Int. j. adv. multidisc. res. stud. 2022; 2(5):240-243

Received: 28-07-2022
Accepted: 08-09-2022

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Effect of Intelligent Software Agents on Artificial Intelligence: A Review Study

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Abstract
In the current scenario of networking technologies, and due to the large volume of data and knowledge on the Internet, the decision support systems get incredible opportunities for providing more abundant and reliable information for every domain and application area. Some prevailing features of the Internet technologies, however, have slowed down the successful use of the Internet by humans or decision support machine systems. It is due to the fact that, firstly, the information available on the internet is spread around the globe on server pages and is disorganized. Every individual connected to the internet has his own perception of the data and its sources and hence the services grow dramatically. Secondly, the dependability, type and availability, of information services are changing all the time. Thirdly, due to the complex information updating and maintenance issues, information is imprecise and probably incorrect last but not least, the same piece of knowledge can be obtained from a number of different sources. As a result, it has become a critical challenging task for a human or computer device for collecting, identifying information sources, accessing, filtering, evaluating, and using the information in problem-solving as well as integrating data in support of decision-making, for information retrieval and problem-solving efforts. To fix this issue, one of the suggested methods is to use “Smart Software Agents". These Smart Software Agents are program codes that act on behalf of their human users to perform strenuous information gathering tasks from various online information sources, resolving discrepancies in the retrieved information, and filtering out irrelevant data.

Keywords: Artificial Intelligence, Swarm Intelligence, Smart Agent

1. Introduction to Artificial Intelligence

There are various new domains in computer science and information science. Artificial intelligence (AI) is one such domain. It focuses on creating hardware and software systems that can solve complex problems with fewer efforts and time as compared to humans. The AI sector has grown in the field of defence, in the form of “smart” military arms, automatic pilots for aeroplanes and space ships, the medical field, and research and development of machines such as robots. Nowadays, the word artificial intelligence (AI) is replaced with machine intelligence (MI).

There are various artificially intelligent tools that can assist in the solving of a growing number of problems, without the supervision of a human. AI has been providing a range of outcomes that are significant to researchers, developers, students, teachers, and our overall educational system over last few years.

2. Artificial Intelligence

Here are three different ways to define AI. The first definition is. “Artificial intelligence is the science of making machines do things that would require intelligence if performed by men,” Marvin Minsky said in the early 1960s. The second is by Allen Newell, who describes intelligence as "the degree to which a system approximates a knowledge-level system" in his book Unified Theories of Cognition. The ability to bring all of a system's information to bear in the solution of a problem is known as perfect intelligence (which is synonymous with goal achievement). This is distinct from ignorance, which is described as a lack of knowledge about a specific problem space.

AI, in its broadest sense, is the discovery of strategies assisted by computers for resolving complex problems that have been solved by humans. Complex logical inference, diagnosis, visual recognition, natural language comprehension, game play, interpretation, and preparation are examples of such activities (Horvitz, 1990).

3. Human Intelligence

Intelligence research and measurement have a long history. In the early 1900s, Alfred Benet and Theodore Simon, for

example, created the first Intelligence Quotient (IQ) test. IQ is a difficult term to grasp. There is no consensus among IQ experts on what constitutes intelligence or how to calculate it. (Most people are unsatisfied with the argument "IQ is what an IQ test measures."). You've probably taken a few IQ tests and can recall a number that represented your score on one of them.

It is very unusual that a person's cognitive abilities are measured by a single number. Many people had and may have multiple intelligences and that a single number cannot reflect their intelligence.

4. Introduction to Smart Agent

An Intelligent Smart Agent (ISA) is a computer-generated decision-maker that make high-level, independent, intelligent decisions, based on interactions with other objects and decision-makers in the virtual world. These ISAs observe the environment and depending on the necessary conditions take actions independently in order to achieve some desired goals. It also updates and upgrades its knowledge base with learning and may improve its performance. They may be simple or complex.

Artificial intelligence is the mechanical replication of human intelligence. Clients can minimize human workload by delegating tasks to Intelligent Software Agents (ISAs) that would usually necessitate human-like intelligence.

An agent has an "objective function" that encapsulates all the ISA's goals. For example, a reinforcement learning agent has a "reward function" that allows the programmers to shape the ISA's desired behaviour, and an evolutionary algorithm's behaviour is shaped by a "fitness function".

Many researchers who used to refer to their work as "AI" are now focusing on "agent technology." As a consequence, in today's research culture, the term "agent" alone usually connotes ISAs. Intelligent agents are also closely related to software agents (autonomous computer program that carries out tasks on behalf of users).

For ISAs, delegation is even more absolute. ISAs have the potential to create and apply unique rules of conduct that humans do never have the time or desire to examine. ISAs may also analyse data to identify non-obvious or secret patterns, extracting knowledge from raw data, in addition to interacting with their environment to gather data and actuate changes.

ISAs possess adaptability as well as continuous, online learning to enhance performance due to which environmental changes don't affect their decision-making capabilities. All human senses such as vision, voice and natural language are incorporated into environmental modes of interaction, making them richer. ISAs can also assist clients to articulate their desired goals in concrete terms.

5. Agent variants

5.1 Mobile Agents: These agents move around the resources where the data resides. Hence sometimes they are referred to as traveling agents. The alternative typical operation involves a client-server model, where the agents are the clients and request the server to send data volumes that is to be analysed. The agent then sends the processed data back to the server. Since the agents are moved to the data storage areas, significant performance improvements is achieved. These agent frameworks are rare, due to the fact that a high level of trust is required to accept a foreign agent onto one's data server. With the technological advancement for accountability and immunity, mobile agent systems will become more popular.

5.2 Distributed Agents: These agents are used to achieve load-balancing over a set of computational resources. These are self-distributing, always in a quest for agent platforms that can offer higher computational resources at lower costs.

5.3 Multiple Agents: Using the concept of modular programming, the processes are broken into sub-processes. These sub-processes are handled independently by specialized agents. Such agents are oblivious of the existence of the others but nonetheless rely upon the successful operations of all.

5.4 Collaborative Agents: These agents work together for sharing information or bargain for specific services to effect a measured synergism. Each agent uniquely follows the particular operating environment’s protocol, they usually share a common language for communication which enables them to request specific services from their associates as required.

6. Intelligent Software Agent Architecture

The main purpose of such an architecture is to enable intelligent interoperability among heterogeneous sources and avoid centralized control of the system. Mediator agents handle the central functionality of such an agent-based distributed database system and a set of wrapper agents team up with user interface agents, matchmaker agents, and ontology agents. Wrapper agents are used for accessing the native information sources, extract the related content from that source and perform data conversion. In addition, a mediator is required to collaborate with stakeholder or matchmaker agents, ontology agents, and user interface agents.

There are various mediator agents involved in the process. A covering agent, is the one which hides and protects the query by the candidate datasets, whereas the planning agent, is the one which creates a plan for the optimal cover and manages the entire process of plan execution. Matching agent uses a negotiating agent, to determine the possibility of full integration, if a partial match is made. The task of a negotiation agent is to determine a common ontology for mapping different classification schemes with each other. Classification servers are used for performing this task. The brokering agents possess the ability of learning other retrieval strategies if there is a problem with the optimal strategy (as constructed by the covering agent). The overall cost of retrieving various data fragments from possible data sources; is managed by the costing agents (including authentication), along with internet transportation time and processing time. Information agents act on behalf of the data sources. These agents are connected through the centralized wrapper agents that controls the activities of all the other agents.

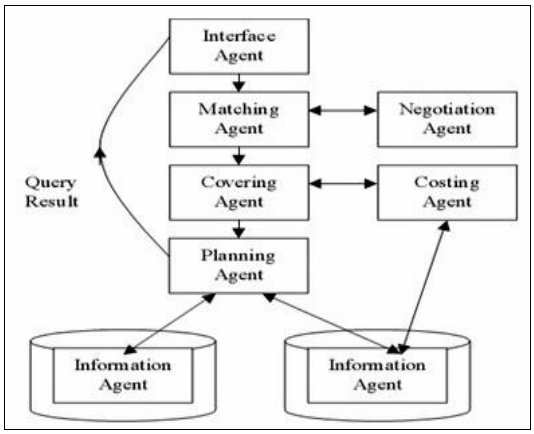

Fig 1: Types of Agents

7. Classification of Intelligent Software Agents

The classification of agents are done on the basis of the attributes and specific properties, they exhibit. These include the following:

7.1 Primary Attributes

7.1.1 Autonomy: The ability of agents to be self-operative, without immediate guidance from humans.

7.1.2 Cooperation: The ability to exchange high-level information with other agents. These agents are also called as collaborative agents.

7.1.3 Learning: The ability of agents to increase performance over time when interacting with the environment in which they are embedded. These are sometimes referred to as interface agents. And the agents that can cooperate and learn by self are termed as smart agents.

7.1.4 Mobility: The ability of agents to move around a network.

7.1.5 Deliberative Behaviors: The ability of agents to unveil planning and negotiation skills using an internal reasoning model in order to achieve their goals.

7.2 Seconday Attributes: Agents can also be classified according to a number of other attributes, which could be regarded as secondary attributes. For example, the social abilities of agents or the range to which they engage in a variety of tasks. By combining these properties and attributes, hybrid agents and heterogeneous agents can be constructed. By using a particular communication language for interaction, two or more categories of agents can be combined together. This is referred to as the heterogeneous. Similarly, two or more properties and/or attributes are combined in the design of a single agent and can be referred to as hybrid agents.

8. The Agent Model

A detailed model of the internal workings of an agent is given. It is a layered model of an agent that is deliberative, reactive and co-operating. This agent comprises the behaviours-based layer, the local planning layer and the cooperative planning layer. The agent uses three models representing various parts of reality. The agent will use the models to interpret the input from the environment and to plan possible internal and external actions. A description of the agent's environment is handled by the world model and is linked to the behaviours-based layer. The inner state of the agent itself is managed by the mental model and it is linked to the local planning layer and the inner states of other agents in the environment is handled by the social model which is linked to the co-operative planning layer.

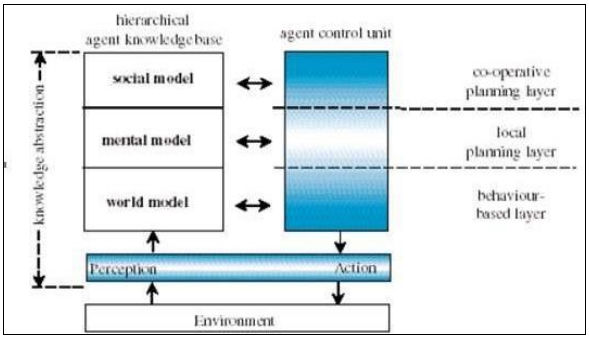

Fig 2: The layered design of an agent that is both deliberative, reactive, and co-operating

Fig. 3 depicts the agent control unit of the hybrid agent, its conceptual building blocks, and their relationships. Conceptually, one can distinguish the following components.

8.1 Perception: It is the symbolic representation of the information communicated to the agent.

8.2 Situations: These inform the agent to identify the need for activity.

8.3 Beliefs: These symbolizes the expectations of an agent about the current state of the world and about the likelihood that a specific action produces certain effects.

8.4 Goals: Every agent has a set of context- independent goals. These goals are classified into reaction goals, local goals and cooperative goals. The goals that are triggered by external events that require a fast reaction and are of a short-term base are called reaction goals. The goals of the agent itself are called as local goals and goals that are shared among a group of different agents are known as Cooperative goals.

8.5 Options: The motivational state of an agent is represented by a set of options. A set of context-dependent options is selected based on the current situation. These options are directly connected with the agent's goals. To achieve the current goal(s), operational primitives are selected based on the selected option.

8.6 Operational Primitives: The software techniques also called as operational primitives assist an agent to achieve certain goals. Once selected, these operational primitives are merged into an execution schedule.

8.7 Intentions: An agent also has intentions. These intentions define the action an agent is going to take (the deliberative state of the agent). The intentions lead to the execution of the operational primitives from the execution schedule.

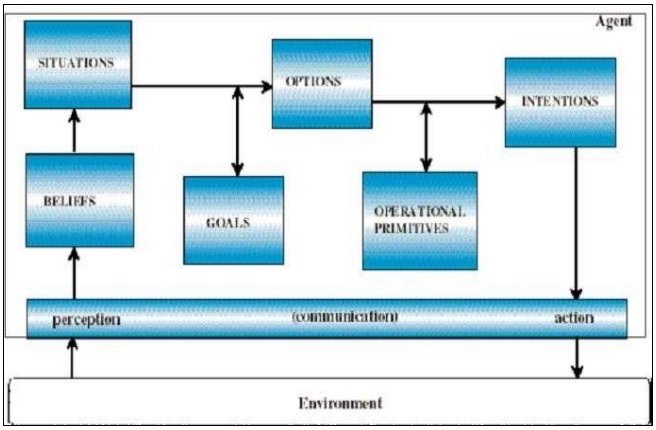

Fig 3: The agent control unit of the hybrid agent

9. The Communication Model

For communication, all the agents responsible for the task must be active in the same network framework. The framework must possess the following properties:

- Agent execution facilities;
- Agent communication facilities;
- Agent mobility or migration facilities;
- Mobile agent cloning in local environment facilities;
- Agent information encapsulate facilities;
- Agent identification and authentication facilities;
- Agents movement makes the task more efficient to achieve.

The following presents a black box model of the way agents communicate with their environment independently of their exact location in the environment.

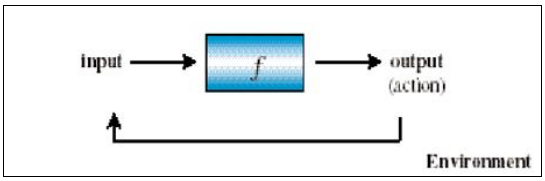

Fig 4: Black box model of an agent

10. Applications

Intelligent Software Agents have been successfully employed in multiple application endeavors, some of which are listed below.

- Data Collection and Filtering
- Pattern Recognition
- Event Notification
- Data Presentation
- Planning and Optimization
- Rapid Response Implementation

11. Future Areas of Application

1. Systems and Network Management
2. Mobile Access / Management
3. Mail and Messaging
4. Information Access and Management
5. Collaboration
6. Workflow and Administrative Management
7. eCommerce
8. Adaptive User Interfaces

12. Swarm Intelligence

Swarm Intelligence (SI), is a field of artificial intelligence (AI) that is based on the collective behavior of elements in self-organized and decentralized. For logically controlling the procedures of IoT based systems, SI plays a very significant role. The IoT based systems consist of smart objects, so powerful decentralized algorithms supported by SI are used to resolve such complex problems. Various properties of intelligent algorithms of SI like dynamic properties, device mobility, wireless communication, and information provision, they can solve the challenging issues of IoT systems more efficiently. These SI algorithms are used for aptitude-based problems in real-time systems for handling the actions efficiently. The complex IoT processes are normalized by the techniques like ant colony optimization, artificial bee colony, and social spider optimization of the SI algorithms.

13. Conclusion

Today as internet technology is growing fast, autonomous Intelligent Software Agents (ISA) are finding their place in every domain for finding, organizing, and analyzing information on behalf of their owners. This autonomous agent technology can reduce the time, effort and cost of retrieving and filtering information on the Web. This agent technology is in its learning phase and with more and more research and development work is expanding its boundaries for all dimensions of the horizon. These new tools for data visualization and intelligent will be able to help humans to handle problems related to real-time tracking, smart pharmaceuticals, bio-technical convergence, nanotechnology and above all technology augmentation – implants, The future belongs to augmented reality, SI and autonomous Intelligent Software Agents (ISAs).

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