EXPERT
BOOK REVIEWS

Technical editor: R. Bhaskar, IBM T.J. Watson Research Center
Vendor contact: Dale Strok, *IEEE Expert*, 10662 Los Vaqueros Circle, PO Box 3014, Los Alamitos, CA 90720-1264

AI and intelligent networks in the '90s

Reviewed by Lundy Lewis, Cabletron Systems

Managers of computer and telecommunications networks must detect and resolve faults, optimize network performance, plan for growth, bill network users fairly, and maintain the security of network traffic and data repositories. As networks become larger and more congested, these problems become more difficult. Some managers have turned to AI for assistance.

Expert systems have been embedded successfully in exisiting operations software that manages stable and predictable networks. But when networks are reconfigured routinely to accommodate innovative services and increased coverage, expert systems become difficult to maintain and quickly become obsolete. Users of these systems are confronting the well-known limitations of the expert-system paradigm: the inability to learn and adapt in unpredictable domains.

Nonetheless, the idea of an intelligent network has caught on. As in the robotics community, network researchers foresee an autonomous, self-managed network that can negotiate problems with little human intervention. In the late '90s we should see a shift toward a view of computer networks as autonomous agents. Where robotics has sensors, sense data, and effectors, networks will have analyzers, message traffic, and system commands to effect such tasks as upgrading software and managing network devices. This view of a network opens the way for thinking about general issues of intelligent architectures.

One such issue is task analysis: What tasks should be done by reasoning with raw message traffic data? What tasks should be done by reasoning with a symbolic model of a network? What layers of abstraction exist in between? What tasks require reasoning that is distributed over multiple layers of abstraction, as opposed to cooperative reasoning systems over a single layer of abstraction? What control mechanisms will be needed? These issues are unsettled in the AI/robotics community, and similar issues have surfaced in recent research on intelligent networks.

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Additional AI research problems include comparative analyses of reasoning paradigms for specific kinds of tasks. For example, the bulk and variety of data collected by a network analyzer is overwhelming, and translating this data into commonsense terms from which one can draw inferences about network behavior is difficult. One approach is to cast the problem in a fuzzy-logic framework; another is to use a connectionist method. It might turn out that the solution requires a hybrid reasoning paradigm.

There are only three books on AI approaches to network management problems: *Expert-System Applications to Telecommunications*, *Expert-Systems Applications to Integrated Network Management*, and *Intelligent Networks: Telecommunications Solutions for the 1990s*. With few exceptions, the material in these books centers around the expert-system paradigm of problem solving. More recent work on post-expert-system solutions is available in the proceedings of network conferences, such as the IFIP/IEEE International Symposia on Integrated Network Management, the Annual IEEE Phoenix Conferences on Computers and Communications, and the IEEE Infocom conferences. The time is ripe for books that collect on-going work with more recent AI approaches to network problems.

The first book, *Expert-System Applications to Telecommunications*, has three main sections on case studies, methodologies, and future applications. The first chapter on case studies — "Expert System Applications to Network Management" by S. Goyal and R. Forrest — is a well-rounded introduction to the nature of networks and the problems of managing them; a survey of expert system applications; and a call for enabling technologies, including alternative knowledge representations for network expertise, learning and adaptation in networks, and distributed AI. The other chapters in the section report on ongoing projects that began in the '80s, such as AT&T's ACE system and the Naval Research Laboratory's FIS electronics troubleshooting project. The section on methodologies is aimed at managers of expert-system projects. The contributing authors discuss

strategic planning, assessing expert-system applications, and managing conventional versus expert-system software. The two chapters in the section on future applications describe ideas for applying expert systems to a network control center and the management of the radio spectrum.

The second book, *Expert-Systems Applications to Integrated Network Management*, is organized around ISO OSI's five functional areas of network management: configuration, performance, fault, accounting, and security management. The editors have collected relevant papers under each heading, plus others under the headings "General Network Management Applications" and "Network Administration, Logistics, and Planning Tools." The book is well-organized and in tune with current thinking in the network community. The first paper — "The OSI Management Architecture: An Overview" by M. Klerer — describes the proposed services and protocols of the five OSI management functions. Several papers after this describe the basic expert-system paradigm, with a bent towards network management applications. These discussions provide a good background for the papers on the five OSI management areas.

The 38 papers are reprinted from such sources as *IEEE Network Magazine*, *IEEE Transactions on Pattern Analysis and Machine Intelligence*, *AI Magazine*, *AI Expert*, conference proceedings, and technical reports. The editors did an admirable job of collecting relevant pre-1989 papers in one place. Most of the authors are members of the network community who have turned to AI for possible solutions, and only a few papers will be familiar to the AI community (such as Laffey et al's survey paper "Real-Time Knowledge-Based Systems," and Forbus's "Intelligent Computer-Aided Engineering"). As such, the book is an excellent resource for AI people who want to learn about outstanding problems in networking and various AI approaches.

The last book, *Intelligent Networks: Telecommunications Solutions for the 1990s*, is aimed at network business managers who are considering investments in AI solutions. The authors discuss global networking, how networks will evolve in the '90s, and where AI will make a difference. The book covers intelligent databases, intelligent buildings, and security, but network/AI researchers will be disappointed. There is little AI jargon other than "expert systems" and "rules," and there are no references. The authors discuss existing AI applications with reference to the number of rules used, and they overuse the terms "AI-enriched" and "AI construct." The book could mislead readers who are not familiar with AI and the problems of deploying and maintaining useful AI systems. It could also foster unrealistic expectations in '90s consumers, just as unrealistic expectations for AI in general were fostered in the early '80s.

Of the three books, the historical accounts of ongoing '80s applications make *Telecommunications* useful for potential AI/network researchers; the book also contains useful material for potential project managers. On the other hand, *Integrated Network Management* is more in touch with the network community and would make a good reference, although it would be of less interest to project managers. Finally, *Intelligent Networks* would be useful to network business managers if read in conjunction with a gentle, realistic introduction to AI.

Expert System Applications to Telecommunications, edited by J. Liebowitz, John Wiley and Sons, New York, 1988, ISBN 0-471-62459-4, 371 pp., $56.95

Expert Systems Applications to Integrated Network Management, edited by E. Ericson, L. Ericson, and D. Minoli, Artech House, Norwood, Mass., 1989, ISBN 0-89006-378-8, 451 pp., $49.00

Intelligent Networks: Telecommunications Solutions for the 1990s by D. Chorafas and H. Steinmann, CRC Press, Boca Raton, Fla., 1990, ISBN 0-8493-7401-4, 380 pp., $49.95

Lundy Lewis is a principal engineer in the Network Management group at Cabletron Systems Research and Development Center. Readers can reach him at Cabletron Systems, 9 Executive Park Drive, Merrimack, NH; Internet, lewis@ctron.com