Expert Systems

Chuleeporn Changcchit
Texas A&M University – Corpus Christi, USA

INTRODUCTION

While technology and human abilities have evolved over the years, individuals still have limitations in their abilities to accomplish certain tasks. This may be due to limits on financial or cerebral resources. Information needs have expanded and evolved as well. With the spurring of globalization and flatter hierarchies in organizations, it has become imperative that individuals are able to analyze, in shorter periods of time, information that is more complicated and wider in scope.

An increasing number of countries are expanding their companies across many borders, and as events and changes create more dynamic situations, these companies are turning more towards flexibility than rigid structures. The context of these situations, however, is a greater limitation of resources as organizations also try to emphasize efficiency in their processes. This creates a steady, and even increasing, demand for expert systems.

An expert system, also known as a knowledge-based system, is a computer-based system that uses captured human knowledge to solve problems that ordinarily require human experts (Foltin & Smith, 1994). This system is also considered as a branch of artificial intelligence that aims at making computers capable of emulating human reasoning behavior (Holsapple & Whinston, 1987). Like a human expert, an expert system is able to use stored expertise in making inferences about a situation, offer recommendations, and provide explanations to a user. The value of expert systems in providing decision support has long been recognized and is widely accepted today.

The goal of expert systems is to ensure that scarce expertise can be utilized when a human expert is not available (e.g., due to cost, other commitments, illness, and retirement) and when efficiency or consistency of an expert needs to be enhanced. Expert systems can be utilized to alleviate these needs from simple to complex situations. For example, when a decision maker needs some expert advice about a problem, a human expert may not be available. Instead of waiting or paying to consult another human expert, the decision maker could immediately consult an expert system to get comparable advice.

Unlike traditional data processing techniques that require complete modeling and precise data, an expert system uses information that is not always entirely consistent or complete but still can produce satisfactory answers and useful approximation (Bonczek, Holsapple, & Whinston, 1981). Expert systems can tackle problems that require judgmental decisions. For instance, MYCIN, an early expert system application, recommended treatments for suspected meningitis and other bacterial infections of the blood by analyzing a physician's observations of a patient (Scown, 1985).

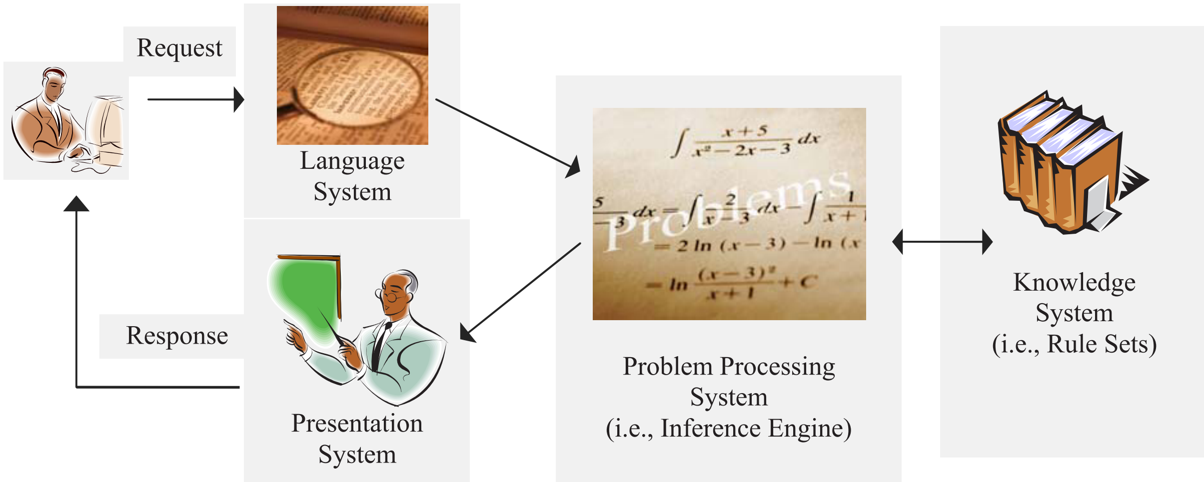
Expert systems are most often used as intelligent assistants or consultants to human users. They can be used to solve routine problems, thus, freeing the expert for more novel and interesting ones. Some corporations even see an expert system as a way to collect and preserve "corporate memory" because an expert system never retires, becomes sick, or leaves (Scown, 1985).

BACKGROUND

Generic Architecture of an Expert System

Expert systems have emerged as an economically rewarding branch of artificial intelligence (Jancura, 1990). They also form a subgroup of decision support systems. In order to emulate a human expert's behavior, the reasoning knowledge for a particular problem domain must be acquired and stored in the computer. Furthermore, there must be software that is able to actively process such knowledge in order to derive advice for a user. A generic architecture of a decision support system, and thus an expert system, developed by Bonczek, Holsapple, and Whinston (1981) is shown in Figure 1.

Figure 1. Generic architecture of an expert system (Source: Adapted from Holsapple and Whinston, 1996, p. 173)



As shown in Figure 1, the generic architecture of an expert system consists of four essential components as follows:

1. **A Language system:** A language system consists of all messages an expert system can accept (i.e., all requests that a user can make to the system).
2. **A Presentation system:** A presentation system consists of all messages an expert system can emit (i.e., all responses that the system can present to a user).
3. **A Problem processing system:** The problem processing system of an expert system is commonly called an inference engine. This engine is a program's protocol for navigating through the rules and data in a knowledge system in order to solve the problem. The major task of the inference engine is to select and then apply the most appropriate rule at each step as the expert system runs, which is called rule-based reasoning.
4. **A Knowledge system:** A knowledge system consists of all knowledge an expert system has stored and retained. The effectiveness of the system comes from the quality and amount of knowledge provided for it. The major consideration is how to represent the knowledge in the system such that it can be used to recognize or solve problems. A knowledge representation can be defined as a formalized structure and set of operations that embodies the descriptions, relationships, and procedures provided in an expert system.

The Development of Expert Systems

Typically, the development of an expert system involves four major activities as follows:

1. **Knowledge acquisition:** These activities are conducted to extract, accumulate, transfer, and transform problem-solving expertise from human experts and/or documented knowledge sources to a computer program for constructing or expanding the knowledge base. The commonly used techniques are interview, protocol analysis, and observation.
2. **Knowledge representation:** These activities refer to the techniques used to represent problem-solving expertise from experts and/or documented knowledge sources into a computer knowledge base. Some of the more common methods by which expert systems internally represent their expertise are: (a) Rules, (b) Frames, (c) Semantic nets, and (d) Heuristics.
3. **Knowledge inference:** These activities refer to the techniques of programming a computer in such a way that it can make reference in an attempt to imitate the reasoning behaviors of human experts.
4. **Explanation and justification:** These activities refer to an attempt by an expert system to clarify reasoning, recommendations, and other actions (e.g., asking a question).