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Abstract:

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Human Computer Cooperative System for Decision Support

Abstract

After reviewing current decision support systems, this paper points out some of their limitations and suggests a framework of HCC-DSS for supporting ill-structured decision making.

Introduction

In this paper, I first review some basic concepts related to DSS, then point out some limitations of current decision support systems (DSSs). Based on my analysis, I point out the basic requirements of a DSS which can support ill-structured problem solving. The requirements include:

1) combining the descriptive models and prescriptive models in the system;
2) combining artificial intelligent techniques and broad domain knowledge in the system.

Finally, I propose a new conceptual model of DSS.

The decision making process

The decision process could be divided into three phases: intelligence phase, design phase, and choice phase [Simon 60, Turban 90]. According to [Smith 89, Sabherwal and Grover, 1989, Turban 90], the following activities are included in three phases:

Intelligence phase -- problem identification, problem definition and problem formulation (structuring);

design phase -- searching ready-made solutions or developing new solutions;

choice phase -- selecting a solution from those available.

In DSS, decision implies problem solving [Er, 88]. For solving a problem, we should first define and formulate the problem. Generally we can divide problems into two types: structured and ill-structured. A structured problem is one in which all three phases are structured [Turban 90]. Here structured phase means its procedures are standardized, the objectives are clear, and the input and output are clearly specified [Turban 90, p.6]. On the other hand, an ill-structured problem is one with unstructured phases.

There are two approaches or models of decision making: normative (prescriptive) approach and behavioral (descriptive) approach [Minch and Sanders 86]. In the descriptive approach, decision making is based on the decision maker's judgement and intuition. Subjective expected utility theory and heuristic method are examples of the descriptive approach. Prescriptive approach uses preset models to make decisions. The three phase decision process which I mentioned above is an example of the prescriptive approach.

Both descriptive and prescriptive approaches have pros and

cons. For descriptive models, past studies have show that human judgment and decision-making have limitations [Hammond, K. R., et al., 1980]. One of the major limitations is that human judgement and decision-making is consistently biased [Tolcott, et al., 1989]. On the other hand, prescriptive models are objective but inflexible.

In the prescriptive decision making process, each phase consists of several components. In the intelligence phase, we need to identify the variables, parameters, and objectives, establish the relationship between them, and determine the preference structure of the decision makers [Weber and Coskunoglu 90].

Sabherwal and Grover cited Mintzberg's study of four modes in the design phase: given solution, ready-made, custom-built solutions and combination of ready-made and custom-built [Sabherwal and Grover, 1989, p. 58].

In the choice phase, there are three possible alternatives; judgement, analysis, and bargaining. [Mintzberg et al.,1976, Sabherwal and Grover, 1989, p. 58]. The analytic mode are commonly discussed in the normative literature, and the judgmental mode are commonly used in practice [Mintzberg et al.,1976, Sabherwal and Grover, 1989, p. 58]. In the bargaining mode, "the choice is made by a group of decision makers with conflicting goal systems, each exercising judgment." [Sabherwal and Grover, 1989, p. 58].

The Decision Support System

According to a survey accomplished by Eom and Lee, there are no universal definitions for DSS [Eom and Lee, 1990]. The DSS was first defined by Scott-Morton as "interactive computer-based systems, which help decision makers utilize data and models to solve unstructured problems" [Scott-Morton,1971]. Later, Keen and Scott-Morton gave the definition as follows: "Decision support systems couple the intellectual resources of individuals with the capabilities of the computer to improve the quality of decisions. It is a computer-based support system for management decision makers who deal with semi-structured problems." [keen and Scott-Morton, 1978]. Eom and Lee described the DSS is a computer-based interactive system. This system:

1) supports decision makers rather than replaces them,
2) utilizes data and models,
3) solves structured and ill-structured problems, and
4) focuses on the effectiveness rather than the efficiency of decision processes [Eom and Lee, 1990].

A decision support system consists of a language system, a knowledge system, and a problem processing system [Bonczek et al., 1981]. The language system is an interface between users and the DSS. The knowledge system includes model base and database. The problem processing system accepts problem statements specified by language system, draw on relevant knowledge held in a knowledge system, and proceeds to generate appropriate responses that can be used to support a decision-making process [Holsapple, et al., 1987].

DSS usually use prescriptive models [Weber and Coskunoglu 90]. MS/OR models are essential elements of DSS [Eom and Lee, 1990]. Among these models, statistical analysis, simulation, and linear programming are most frequently used techniques [Eom and Lee, 1990].

The Effects of DSS

As mentioned above, most authors emphasize two main purposes of DSS:

1) supporting to solve ill-structured problems;
2) improving the effectiveness of the decisions.

By surveying the literature, I have not found the evidence that the current DSSs support above two purposes, especially the purpose of supporting ill-structured problem solving. For instance, Turban listed 10 benefits for using DSS in his book, including time and cost saving, more objective than decisions made intuitively [Turban, 1990, p.10]. These benefits are mainly concerned with efficiency not effectiveness. The efficiency of DSS has also been showed in laboratory experiments [Sharda et al., 88]. But the effective of DSS have not been confirmed [VanSchaik and Sol, 1990]. For supporting ill-structured problem solving, some empirical assessment suggested that use DSS carefully [Aldag and Power, 86].

Recent research on DSS

Since both descriptive and prescriptive models have pros and cons. People tried to combine these two approaches and let them complement each other. Weber and Coskunoglu [90 p.315] proposed that prescriptive and descriptive research should interact in two ways: 1) situations and decision stages during which descriptive research has demonstrated shortcomings of human decision-makers need to be automated; and 2) automated prescriptive decision systems need to learn from descriptive research how deal flexibly and efficiently with changing problem environments. The previous studies have shown that combining human and computers can "complement" each other and get better results [Blattberg and Hoch 90].

The expert systems, which using artificial intelligent techniques to provide user expert experience, are descriptive models. In recent years, there has been an explosion of interest in the integration of the techniques from artificial intelligence (AI) and decision analysis(DA), so establishing intelligent DSS.
For instance, Weber and Coskunoglu [90] suggested that future coordination of three areas: descriptive decision research of psychology, prescriptive models of operations research, and symbolic reasoning research of artificial intelligence.

Another trend of developing DSS is trying to broaden the knowledge domain of DSS. We have seen the suggestions that the further development of DSS depends on integrating organizational (cross functional) decision making. They further suggested that use

distributed decision-making systems [Eom and Lee 1990]. ? also suggested an ODSS (Organizational DSS) that entire organization shares common data and models [Philippakis, et al., 1990, p.89]

The limitations of DSS and ES

As mentioned above, DSSs use prescriptive models, they are suitable for solving structured problems, but not very effective for solving ill-structured problems. we need extending DSSs to solving ill-structured problems which are commonly faced by upper-level management.

DSSs are not flexible to fit different decision makers with different decision style [Er, 1988].

Current DSS technology allows for sequential execution of procedural steps with little flexibility in shifting the control from a predefined sequence of operation [Weber and Coskunoglu 90 p.314]. This is inflexibility in another way.

In ill-structured problem solving situations, the user is an adaptive system, learning from DSS interactively both about the decision problem and use of the DSS [Santos and Holsapple 1989]. So, one of the most important objectives of DSS development is the design of flexible tools that users can employ individually during their decision process [Angehrn and Luthi 1990].

Turban pointed out the limitations of current expert systems are that "knowledge is not always readily available and ES work well only in a narrow domain." Also precise and complete knowledge acquisition can be time consuming [White 90 p.358].

Another shortcoming of expert systems is that they potentially have the same shortcomings of human -- limitations and biases [Weber and Coskunoglu 90].

The Human computer cooperative Decision Support System

According to above analysis, we can see that the DSS which we need should be an integrated system combining descriptive and prescriptive models, based on a broad knowledge domain. And this system can assist the user to solve ill-structured problems. We think that is HCC-DSS.

A human-computer cooperative approach proposed by Dr. Niwa includes a knowledge base, a computer inference function, and human associative ability [Niwa, 1986, 1989, 1990].

The advantages of HCC are:

1) using knowledge association mechanism to combine human's intuitive ability and computer's prescriptive models and domain expert's knowledge;

2) it is flexible for different types of users, e.g. distinguish between novice and experienced users;

3) it is flexible for different decision situations and stages;

For instance, in the intelligence phase, the system can provide similar problems to assist the problem definition and

formulation process. In the design phase, the system can provide all four modes of solutions. The ready-made solutions could come from the knowledge domain and through knowledge associate mechanism.

The major components of the system

We think a HCC-DSS will include a knowledge base, an knowledge associative mechanism, an ill-structured knowledge base, an interface, and a normalization model.

Knowledge base contains:

1) knowledge from different knowledge domains;
2) knowledge about models and data;
3) knowledge about decision-makers;

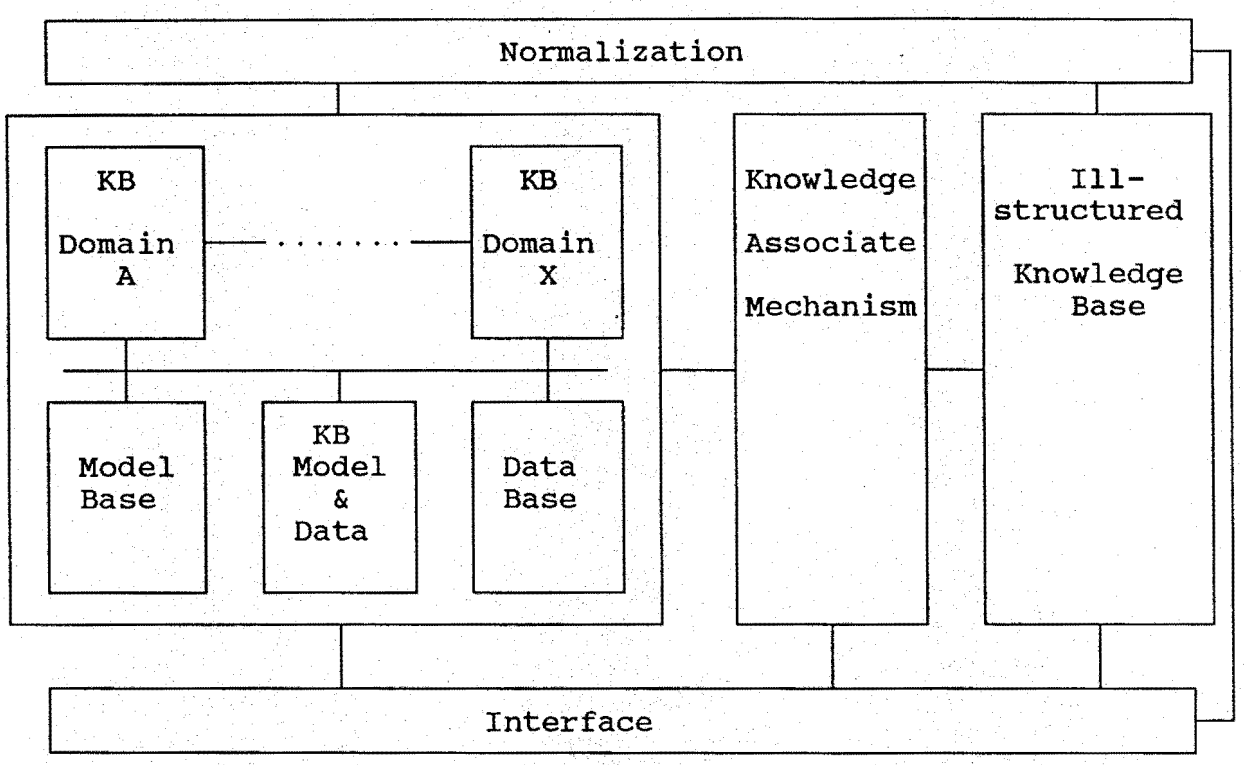
knowledge Associate Mechanism

knowledge associate mechanism is a software which deals with associative knowledge. Based on his or her intuition and experience, the user can find extra knowledge which are not available in his or her domain knowledge base.

Ill-structured knowledge base

Ill-structured knowledge base contains ill-structured knowledge which is input by user through interface. Ill-structured knowledge will be normalized and then added in knowledge base. As Weber and Coskunoglu suggested we can first identified the problem by descriptive approach and late incorporate into prescriptive models. By this way, we can minimize the bias of human behavior [Weber and Coskunoglu 90].

The structure of the system



Here I just present a basic idea of the new system. Further research is needed to make clear the specific functions of the components and their interrelations.

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