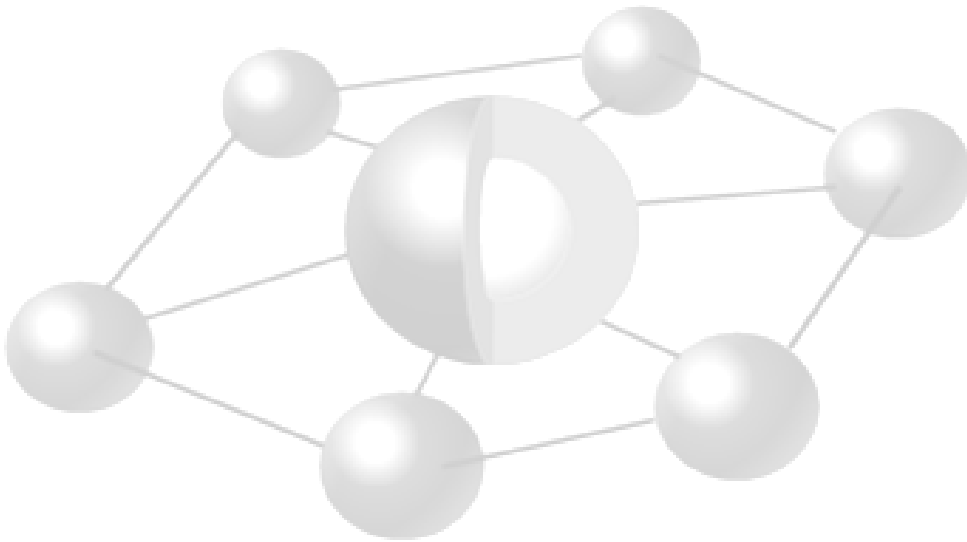


# Intelligent Agents 101

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Cougaar Software, Inc. – An Intelligent Agent Technology Company



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## Abstract

Cougaar Software applications are built upon a powerful new architecture concept called distributed intelligent agents. Because this technology is currently having such an impact in IT and is still a “hot topic” of research, this white paper serves to define the concepts of intelligent software agents, or agents, for short, as they apply to Cougaar Software solutions. This white paper is intended only to present a brief discussion of what agents are and what they are not; and, more importantly, it demonstrates how agents can be used to improve our everyday business operations.

This document is the first installment in our *Understanding the Technology* series. This series provides basic overviews of the important and innovative technologies currently used at Cougaar Software and that will be shaping technology’s future in general.

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## Agents Defined

Intelligent agents represent the next leap forward for network computing systems. At Cougaar Software, we build our cutting edge applications on a distributed, intelligent agent framework. But, what exactly is an agent?

*Agents are  
autonomous,  
continuous,  
collaborative,  
adaptive,  
reactive, and  
mobile.*

The definition of "agent" is widely debated in the research community today. For Cougaar Software, the discussion presented by Jeff Bradshaw in the introduction to the book, *Software Agents*, is the most appropriate. It states that an agent is...

"... a software entity which functions continuously and autonomously in a particular environment ... able to carry out activities in a flexible and intelligent manner that is responsive to changes in the environment ... Ideally, an agent that functions continuously in an environment over a long period of time would be able to learn from its experience ... an agent that inhabits an environment with other agents and processes to be able to communicate and cooperate with them ... perhaps move from place to place in doing so."

In general, agents must be autonomous, able to execute without user intervention. They must be able to communicate with other software or human agents and to perceive the environment in which they reside.

## Human Agents vs. Software Agents

To demonstrate how the concept of an agent can be applied in the real world, let's assume a very simple scenario of a human 'agent' making travel reservations for a customer. When you need to book a business trip, you can contact a travel agent to help you plan your trip. While this person initially knows nothing about what you want to do on your trip, he/she is expert at making airline reservations, arranging ground transportation such as a rental car, and booking your hotel. This agent acts on behalf of the airlines, the hotels, and the rental companies as well as on behalf of you, the customer.

### Human Travel Agent

Once you know that you need to make a business trip, perhaps you contact your personal assistant to coordinate your travel arrangements for you. Your assistant then works with the travel agent and communicates your destination and dates of travel. Your assistant will also research your destination and let you know what the weather is forecasted to be like. The travel agent uses his/her vast knowledge and tools to find a combination of travel arrangements that will meet your needs. Often, the travel agent will present a set of alternatives from which you or your assistant (who knows your preferences) can select the most agreeable trip.



The travel agent also operates on some level of autonomy; for instance, he/she can research the best flight deals for the day without acting on any one customer's behalf so that he/she will be prepared to provide quicker recommendations for prospective clients. In addition, the travel agent proactively and reactively responds to customer needs. For example, if you have a budget constraint for travel, the travel agent will not just wait for the airlines to come to him/her and offer the right flight price nor will the travel agent ignore a warning from the airlines about a scheduled fare increase. Also, in the future, the travel agent will let you know when the same airfare goes on sale in case you have a similar business trip coming up to the same place.

The travel agent will use his/her knowledge to find you the best combination of travel arrangements that fall within your budget. While you can make travel arrangements yourself, the travel agent's relevant experience and specialized tools yield better and more cost effective choices in a more timely fashion.



## Software Travel Agent

Similar to how the human travel agent described above makes travel arrangements for a customer, a software agent acts on behalf of a user to find and filter information, negotiate for services, automate repetitive or complex tasks, or collaborate with other agents to solve complex problems.

Just as different humans can do different jobs based on their training and experience, software agents do different jobs based on functional business processes they are configured



to execute. Agents can communicate with each other and with other systems and applications through business process interfaces. Agents can also perceive and monitor the environment in which they reside and make appropriate behavior choices; and, they are autonomous, able to execute without user intervention. Unlike humans, agents never get tired, do not make mistakes, can pay attention to every detail in massive amounts of data and work at electronic speeds.

To continue with our travel agent scenario, imagine that the travel arrangement activities described above are handled by agent software. For instance, when you need to schedule your business trip, you enter the parameters of your travel in an application, which we will call an 'assistant agent.' This assistant agent captures your itinerary and travel preferences once and then communicates them with a software travel agent. Your travel preferences are stored and 'remembered' for the next time you request travel reservations. This assistant agent also is already configured to provide you with a projected weather forecast for your trip.

The software travel agent then searches various database systems for matches to your travel preferences and trip requirements, and within minutes or seconds returns a list of travel options from which you can choose and book your trip. Further, the travel agent software, remembering where you are traveling to, may send you periodic reminders about fare increases/decreases on that particular flight in case you need to book it again in the future.





## Software Agents Applied

As illustrated by our simple scenario, agents can play many roles and are well-suited for a wide variety of processes and applications in today's business world. They are particularly well-suited to areas such as:

- process and workflow automation
- electronic commerce
- distributed problem solving
- Internet applications

Simple examples of how software agents are used today include the travel agent scenario we just described, context sensitive help in various client applications, search and information retrieval agents that can suggest search terms or help users compare prices for merchandise on multiple websites, and meeting agents that can juggle schedules according to relative priorities of the people involved.

## What Makes an Agent 'Intelligent'?

Any software that behaves in an agent-like manner and exhibits one or more of the characteristics identified in the definition in the previous section is considered an agent. "Intelligence" in agents adds a more realistic, dynamic dimension to the characteristics of software agents.

To be intelligent, agents must be able to work together on solving problems in a dynamic environment and must be able to communicate understandable results back to the user. As demonstrated in the scenario in the previous section, intelligent agents must be proactive and able to react to changing situations. Emulating more realistic behavior in day-to-day operations, intelligent agents can do much more than just match situational patterns or apply a static set of rules to solve a problem. An intelligent agent can operate in real time and use natural language to communicate; and, it is able to learn from the environment and be adaptive to user behavior.

*Intelligent agents must be able to learn, adapt, remember, react, assist, and reason.*



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## Is It a Software Agent or Just a Program?

Information Today's *Searcher: The Magazine for Database Professionals* October 1999 issue offers a clearly detailed article that defines Intelligent Agents today. In this article, authors Susan Feldman and Edmund Yu provide a very clear distinction between software programs vs. software agents and list the following characteristics of both:

“... All software agents are programs, but not all programs are agents.

- **Program** Static. Direct manipulation – user initiates every action. Non-interactive. Dialogs are fully scripted. Never changes, unless changed by a human or an error in the program. Runs one time, and then stops to be run again when called. Predictable—does what you tell it to, even if you didn't mean what you said. Follows instructions.
- **Agent** Dynamic. Indirect manipulation — autonomous. Actions may be initiated by either the user or the agent system. Interacts with user and with other agents. Adapts, learns. Persistent. Continues to run over time. Interprets what you mean, not what you say. In the best of circumstances, actions are based on rules, but they may change over time, or in reaction to different circumstances. May initiate actions, as well as respond to instructions. Stays in one place. May be mobile, traveling to other servers. “

As you can see from these distinctions, intelligent agents and their powerful features represent the next major advancement in capability for software systems. More flexible and advanced than basic peer-to-peer or object-oriented computing, agent-based systems allow us to build larger and more complex systems than are possible with conventional architectures.

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## Intelligent Systems in the Enterprise

The power of agent systems (software applications constructed in part or whole by agents) in the enterprise is in their ability to be experts individually but to collectively perform very complex activities through communication and coordination. This is not to say that only agent systems can do complex tasks, but, rather, that the agent-oriented approach makes it very logical and understandable to design, which generally translates to better code, less complexity, and greater reliability. From a software-engineering point of view, it is easier to build something reliable that knows one aspect of the problem than it is to build something that knows every aspect of the problem.

Like any engineering problem, the features of the problem space and your requirements will dictate the most appropriate solution to the problem. Though very flexible and powerful, agents alone are not a silver bullet for a successful system. Intelligent agent applications do however enable secure, dynamic collaboration over complex business processes that deal with massive amounts of information to levels of accuracy, timeliness and quality never possible before.



As stated by the Intelligent Agents Group (IAG) in their report, *Software Agents, a Review*:

“...Researchers and software companies have set high hopes on these so-called *software agents*, which “know” users’ interests and can act autonomously on their behalf. Instead of exercising complete control, people will be engaged in a cooperative process in which both human and computer agents initiate communications, monitor events and perform tasks to meet users’ goals. In essence, we need software agents because:

- more and more everyday tasks are computer-based
- the world is in a midst of an information revolution, resulting in vast amounts of dynamic and unstructured information
- increasingly more users are untrained

And, therefore, users require agents to assist them in order to understand the technically complex world we are in the process of creating. The number and type of application domains in which agent technologies are being applied to or investigated include workflow management, network management, air-traffic control, business process re-engineering, data mining, information retrieval/management, electronic commerce, education, personal digital assistants (PDAs), scheduling/diary management, etc. “

In the enterprise, agents can be used for collaborative filtering and fusing of data, gathering and analyzing logical sets of data in real time, and then visualizing those large data sets at a glance. Intelligent agents can also monitor user behavior to automate repeated tasks. Effective uses of intelligent agents as they are applied in the enterprise include data mining, profile management, privacy management, rules management, and application management.

Depending on the application, these systems can be rather simple or very complex. A simple example of an intelligent enterprise application would be a facilities management program where sensors monitor the environment and actuators make adjustments according to business rules, time of day, etc.

More complex examples of intelligent applications would include logistical and supply chain planning operations. In such applications, the system reasons about the environment and builds optimized plans for resource allocation, routes and action sequences. It continuously evaluates and adjusts during execution. While being data intensive, intelligence in this domain can provide significant cost savings.



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## For More Information

If you would like to learn more about intelligent agents and how they are used to improve today's business processes, there are various research sites and articles on the web that provide more detailed information. A small sampling is listed below:

- "Introduction to Software Agents," Jeffrey Bradshaw in *Software Agents*, AAAI Press/The MIT Press, 1997.
- "Intelligent Agents: A Primer," Susan Feldman and Edmund Yu. *Searcher: The Magazine for Database Professionals*, Volume 7, No. 9, October 1999.
- Cognitive Agent Architecture (Cougaar) is a Java-based, open-source architecture for the construction of large-scale, distributed agent-based applications. To learn more about Cougaar or download open source software, visit the Cougaar home page at <http://www.cougaar.org>.

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## About Cougaar Software, Inc.

Cougaar Software, Inc. (CSI) is a leading provider of intelligent middleware systems for the commercial and military sectors. CSI was created in 2001 to transition a suite of advanced technologies from military research to the commercial market. These technologies represent some of the most advanced reasoning and intelligent automation capabilities in existence, integrated to form a complete system architecture for global military logistics. The CSI team has extended this technology for the domain of RFID, developing a powerful foundation upon which to realize the full value of RFID down to the item level. Scalability, adaptivity, flexibility, and security have been the cornerstone concepts of our approach, bringing our military knowledge and experience to applications that empower enterprises.

Contact us today to schedule a demo of our powerful intelligent architecture and products!

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