

# Intelligent Agents

The notion of an intelligent agent that dutifully serves computer users has fascinated us since the invention of the digital computer. The computer Emerac in the Katharine Hepburn and Spencer Tracy 1957 movie, *Desk Set* is an example of such an agent. In this movie, Spencer Tracy plays an efficiency expert who is contracted to computerize the various business units of Federal Broadcasting Agency with Emerac. One of his projects is to encode the knowledge of every textbook in the research department managed by Miss Bunny Watson. To test the knowledge of Emerac, Miss Watson poses the following question to Emerac:

*Computer, what is the annual damage done by the spruce budworm to American forests?*

So how far have computers come in being able to answer the question that Miss Watson posed to Emerac in 1957? Well, not close enough if we require understanding the semantics of the question, as natural language understanding has proven to be a tougher problem than anticipated in computer science. Close enough, however, if we can point Miss Watson to a related URL, submitting

the keyword “spruce budworm forest” inquiry into one of the Internet search engines to get this Web address: <http://www.odf.state.or.us/pubaff/log/0009.html>.

Although our concept of an intelligent assistant has been refined over the years—from HAL in the Stanley Kubrick movie, *2001: A Space Odyssey*, in the late 1960s, to Phil in Apple Computer’s video, *The Knowledge Navigator*, in the late 1980s—the kind of intelligent agents we can actually build has not kept up with our expectations.

Nonetheless, we are getting closer (although the current hype in software agents seems to imply that we are already there). In this book, we will describe what is achievable in the short term with software agent technology, and show you how agent technology can change your business for the better. We start with a definition of an agent. The *Webster’s New World Dictionary* (Guralnik, 1970) definition is:

*Agent:* A person or thing that acts or is capable of acting or is empowered to act, for another.

This general definition of an agent points out its two key attributes:

- An agent does things.
- An agent acts on behalf of someone or something.

Intelligent agents that reside on computers always incorporate these two central attributes. Currently, there is no widely accepted universal definition of a software agent. The following definition of an agent will suffice to discuss the business applications of agents:

*Software agent:* A computing entity that performs user delegated tasks autonomously.

Our definition of an agent implies a personal assistant metaphor where the agent performs tasks on behalf of a user. Mail filtering agents, information retrieval agents, and desktop automation agents all fit this definition.

## Attributes of Intelligent Agents

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Our definition of software agent implies that the agent possesses the following minimal characteristics:

- *Delegation*: The agent performs a set of tasks on behalf of a user (or other agents) that are explicitly approved by the user.
- *Communication skills*: The agent needs to be able to interact with the user to receive task delegation instructions, and inform task status and completion through an agent-user interface or through an agent communication language.
- *Autonomy*: The agent operates without direct intervention (e.g., in the background) to the extent of the user's specified delegation. The autonomy attribute of an agent can range from being able to initiate a nightly backup to negotiating the best price of a product for the user.
- *Monitoring*: The agent needs to be able to monitor its environment in order to be able to perform tasks autonomously.
- *Actuation*: The agent needs to be able to affect its environment via an actuation mechanism for autonomous operation.
- *Intelligence*: The agent needs to be able to interpret the monitored events to make appropriate actuation decisions for autonomous operation.

In essence, the concept of an agent introduces an indirect management metaphor in a computerized environment (Alan, 1984) to supplement today's mainstream style of direct manipulation metaphor via graphical user interfaces. This functionality enables users to accomplish tasks in a collaborative manner with software agents without having to be physically present in front of their machines.

In addition to the basic attributes of agents discussed above, agents may have additional attributes such as mobility, security, personality, and others that will be discussed in later chapters.

The origins of agent technology are rooted in the computational intelligence, software engineering, and human interface domains. Computational intelligence for intelligent agents draws from the fields of intentional systems, production systems, reasoning theory, and neural networks. Software engineering for intelligent agents covers the areas of on-line monitoring, high-level event inference, remote actuation, image and speech processing, and distributed objects. Human-computer interaction for intelligent agents comes from the fields of cognitive engineering, user modeling, man-machine experiments, intelligent tutoring systems, and computer vision, as illustrated in Figure 1.1.