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ARTIFICIAL INTELLIGENCE AND NATURAL RESOURCE MODELING

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INTRODUCTION

Contrary to the impression which the title might convey, artificial intelligence (AI) has nothing to do with raising one's intelligence quotient so as to understand the complexities of the natural resource models which have been presented at this symposium. Rather, it is an exciting area of computer science research that has developed tremendously in the past decade, so that many practical applications may now be available.

Artificial intelligence research has several goals, including the development of computational models of intelligent behavior, both its cognitive and perceptual aspects (Duda and Shortliffe 1983). A more engineering-oriented goal of AI is the development of computer programs that can solve problems normally thought to require human intelligence. The field of AI consists of several areas, including speech recognition, language understanding, image analysis, robotics, and consultation or expert systems. This later area is the one with the most immediate applications (Michie 1983) in agricultural research and, specifically, natural resource problem solving. Potential applications of other AI areas may become apparent to most scientists in their own particular research programs.

EXPERT SYSTEMS

The goal of expert systems research is to provide tools that exploit new ways to encode and use knowledge to solve problems--not to duplicate intelligent human behavior in all aspects. The simplest, and generally the most successful, expert systems are classification programs. Their purpose is to weigh and balance evidence for a given case to decide how it should be categorized. Much effort may be needed to effectively implement an expert system. Thus it is necessary to constrain the expert system problem to a realistic one so that realistic solutions can be found to real-world problems.

The identification and encoding of knowledge is one of the most complex and arduous tasks encountered in the development of an expert system. And in fact, the very attempt to construct the knowledge base often reveals knowledge gaps in the subject, as well as weaknesses in available representation techniques. A major effort in the development of the expert system then is to overcome these gaps and to build a system where future knowledge can readily be inserted.

One of the easiest ways to understand the use of expert systems is to think of some cases where you have had some experience with such a system. Duda and Shortliffe (1983) provide a list of 10 such systems. Certainly the one which my family doctor employs is the one I think of. My doctor is a member of the faculty of the University of Arizona Medical School but works at the Family Practice Center designed for training medical students. The Family Practice Center, located a few miles from University Hospital and most faculty members, is coupled to the computer at University Hospital. When problems of diagnosis arise, the doctor consults via a remote terminal with programs designed to assist with such diagnosis. Perhaps one program available is the MYCIN System developed at Stanford University in the mid-1970's to assist in the selection of antibiotics for patients with severe infections (Shortliffe 1976).

Those of you with VAX computers probably are aware that the physical layout and interconnection of the VAX components is done by using a rule-based expert system called XCON or RI (Duda and Shortliffe 1983).

Finally, I would be remiss if I did not mention that I first heard about AI and the development of expert systems from Dr. Gary C. White of the Environmental Sciences Group at the Los Alamos National Laboratory in New Mexico (personal communication). Dr. White recently proposed and has initiated with coworkers, the development of an expert system to provide consultation on the siting, design, and development of waste disposal facilities as well as for the construction and operation of such facilities. The expert system Dr. White envisions consists of the current information available to waste-disposal-site designers, as well as such computer models as CREAMS, for the design of the surface and near-surface facility and TRACER3D for that part of the disposal site further underground. The expert system envisioned will simplify the task of utilizing these computer tools by constructing the necessary input files and running the calculations with the program. The user, although aware that these computer models are being executed, would not need to be aware of how to operate the models himself. Model outputs would then become part of the expert system analysis. The expert system would assess the usefulness of an area as a potential site for waste disposal by comparing it to other currently operating sites as well as to a theoretically perfect site as a way to detect future potential problems.

The challenge then, is to apply the concepts of expert systems to other problems facing conservation planners in the agricultural sector. Some rather obvious applications are using USLE for conservation planning to meet soil loss tolerances, or using a combination of EPIC and CREAMS to ensure long-term soil productivity while ensuring that nonpoint-pollution problems and water quality standards are met. As in the waste disposal site expert system, the user might be requested to enter some basic information about the site being considered. Much of the data

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required to operate the computer programs might then reside on disk files and not require keyboard entry. The results of the expert system might be a series of potential crop/management systems which might satisfy the environmental constraints.

SUMMARY

Although expert systems have not been applied to very many agricultural problems, and certainly not to many natural resource problems, their potential is great, and efforts along this line should be initiated. Much of the expert system research heretofore has been basic, but the field is beginning to make the transition to application and especially in the area of planning and design. It seems likely that the inclusion of economics in some design problems will add a further dimension to the utilization of expert systems.

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