Chapter 4.1
Intelligent Software Agents with Applications in Focus

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INTRODUCTION

Most people are familiar with the concept of agents in real life. There are stock-market agents, sports agents, real-estate agents, etc. Agents are used to filter and present information to consumers. Likewise, during the last couple of decades, people have developed software agents, that have the similar role. They behave intelligently, run on computers, and are autonomous, but are not human beings.

Basically, an agent is a computer program that is capable of performing a flexible and independent action in typically dynamic and unpredictable domains (Luck, McBurney, Shehory, & Willmott, 2005). Agents are capable of performing actions and making decisions without the guidance of a human. Software agents emerged in the IT because of the ever-growing need for information processing, and the problems concerning dealing and working with large quantities of data.

Especially important is how agents act with other agents in the same environment, and the connections they form to find, refine and present the information in a best way. Agents certainly can do tasks better if they perform together, and that is why the multi-agent systems were developed.

The concept of an agent has become important in a diverse range of sub-disciplines of IT, including software engineering, networking, mobile systems, control systems, decision support, information recovery and management, e-commerce, and many others. Agents are now used in an increasingly wide number of applications — ranging from comparatively small systems such as web or e-mail filters to large, complex systems such as

air-traffic control, that have a large dependency on fast and precise decision making.

Undoubtedly, the main contribution to the field of intelligent software agents came from the field of artificial intelligence (AI). The main focus of AI is to build intelligent entities and if these entities sense and act in some environment, then they can be considered agents (Russell & Norvig, 1995). Also, object-oriented programming (Booch, 2004), concurrent object-based systems (Agha, Wegner, and Yonezawa, 1993), and human-computer interaction (Maes, 1994) are fields that constantly drive forward the development of agents.

BACKGROUND

Although the term 'agent' is widely used, by many people working in closely related areas, it defies attempts to produce a single universally accepted definition. One of the most broadly used definitions states that *"an agent is an encapsulated computer system that is situated in some environment, and that is capable of flexible, autonomous action in that environment in order to meet its design objectives"* (Wooldridge and Jennings, 1995).

There are three main concepts in this definition: *situatedness, autonomy,* and *flexibility:*

- *Situatedness* means that an agent is situated in some environment and that it receives sensory input and performs actions which change that environment in some way.
- *Autonomy* is the ability of an agent to act without the direct intervention of humans. It has control over its own actions and over its internal state. Also, the autonomy implies the capability of learning from experience.
- *Flexibility* means that the agent is able to perceive its environment and respond to changes in a timely fashion; it should be able to exhibit opportunistic, goal-directed behaviour and take the initiative whenever appropriate. In addition, an agent should be able to interact with other agents and humans, thus to be 'social'.

For some researchers - particularly those interested in AI - the term `agent' has a stronger and more specific meaning than that sketched out above. These researchers generally mean an agent to be a computer system that, in addition to having the properties identified above, is either conceptualized or implemented using concepts that are more usually applied to humans. For example, it is quite common in AI to characterize an agent using mentalistic notions, such as knowledge, belief, intention, and obligation (Wooldridge & Jennings, 1995).

INTELLIGENT SOFTWARE AGENTS

Agents and Environments

An agent collects its percepts through its sensors, and acts upon the environment through its actuators. Thus, the agent is proactive. Its actions in any moment depend on the whole sequence of these inputs up to that moment. A decision tree for every possible percept sequence of an agent would completely define the agent's behavior. This would define the function that maps any sequence of percepts to the concrete action – *the agent function*. The program that defines the agent function is called the *agent program*. So, the agent function is a formal description of the agent's behavior, and the agent program is a concrete implementation of that formalism. (Krcadinac, Stankovic, Kovanovic & Jovanovic, 2007)

To implement all this, we need to have a computing device with appropriate sensors and actuators on which the agent program will run. This is called *agent architecture*. So, an agent is essentially made of two components: the agent architecture and the agent program.

Also, as Russell and Norvig (1995) specify,