Intelligent Agents: A Deep Insight

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ABSTRACT

You must have experienced while e-shopping work is being done automatically using sensors. It must have introduced some curiosity to know what technology is working behind it and how it works. That technology is Intelligent Agents. Intelligent Agents is an emerging technology that makes computer system easier to use by entrusting the work back to the computer. It can automate monotonous tasks, wisely recapitulate complex data, memorize things on your behalf, learn from you and even counsel you. In this research paper the emphasis is put on describing the Intelligent Agents in detail by explaining their behavior and structure. This paper also throws light on few areas where these Intelligent Agents are being used.

Keywords

Sensors, Actuators, Perceptions, Knowledge base, Autonomy

1. INTELLIGENT AGENTS

In artificial intelligence, an intelligent agent (IA) is an autonomous entity which observes through sensors and acts upon an environment using actuators (A mechanism that puts something into automatic action) and directs its activity towards achieving goals.

In the words of Maes and Parrie, "Autonomous agents are computations systems that inhabit some complex dynamic environment, sense and act autonomously in this environment, and by doing so realize a set of goals or tasks for which they are designed".

An Intelligent agent is a piece of hardware or more commonly a software possessing a number of properties, which are as follows:

1.1. Autonomy

Intelligent Agent is an autonomous entity that has capacity to make its own decisions about its actions without direct intervention of humans, and they have control over their actions and internal state.

1.2. Rationality

Intellectuality is the main feature of agents. They are targeted towards achieving their goal in the best possible way and they never act in a way that prevents them from achieving their goal. However there are many ways of making goals known to an agent. An Agent could be impelled by a script with pre-defined actions which would then define the agent's goals. Agents could be impelled by rules defining agent's goals. There are also embedded agent goals, such as "planning" methodologies, and in some cases the agent could change its own goals over time.

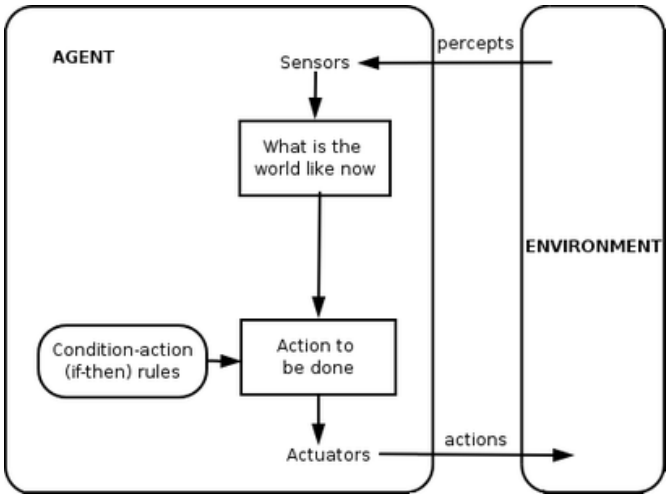

Fig 1: Intelligent Agent perceiving through environment and taking action

1.3. Sociability

Agents have the ability to communicate with other agents (in multi-agent systems) and humans via an agent communication language.

1.4. Reactivity

Agents perceive their environment through sensors and react in a seasonable and rational fashion to changes that occur in it. This characteristic of the agent is at the core of delegation and automation. For example, Agent is told that "whenever x happens, do y" and the agent is always waiting for x to happen. An agent continues working even after the user is gone, which make it capable of running on a server, but in some cases, an agent also runs on the user systems.

1.5. Pro-activeness

Agents do not simply act in response to their environment, they are capable of taking the initiative (generate their own goals and act to achieve them).

1.6. Ability to learn

Intelligent agents are capable to learn or change their behavior base on their previous experiences and then use this knowledge to achieve their goals.

1.7. Mobility

Agents have ability to travel from one machine to another and across different system architectures and platforms. This feature enables them to move from machine to machine to be closer to data they may need to process and do so without network delays.

1.8. Veracity

Agents are truthful and never knowingly communicate false information.

1.9. Benevolence

Agents always try to do what they are asked of.

Finally, some agents attempt to be believable, such that they are represented as an entity visible or audible to the user and may even have aspects of emotion or personality. For Example while using the Global Positioning System the agent communicate with the user and tells the directions to the user about their destination when the user is actually driving.

Autonomy, Pro-activeness, Reactivity and Sociability are the weak agent characteristics whereas Mobility, Veracity, Benevolence and Rationality are the strong agent characteristics. In short we can say that Intelligent agents are software entities that carry out some set of operations on behalf of a user or another program with some degree of independence or autonomy, and in so doing, employ some knowledge or representation of the user's goals or desires (from IBM).

2. BEHAVIOR OF INTELLIGENT AGENT

Let's first explain what an Ideal Rational Agent is? For each percept sequence it receives, an ideal rational agent on the basis of its knowledge base and the evidences provided by the percept sequence, should perform the expected action to maximize its performance measure. In order to solve a problem, Intelligent Agents should be able to do reasoning by using its dynamic information (deduced by system) together with the static knowledge stored in its knowledge base and then decide upon an action. Thus the behavior of an Intelligent Agent can be described as follows:

2.1. Percept Sequence

In artificial intelligence, percept sequence is a chain of inputs that an agent receives from the environment. As an analogy, just like human agents have sense organs like ears, eyes, nose, tongue and skin through which they perceive the environment and the other parts legs, hands, mouth etc. work like effectors through which they take actions, intelligent agents can perceive through its sensors and acts upon that environment through effectors. A robotic agent has cameras and infrared range finders for the sensors and various motors for the effectors. On the other hands a software agent has encoded bit strings as its percepts and actions. In simple terms percept sequence is everything that an intelligent agent ever perceives in the environment and depending on its entire percept sequence; it makes its choice of actions.

2.2. Mapping from percept sequence to action

Now we know that an agent's behavior is dependent on its percept sequence. So there is a need to make a list of actions it will take in response to each possible percept sequence. Such a list from percept sequence to actions is called mapping. But there is also a need to put a bound on the length of percept sequence otherwise the list will be very long (infinite in fact). In order to realize which mapping correctly portrays an agent, there is a need to try out all the possible percept sequences and record which actions the agent does in response. However if the agent is using some randomization in its calculation, then there is a need to try some percept sequences many times to get a precise idea of the agent's behavior. Specifying which action an agent ought to take in response to any given percept sequence provides a design for an ideal agent.

Here it should be noted that there is no need to create an explicit table containing each possible percept sequence and their actions instead agent should be a nice compact program that implements the ideal mapping for general situations. More precisely an agent should be designed in such a way that it should be able to solve a limitless variety of tasks in a limitless variety of environments.

2.3. Autonomy

Autonomy is another important aspect to be considered. Every agent is equipped with built-in knowledge for the particular environment in which it operates. But if the agent's actions are completely based on built-in knowledge, ignoring its percepts, then we say that agent lacks autonomy. An agent's behavior should be based not only on the built-in knowledge but also its own experience. Thus it is obligatory to provide an Intelligent Agent with some initial knowledge base as well as ability to learn from its experience. An agent if is operating only on the basis of built-in assumptions lacks flexibility, whereas an Autonomous Intelligent Agent should be able to operate successfully in an extensive range of environments, provided sufficient time is given to acquaint with.

3. STRUCTURE OF INTELLIGENT AGENT

An Intelligent Agent is a blend of an Agent Program and the architecture.

i.e. Agent = Architecture + Program

3.1. Architecture

By architecture we mean the description of the computing device on which agent program will run. So the agent program should be compatible with the architecture of the computer. The architecture can include some special purpose hardware for some tasks like processing camera mages, filtering audio input, sensors for measuring temperature etc. the job of the architecture is to provide the percepts form the sensors to the agent program (accepting input), execute the program (processing) and feed the program's action choices to the effectors as they are generated (generate output).

3.2. Agent Program

We can define the Agent Program as a function that implements the agent mapping from percepts to action. Designing an agent program needs the knowledge of the possible percepts and actions, goals or performance measure of the agent and the type of environment in which the agent will operate.

3.3. Example Agent Program

Here is a basic agent program that accepts percepts from an environment and generates action, called as Skeleton Program.

```
function SKELETON-AGENT( percept) returns action
static: memory, the agent's memory of the world

memory    UPDATE-MEMORY(memory, percept)
action    CHOOSE-BEST-ACTION(memory)
memory    UPDATE-MEMORY(memory, action)
return action
```

Fig 2: A skeleton Agent

- In this skeleton program there is function called SKELETON-AGENT that maps the percept sequence to actions. The function accepts only one argument specifies that only one percept at a time is accepted as its input whereas the agent can build up the percept sequence in its memory.
- On each invocation the agent program is updating the memory of the agent to reflect the new percept using UPDATE-MEMORY function.
- Then the program chooses the best possible action from the memory as per the perception by invoking the CHOOSE-BEST-ACTION function.
- UPDATE-MEMORY function stores the action chosen in memory and updates it.
- Memory being static sustain from one invocation to the next.
- Skeleton program does not include goals or performance measure because the performance measure is applied externally to judge the behavior of the agent.

Thus the Agent Program is not only using its initial knowledge base but also updating it by storing the percepts and the actions.

4. EXAMPLES OF INTELLIGENT AGENT

A reflex machine such as a thermostat is an intelligent agent, as is a human being or a community of human beings working together towards a goal. Similarly A payroll program and a spell checker are also examples of Intelligent Agents. Here are few real examples of usage of Intelligent Agents by real people to solve their various problems.

4.1. IBM's Customer Help Desk

In call centers, when customers calls, the person receiving the call has to answer the questions asked promptly by searching manually from searchable CD-ROM collections, custom online databases, searching from the internet or by consulting with other help desk personnel. IBM's Customer Help Desk uses Intelligent Agent to solve this problem. Where the customer explains its problem to an Intelligent Agent, and it automatically searches the suitable databases whether local, CD-ROM, or through the Internet, and finally provide the customer with a consolidated answer with the most likely information first. This Application uses Intelligent Agent to find and filter information.

4.2. IBM's Web Browser Intelligence (WBI or Webby)

WBI is a Software Agent specifically designed to work as a personal assistant observing and learning everything you do on a web browser. It keeps track of each web site you have visited by automatically keeping a bookmark list ordered by how frequently and how lately you have visited that site. That's why it also enables you to find where you were by showing all the different trails you took starting from the current page. It enables you to search for a web site by any word you have seen in your web journey and takes you to that site as well. It also apprises you when the sites you like are updated. It can also download web pages as per your preferences so that you can browse then later offline, which saves your time as well.

4.3. IBM's Personal Shopping Assistant

IBM's Personal Shopping Assistant also works on the mechanism of Intelligent Agent that helps the internet shopper to find the desired item promptly, that saves time of the shopper as he does not need to browse the pages in search of the item. This Intelligent Agent can help an internet shopper by customizing both the stores and the merchandise. It learns the predilection of the customer and rearranges the merchandise accordingly when you visit a site.

5. CONCLUSION

Intelligent Agents have been in existence around us from years, but its true enforcement is still in its infancy. Knowing that they have capability to learn and react they will simplify the task of accumulating the information for the end user. They will not supersede surfing thoroughly; rather they work as an assistant untangling the complicated task for the customer. It is universally accepted that Intelligent Agent will become a prime constituent in the future of internet and this is the reason a lot of ceaseless research is being conducted in this field.

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