Decision-Making Support Systems and Representation Levels

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INTRODUCTION

The concept of Decision Support System (DSS), which was first coined by Gorry and Scott Morton (1971), was proposed in an attempt to focus the attention of IS researchers and practitioners more closely on the decision-making processes of managers. It sought to acknowledge the importance of decision-making as the key activity that managers must perform in organizations (Huber, 1982).

Even though there are good functional definitions of what DSS should do, a readily understandable definition that takes into account the specificities of human reasoning (e.g., studies by Herbert Simon; Pomerol & Adam, 2004) is still lacking. In this chapter, we try to bridge the gap between human reasoning and the understanding and design of DSSs. We begin with a description of the human process of decision-making, then we give a semi-formal definition of Decision Making Support Systems (DMSS) and conclude with a few words about the architecture of such systems.

BACKGROUND

Human decision-making has its origin in a dissatisfaction commonly referred to as a decision problem. The dissatisfaction arises from the difference between the current state of affairs and another, not yet existing, more desirable state of affair. The notion of state of affair or *state of the world* refers to the seminal work of Savage (1954). As described by Simon, managerial decision-making is characterized by a number of key factors: (1) the personal dimension, which is at the core of the decision-making process, in that what one person wants may not be desirable for another; (2) the issue of uncertainty, whereby the current state of the world may not be known with certainty; and (3) the difficulties inherent in evaluating the desirable state of the world when it includes many different attributes that are not fully compatible (e.g., increasing market share and reducing costs). The process of human decision-making is represented in Figure 1.

In Figure 1, we have sketched what may be regarded as a realistic human decision process, tracking the main components of decision reasoning. For the sake of simplicity, we have divided the process into two main parts: diagnosis and look-ahead. It is, of course, not always easy to separate these two, but from an engineer's point of view, it facilitates the design of systems aimed at supporting the process of decision-making.

DECISION MACHINES, WHAT-IF ANALYSIS, AND LOOK-AHEAD

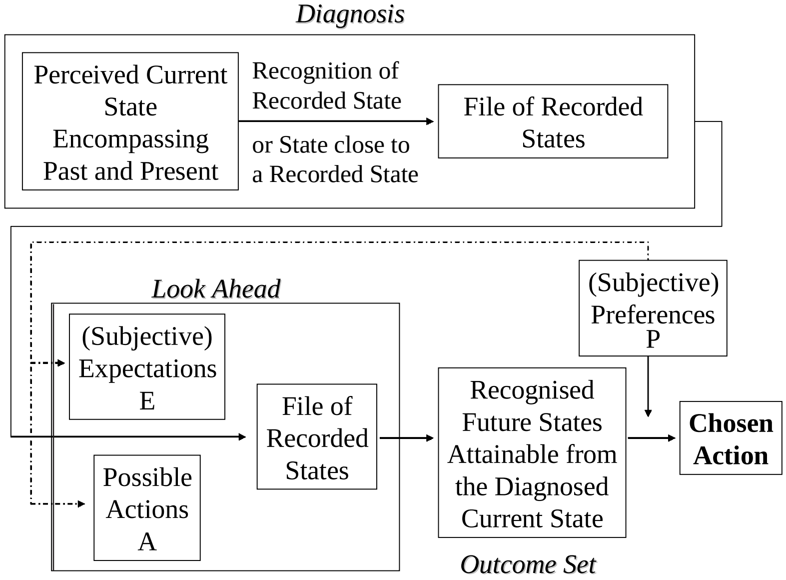
The model presented in Figure 1 can be used to predict what may be the most appropriate systems able to support the decision process. A number of corresponding DMSS designs can be proposed—diagnosis machine (or decision machine), "what-if" analysis machines, and look-ahead machines—which seek to tackle the most difficult and abstract level in human decision-making.

Decision Machines

A decision machine is an automaton adhering to one-to-one correspondence between the diagnosed current state and a proposed action. As said before, the word "decision" is, in this case, improper because the decision has already been made by the designer of the system. However, when people are unaware of the program or when it is so sophisticated that it is impossible to look through its operations, one can refer to these as decision machines. As such, most decision machines are mere classifiers linking a recognised state to an action. Numerous of these machines exist in the context of almost continuous decision (i.e., control of industrial processes, underground train driving, etc.).

With a programmed decision machine relating the current state to an action, one does not capture the full complexity of human decision-making. In addition, in many concrete situations, the set of all the possible current states cannot be described either extensionally or intentionally. Thus, the human decision maker is always

Figure 1. The decision process (adapted from Pomerol, 1997)



indispensable, working in an interactive way with the machine, mainly because unexpected (not programmed) states might occur. Many accidents have resulted from the bad recognition of the current state (wrong diagnosis) by a subject (Boy, 1991). Thus, the designers of decision support systems are confronted with the paradoxical problem of developing systems capable of helping people in situations that neither the user nor the program can foresee. This is one of the most difficult challenges in the development of decision support systems.

"What-If" Analysis

Although various frameworks have been proposed to cope with uncertainty, many decision makers discover that, in real situations, events are either very interdependent or the probabilities remain unknown (e.g., what is the probability that the price of oil will be higher in three months than today?), such that rational decision-making is impossible. Predicting or even identifying all the possible reactions of other agents and competitors is another key difficulty. The ability to envision the future and to anticipate events exists only in most advanced animals. Key components of the intelligent behavior of human beings are the capacity for anticipation, the ability to decide against immediate short-term advantage, and the desire to pursue future gains.. This type of multi-criteria choice can be regarded as a basic expression of rationality. This is consistent with Damasio's view that "will power is just another name for the idea of choosing according to long-term outcomes rather than short-term ones" (Damasio, 1994, p. 175).

In any case, "what-if" analysis or, more accurately, "scenario reasoning," should produce two outputs: all possible outcomes at a given horizon and the probability or plausibility of each outcome. Decision makers exercise their preferences on probabilistic outcomes (preferably multi-attribute), and then make their decisions and implement the resulting actions in accordance with the chosen scenario. Unfortunately for non-aided decision makers, scenario reasoning may lead to a combinatorial explosion such that it is often impossible to handle long, precise, and diverse scenarios (Pomerol, 2001). This is the very reason why support from machines is necessary.

Look-Ahead Machines

Two capabilities appear to be necessary in a look-ahead machine: (1) the ability to combine many actions and events (with their probabilities); and (2) the ability to imagine the possible actions and to anticipate all possible reactions of other agents and/or nature. According to Figure 1, this "imagination" ability is simply provided by the file of recorded states, such that for a given subject, all possible events and reactions of the other agents are drawn from a set of memorised items. However, forecasts never predict what is really new (Hogarth & Makridakis, 1981; Makridakis, 1990). It is, therefore, unlikely that look-ahead machines can escape this weakness. Another reason for using recorded states is that human forecasts are often too optimistic because human beings remember success more easily than failures (Kahneman & Lovallo, 1993). The intrinsic difficulty in forecasting is the main weakness of many formalised planning processes. This is

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