Decision Making in Complex Systems

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Received October 3, 1993; revised December 15, 1993

Individuals, organizations, and governments are often expected to make decisions of far-reaching consequences. Judgment and decision-making capabilities are important facets of human intelligence. Systematic studies of these topics have commenced only in the 1960s. Simultaneous developments in computer hardware and software and in fields such as artificial intelligence have given impetus to the study of human decision making from descriptive, normative, and prescriptive points of view. Real-world decision problems are often unstructured and difficult to formulate. There are multiple objectives, distributed decision makers and difficulties in acquiring different types of knowledge needed for problem solving. Human knowledge is often available in natural language with its inherent ambiguity and vagueness. While a human being has only "bounded rationality," his intuition and common sense enable him to make good decisions in using qualitative nonnumerical information in narrow domains of expertise such as medical diagnosis. He has to be supported by decision aids when confronted with situations in complex systems. In this paper, we briefly review decision making in complex systems from the point of view of intelligent decision support systems, which applications to the project management task.

KEY WORDS: complex systems; decision making; decision support; artificial intelligence; intelligent systems.

1. INTRODUCTION

Decision making is an all-pervading activity. Individuals have to make decisions often in their lives, and similarly firms and governments have to make decisions continuously. While some decisions seem simple or trivial, certain others seem to have far-reaching consequences. Some decisions are of the one-shot types, while others involve a sequence of actions influenced by feedback of results from earlier decisions. Some decisions seem ad hoc, while others appear to have been made after consideration of all the available knowledge of the problem. It is, therefore, necessary to understand the underlying reasoning process before

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studying decision making. At the outset, it is important to note that agents (individuals or firms) make decisions to achieve some goals following an evolutionary and causally motivated reasoning process.

The term decision making is used to refer to a range of intelligent activities including making a judgment based on reason, selecting a preferred option based on deliberation, and assessing a rapidly evolving situation to choose quickly a course of action.

There appears to be a difference of opinion about the ability of human beings to make sound decisions. Recent developments in artificial intelligence (AI) in computer science have led to the evolution of expert systems and knowledge-based systems in a variety of domains such as medicine, finance, law, and engineering. In these systems, conscious effort is made to elicit the decision-making behavior of a human expert. A human being's expertise in a narrow domain is captured in terms of "If . . . Then . . ." rules in the system's knowledge base characterizing his "Situation–Action" behavior. This shows that human experts are believed to be capable of making sound decisions in situations such as medical diagnosis or engineering design which are narrow domains of human specialization.

The systematic (normative) approach to decision making involves the following steps:

- recognizing a decision problem,
- understanding and modeling the system and its environment,
- recognizing the decision maker (DM),
- recognizing the DM's objectives and preferences,
- analyzing the constraints,
- developing the alternatives, and
- choosing among the alternatives.

2. STUDIES IN JUDGMENT AND DECISION MAKING

Systematic studies on judgment and decision making commenced in 1960s (Arkes and Hammond, 1986). These problems can be studied from several perspectives. The decision maker (DM) may be a human being, a computing machine, or an ideal agent. The approach and emphasis vary depending on whether the problem is studied in a school of engineering, medicine, management, or law. Topics of problem solving, mental imagery, memory, thinking, language, learning, and behavior belong to the realm of psychology. Psychology is also concerned with the nature of human judgment and decision-making processes emphasizing the types of errors people make in complex decision situations and suggesting ways of overcoming these shortcomings. Computers and