

# Taxonomy of Software Agents

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**Abstract:** Agent is an old concept in human civilisation, and it comes from the word agency. Physical agents that act as facilitators in discharging duties unbehalf of their owners or clients are no more in vogue, since the invention of the programmable electronic device called computer, human activities have been influenced greatly and productivity has been on the increase because of the application of softwares to undertake most human activities. These softwares now act as agents for their owners or users to facilitate transactions in this present information age; to birth what is popular known as software agents. The Internet, which is a global computer networked environment, is the physical platform for ubiquitous computation where people of different domains of human specialisation, use software agents for business transactions. The researchers define an agent, software agents and take a panoramic overview of characteristics of software agents, and present a robust taxonomy of software agents for proper understanding, highlight some importance of software agents.

**Keywords:** taxonomy; software agents; adaptability; sociality; coordinativeness; multifarious environment; malicious; artificial intelligence.

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## 1. INTRODUCTION

There are plethora definitions of the term software agent in available literatures. It is salient to mention few for the clarity of this research. Software agents are like programs communicated through Remote Job Entry, or e-mailed documents embedded macros

Ideally, an agent is a thing or individual person who is empowered to act as representative for another person, governments, organisation, group etc., with a level of autonomy and social ability to achieve specified objectives for the person unbehalf of whom it acts. An agent is software processes that act on a user's behalf, perform particular functions autonomously and realise goals. An agent is versatile in changing environments and work in team. Member of team have complementary specialist or duplicate.

## 2. AN AGENT

Some agents are: estate agents, travel agents or brokers etc. At General Magic Incorporated, Lange (1998) cited in Elmarie (2004) said: agent is a software object that is situated within environment of execution and possesses the following mandatory properties: autonomous-that is, acts for the user; reactive- meaning responsive to change in environment; and goal-driven meaning proactive acting in advance to deal with an expected situation; Coordinative-ness meaning agent can accomplish task in an environment.

## 3. SOFTWARE AGENT

Software agents are a conglomeration of computer programs that travel on computer networked environment; to act as representative for users or governments, organisation, group etc, and exhibit social and learning abilities, and with some level of autonomy and proactiveness, to accomplish certain earmarked objectives for the person unbehalf of whom they

acts. Omoghenemuko (2009) defines software agent are autonomous, has goals, a scope of competence and which relates to computer softwares

Software agent is a program that performs duties like information gathering, information filtering, and initiating actions in the background for agents or clients (Smith and Cypher, 1994). Object Management Group (2000) cited in Elmarie (2004) defines a software agent as an autonomous software entity that can interact with its environment.

#### 4. CHARACTERISTICS OF SOFTWARE AGENTS

Some properties or attributes of software agents are:

- **Autonomy.** This is the capability of agent to compute without human interaction or external intervention, although intermittent interaction is required but does not utter agent’s autonomous decision
- **Adaptivity.** Agents are capable to regulate their behaviours to respond to internal knowledge and changes in operation’s environment
- **Interactivity.** An agent should have a high strength of communication with other mobile agents.
- **Sociability.** Software agent acts socially in a friendly way.
- **Mobility.** This is capability for mobile softwares to transfer or move itself from an environment to another environment.
- **Rationality.** A software agent is capable to make a choice action to undertake based on its mission and internal objectives.
- **Coordinativeness.** Mobile agents’ execute tasks in certain environments’ with another agent.
- **Intelligence.** Mobile agents are intelligent, which implies the exhibition of six attributes: mobility; pro-activeness;, reactivity; learning ability; autonomy and sociality.
- **Cooperativeness.** Mobile agent has coordinating capability or work cooperatively with other mobile agents to realise goals.
- **Proactive.** Mobile agent is goal-oriented and it senses the operations within computation’s environments and takes decision of what to do to overcome possible attacks. Mobile agents are goal-oriented, capable of taking the initiative, not just reacting to the environment (Stephen, 2000; and Eli, 2003). Attributes of mobile agent (that are alien to scope of this research) include: ruggedness; unpredictability; accountability; competitiveness, etc.

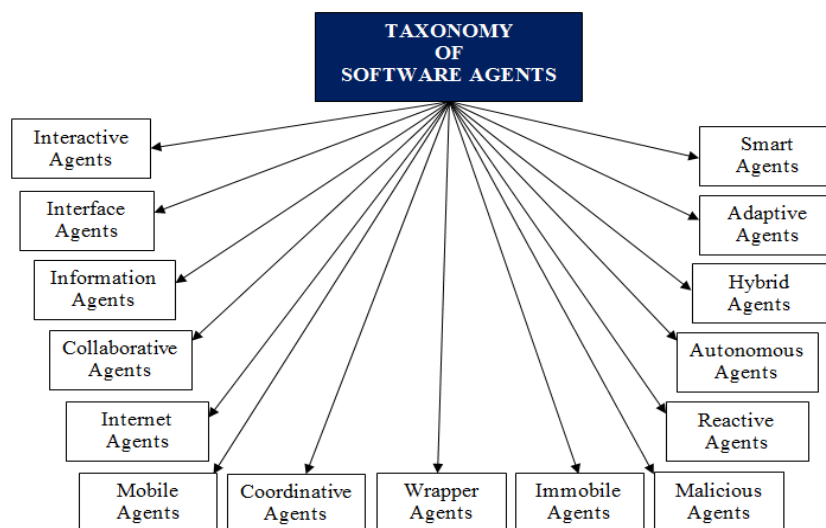


Figure 1: taxonomy of software agents

## 5. TAXONOMY OF SOFTWARE AGENTS

From characteristics of software agents aforementioned, we can categorise software agents according to functions into:

- i. **Adaptive Agents.** These are software agents, which respond to other agents' and its operations environment to certain to certain level. Adaptive agent is capable of reacting to stimuli; to, direct predetermine or predict event or signal in its environment. Sensors in robots, thermostat, thermometers, search engines like Opera-mini are examples.
- ii. **Coordinative Agents.** These are software agents that manage activities like interdependencies among other agents by cooperation and coordination of plans or other management mechanisms.
- iii. **Wrapper Agents.** These are software agents that help in software configuration activities on computers. Java or Windows bootstraps agent using Java agent or windows command's line option are examples.
- iv. **Internet Agents.** All software agents that operate on the Internet, are called Internet agents. All web browsers are examples.
- v. **Collaborative Agents (or Deliberative agent).** This is software agent that is used for simulation in multi-agent systems'. They are also called intentional agents. Deliberative agent works by acting on other agents' predicted actions and use symbolic representation or reasonability of effect of any action it takes.
- vi. **Reactive Agents.** These are software agents that accomplish their objectives by reflexively reacting on external stimuli-which means reactive agents actions are a function of the present perceived state. Example, censor software.
- vii. **Interface Agents.** These are software agents that perform duties for their users by providing proactive support to a person who uses specific application software like solving a given problem without users explicitly requesting. Interface agents include: personal digital assistant (PDA); personal agent secretary software that assists user at work environment
- viii. **Interactive Agents.** These are agents that gather, expand their knowledge, and discharge duties requested of users in natural language. Applying simple statements, the agent can answer questions and when completing a task becomes a problem, the agent must communicate with users' for further instruction.
- ix. **Information Agents.** An information agent is software agent with capability to access potential information in varied sources, manipulates and collates these information obtained from different sources; to answer query requests of users and other information agents (the network of interoperating information sources may be called intelligent information cooperative system.
- x. **Smart Agents.** These are software agents that simulate human abilities so as to assist humans in many areas of work like reasoning without interference of humans. Smart agents exhibit Artificial Intelligence (AI)
- xi. **Hybrid Agents.** These are software agents composed of a combination of multiple agents' attributes and can perform functions of these hybridized agents.
- xii. **Autonomous Agents.** These are intelligently designed software agents acting on their autonomous choices for their owners' without interference of owners in any computation operations' environment.
- xiii. **Immobile Agent.** A Fixed or Immobile or Stationary agent is software agent, which executes only on the system where it begins execution. If it uses desired information with other agents, it surely would use a communication technique, which according to Lange (1998) is known as remote procedure calls. Stationary agent supports other agents like mobile agents to accomplish their objectives. Stationary agents reside on particular or specific platform, but mobile agent defers its computations in one execution platform and shifts to another execution environment to start computation.
- xiv. **Mobile Agent.** A software agent is mobile if it moves about and communicates with different agents' softwares. Mobile agent is autonomous software agent, which migrates between computers; suspends computation on previous host and starts execution on arriving new host platform.

- xv. **Malicious Agents.** All classes of software agents that do not abide by the laws guiding software agency, instead circumvent the law and carryout some form of malicious acts to their advantage, are referred as malicious or malignant agents

## 6. CONCLUSION

This research has examined carefully many examples of software agents' and expanded the taxonomy of software agents and made efforts to present them clearly diagrammatically to demarcate one from the other.

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