Chapter 3.1
Intelligent Agents in Decision Support Systems

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INTRODUCTION

Internet-based, distributed systems have become essential in modern organizations. When combined with artificial intelligence (AI) techniques such as intelligent agents, such systems can become powerful aids to decision makers. These newer intelligent systems have extended the scope of traditional decision support systems (DSSs) to assist users with real-time decision making, multiple information flows, dynamic data, information overload, time-pressured decisions, inaccurate data, difficult-to-access data, distributed decision making, and highly uncertain decision environments. As a class, they are called intelligent decision support systems (IDSSs).

Although various AI techniques such as artificial neural networks, genetic algorithms, case-based reasoning, methods from expert systems, and knowledge representation have been successfully incorporated into IDSSs, intelligent agents are one of the more promising AI research fields with broad applicability to IDSSs. Although there is no universally-accepted definition of an agent, the definition given by Woolridge (2002) is often cited as authoritative:

An agent is a computer system that is situated in some environment and that is capable of autonomous action in this environment in order to meet its design objective.

Woolridge (2002) adds the capabilities of *reactivity*, *proactiveness*, and *social ability* for an intelligent agent, although many researchers, including the DSS community, do not make a distinction. Reactivity means that an intelligent agent can perceive the environment and respond to it as it changes. Proactiveness implies that it is able to take the initiative to meet its design objec-

tive. Social ability means that it can interact with other agents and possibly humans to perform such tasks as negotiation and cooperation. Delivery of these capabilities imposes demanding requirements on the part of the agent designer since the environment may change during execution of the software program and initial assumptions may no longer be valid, and yet the agent's goal remains the same. In complex environments, teams of agents or multi-agent systems have been developed that attempt to balance goal-direction with reaction to the environment. Agents, intelligent agents, and multi-agent systems are active areas of research both in themselves and in application to IDSSs.

The objective of this article is to review characteristics of intelligent agents and their applications to intelligent decision support systems. The article is organized as follows. In the second section we provide a background on intelligent agents and IDSSs. In the third section we discuss intelligent agents within IDSSs and provide examples of applications. In the final section, we examine future research trends.

BACKGROUND

Simon (1997) described the decision making process as consisting of three phases: intelligence, design, and choice. A fourth phase, implementation, was added by later researchers (Forgionne, 1991). The decision maker acquires information and develops an understanding of the problem during the intelligence phase. During the design phase the user identifies criteria, develops the decision model, and investigates alternatives. An alternative is selected during choice and the user acts on the decision during the implementation phase. A similar four-step decision making process is recognized by researchers for defense decisions and is called the observe, orient, decide, act (OODA) loop (Phillips-Wren & Jain, 2007).

Decisions are often characterized by the degree of structure involved in the decision (Turban &

Aronson, 1998). A structured decision is deterministic with a known solution, while an unstructured decision is on the other end of the continuum with decisions with little or no agreement on the solution. In the middle are semi-structured decisions and this is the area where DSSs are most effective at providing support by using computing to assist with the decision. Semi-structured decisions are those that require some human judgment and at the same time there is some agreement on the solution method. Examples of support for decision making are mathematical models and statistical methods. In general, a DSS consists of input, processing, output, the user, and computing resources. Inputs include the database(s) needed for the decision and model base(s) that supply the models needed to evaluate and/or predict potential outcomes. During processing the model(s) is evaluated and a feedback loop to the input permits multiple what-if scenarios and alternatives. In output, the user is presented with alternatives and sometimes recommended courses of action. The user and computer are considered part of the system.

A DSS with embedded AI techniques is referred to as an 'intelligent decision support system.' What is intelligence in the context of DSSs? Turban and Aronson (1998) defined an IDSS as a DSS exhibiting some or all of the abilities that are indicative of 'intelligent behavior':

- Learn or understand from experience.
- Make sense out of ambiguous or contradictory messages.
- Respond quickly and successfully to a new situation.
- Use reasoning in solving problems.
- Deal with perplexing situations.
- Understand and infer in ordinary, rational ways.
- Apply knowledge to manipulate the environment.
- Think and reason.
- Recognize the relative importance of different elements in a situation.

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