overview of the knowledge-based expert systems. He traces the origins and describes techniques and limitations of knowledge engineering. This article surveys the kinds of work performed with knowledge-based expert systems and explains how knowledge systems are built.

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The second article by Reid G. Smith et al. describes an elegant and conceptually correct solution to two practical problems which arise in the development and use of interactive systems. They observe that users frequently encounter situations where analogous semantics require radically different dialogs. Developers and maintainers frequently find that adding a feature or making a correction requires familiarity with a surprisingly large part of the system. The authors identify a common source for both problems—commingling of data acquisition and computation. They describe a way to separate the two and illustrate the practicability of their approach by means of an existing application.

Next, Elaine Rich discusses some of the issues and problems involved in using natural language, or some natural language subset, to interact with a computer. In general terms Rich (1) describes when a natural-language interface is appropriate or useful and discusses the problems that arise from limited natural-language understanding; (2) briefly outlines current views of language understanding, including a discussion of lexical, syntactic, and semantic levels of structure; and (3) discusses three approaches to designing language-understanding systems. She concludes by restating the general circumstances under which natural language interfaces are useful and reiterates a key difficulty in implementing such an interface: language understanding engages knowledge not only of language but also of the domain of the computer application.

The article by Sanjay Mittal et al. explains the frame/slot approach to knowledge construction with triggered procedures and temporal inferences. Patrec is a medical database system, a component of Ohio State University's knowledge-based medical expert system.

Tutoring can be a powerful form of communication. It can lead to new insights and to new awareness about incorrect information. Effective tutoring requires sophisticated knowledge about the student and an understanding of how to teach. Beverly Woolf and David D. McDonald describe the issues involved in building an effective machine tutor and present a system that conducts a sensitive discourse tailored to the student's knowledge.

Those familiar with manufacturing technologies and environments must be familiar with the complexity of decision making at various levels. David A. Bourne and Mark S. Fox present an interesting application of artificial intelligence techniques to automate the manufacturing environment. This article discusses the issues of modeling, planning, and scheduling activities in dynamically changing environments. Approaches to solving these problems are discussed in the context of a constraint-directed, shop-scheduling system and a language-oriented, database system to control manufacturing.

In the last article, Amitava Dutta and Amit Basu, describe a decision-support system. Most decision-support systems, or DSS, consist of a data retrieval facility and a collection of models (programs) that can manipulate retrieved data. The collection of such models can be used in different problem-solving situations. In this article, a theoretical framework for model management based on first-order logic is developed as a basis for data representation and management. As shown by Dutta and Basu, this approach enables not only the representation, but also the integrated control of selection, sequencing (synthesis), and activation of computational models in an elegant manner. It relieves the DSS user of the burden of manually managing these functions, so that a high-level, nonprocedural, and decision-oriented man-machine interface can be designed. By developing both a formal representation of models within the framework of a knowledge base and a method for the automatic synthesis of multiple models, as well as other research issues in the same context, this article addresses major issues in model management. *

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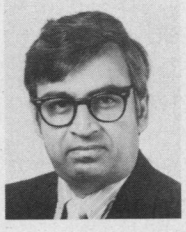

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