

INTELLIGENT AGENTS

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Abstract

The concept of the **agent** has become the most prominent part in both Artificial Intelligence(AI) and also in Computer Science. The main aim of this paper is to make the reader understand the role of the agents in the field of artificial intelligence and how scientists are automating and making the use of these agents in order to develop a decision making machine or a robot. Intelligent agents are an emerging technology that's making the computer and the mobile world easier to use and never failing to amaze us with a hassle free experience. They help in finding the filtered information and also to automate work. This paper examines the architecture and some applications of the intelligent agents in real time.

1. INTRODUCTION

For a system in order to make a valid decision which is acceptable by the user, the system needs to exhibit rational behavior. So agents are the primary cause for certain behavior. Agents are the entities that perceive and act. What I mean by perceive is that the agents are going to gain the information. And this can be through sensors(physical sensors). So if we think about a robot or a self-driving car, there will be things like ultrasound or sonar sensors. These also can be software related inputs as well. So gaining information through channels, reading information from the web, from email. How the agent acts is how the agent interacts back with the environment. So again this can be physical actuators. For example a robot moving an arm, or this could be software related as well like sending a message, posting to a page and things like that. In general we can think about actuators as changing or affecting the environment in some way. So when we think about agents there are many different types of agents of varying complexity. So everything from a simple thermostat which is going to be sensing the temperature in your house and will be actuating change in the environment back by say turning on or off the furnace or the air conditioner. We can also think of humans as being agents, like humans has sensing agents say eyes, skin, nose and all the sense organs and we also have the

actuators as well like limbs, vocal track and more. We can also think about the software agent in receiving information and looking at file structure contents.

2. Agent Structure

In general we can think about these agents as a function, that our function is going to map our history of percepts to an action:

$$f : P^* \rightarrow A$$

Here the history of percept sequence is the entire history of everything that the agent has perceived. And we can implement this agent function as a program.

This function incorporates various principles in decision making like calculation of utility of individual options, fuzzy logic etc.

The agents that are used in Artificial Intelligence and also in the present generation computers are intelligent agents which are also termed as the rational agents. Rational agents are the agents who do the right things. For every possible percept sequence, a rational agent should select an action that is expected to maximise its performance measure, given the evidence provided by the percept sequence and whatever built-in knowledge it has. So we are going to evaluate the agent behaviour based on the consequences. Determining the rationality of an agent at a given time depends on four things 1) Performance measure, 2) The agents prior knowledge of the environment, 3) The actions that an agent can perform and 4) The agent's percept sequence to date.

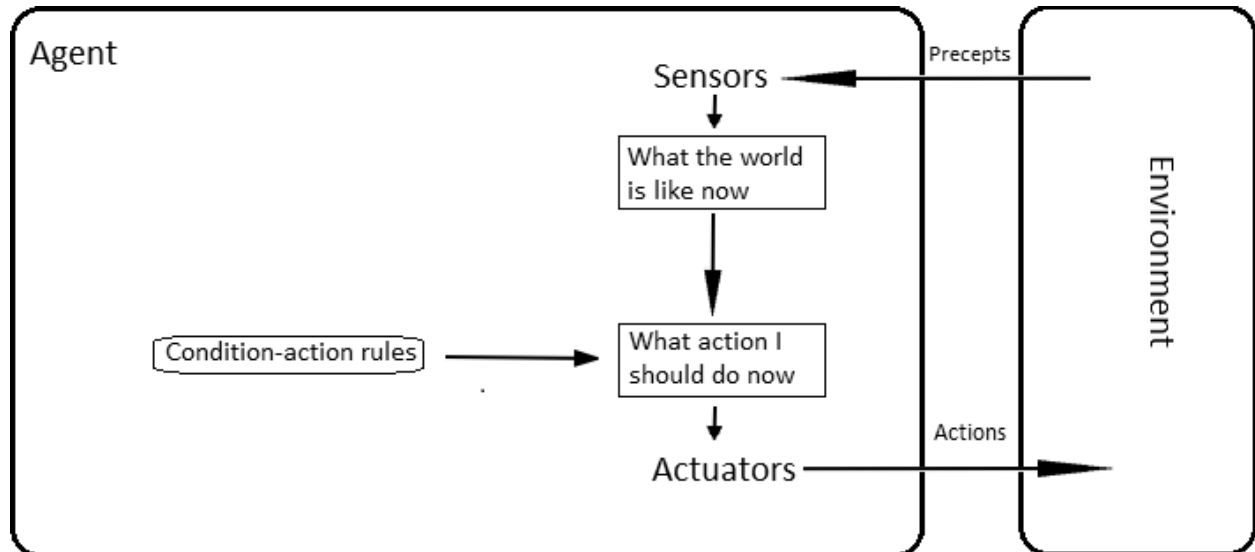
3. Agent Program Types

Each agent program has the same basic skeleton. It's going to take the current percept as the input from the sensors. It's going to return an action to the actuators. This agents can be described using a simple pseudo code language. There are four basic kinds of agent programs. From the top down these are going to be in the increasing order of complexity.

3.1 Simple Reflex Agents

For Simple Reflex Agents the idea is that the agent is going to get the current percept into its sensors. It uses that percept as input to interpret what the world is like right now. It will match the state of the world to the first rule that it sees from the terms of conditions and actual rules that it has. And finally from that rule that the selected rule will find the action specified by that rule and return that to the actuators. We can also think about specifying a vacuum cleaning agent as a Simple Reflex Agent. In general when we

think about this Simple Reflex Agent we are going to choose an action based on the current percept, we do not consider the future consequences of these actions. So we can think about this as sort of acting on the world as it is right now. This agent will succeed only if the environment is fully observable.

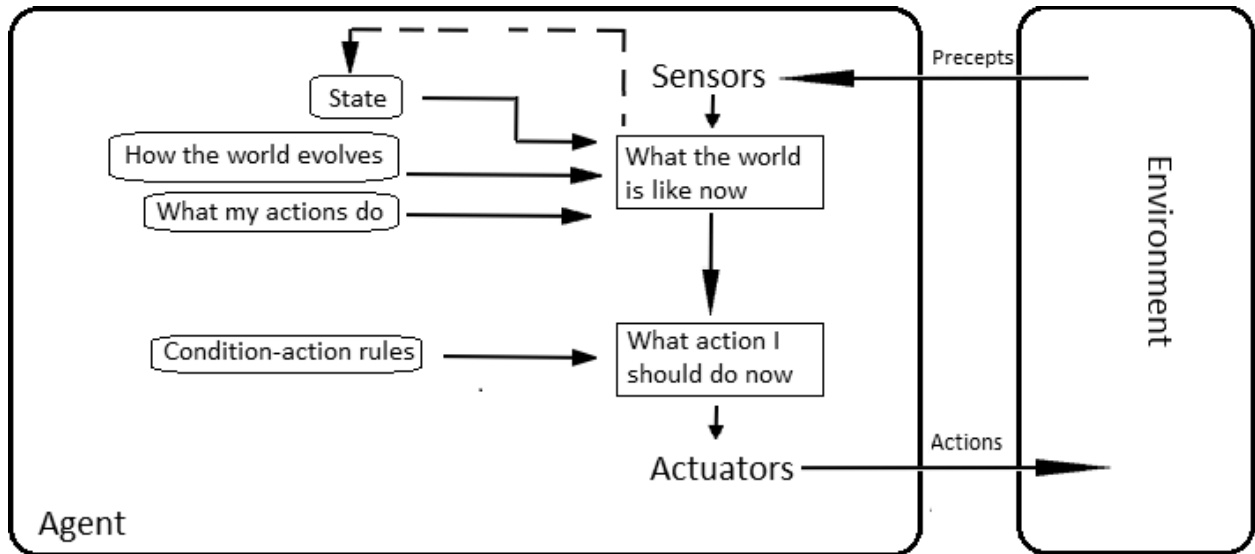


3.2) Model-based Reflex Agents

Model-based Reflex Agents are the complicated versions of the Simple Reflex Agents. These agents handle partially observable environments. It's able to keep track of parts of the world it cannot see, by maintaining and updating some internal state. So updating the internal state information we can think about that the state information is the model of the world. And generally can be found by containing two pieces of knowledge

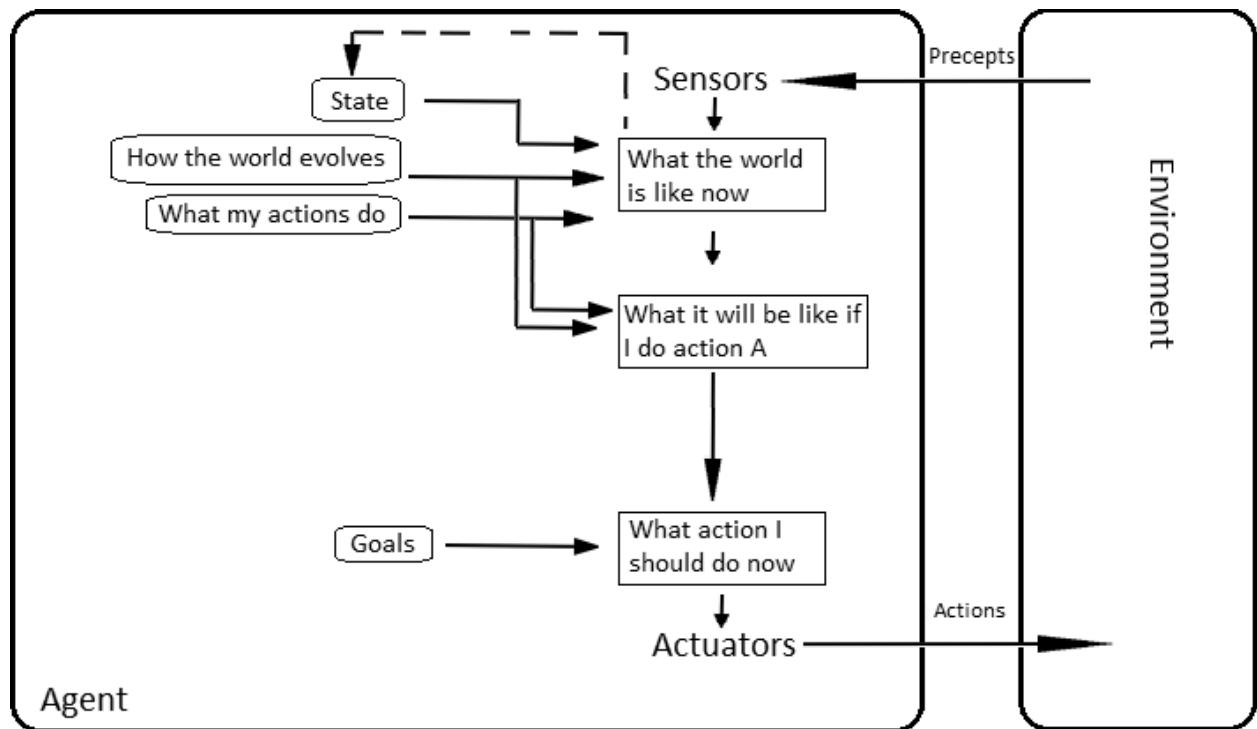
- 1) How the world changes over time?
- And 2) Thinking about how the world is reflected in the agent's percept?

This agent is also used to predict and describe the behavior of other agents in the environment.



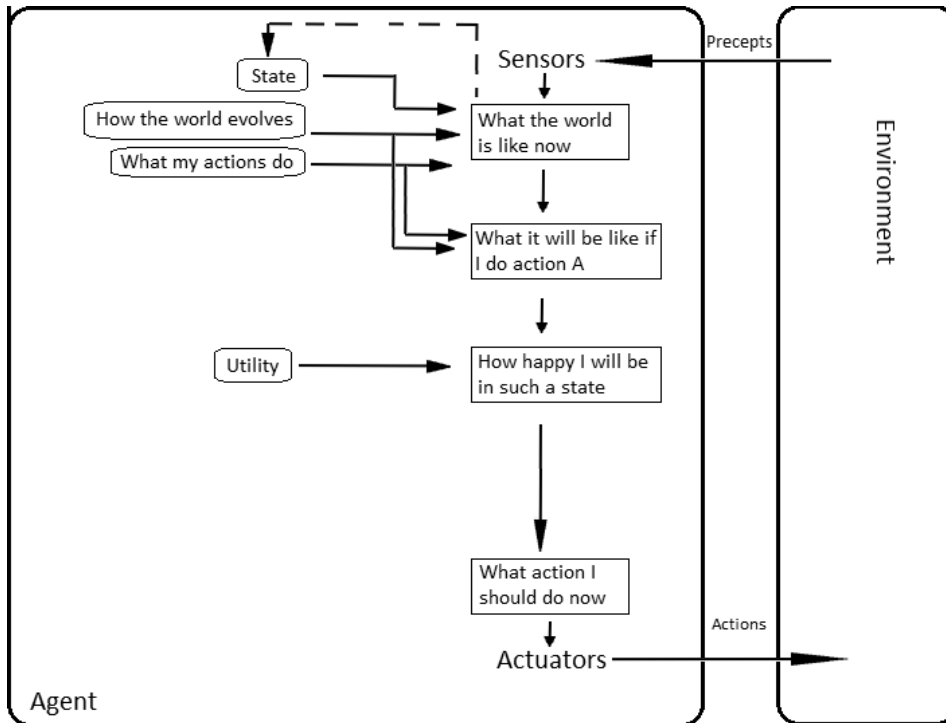
3.3) Goal Based Agents.

A goal based agent is based on the decisions of the actions to select not only on the current state of the world, but it's going to also include the information about the goal of the agent in making the decision. So an important point of thinking about a goal based agent is, a goal based agent can plan ahead, they can ask 'what-if' questions like "What happens if I take action A?", "What happens if I take action B?". And the decisions then are going to be based on these hypothesis consequences of the actions. So our agent is going to act on how the world will be or how the world would be in the future. When we think about goal based agents search planning or some of the fundamental topics in AI that focus on finding action sequences to meet an agent's goal.



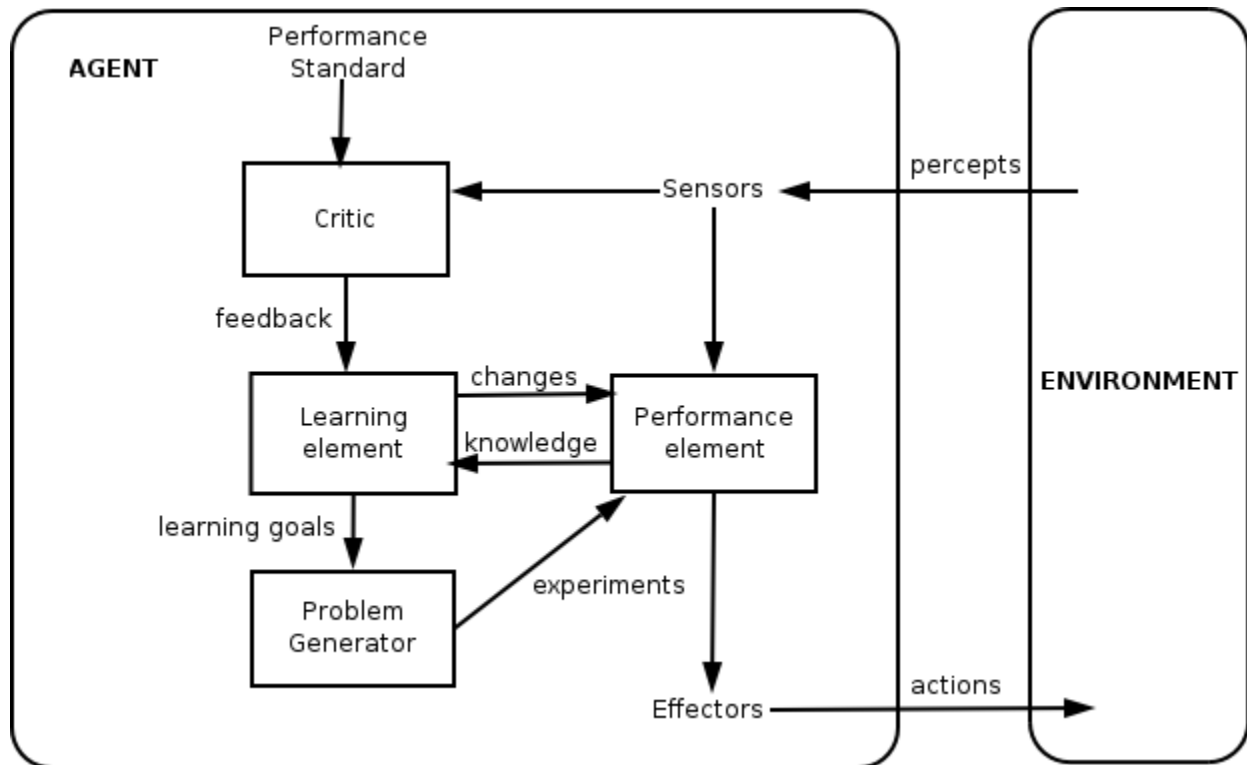
3.4) Utility Based Agents:

Utility based agents are somewhat similar to goal based agents. This agent is going to explore tradeoffs among multiple goals. So an agent will have utility function, that is sort of an internalisation of the performance measure. So it is able to quantify how the agent is doing. What if we think about a rational agent or a rational utility agent, is going to choose an action that maximizes the expected utility of the action outcomes. This is often done by looking at reasoning over the probabilities and the utilities of the different outcomes the agent may consider. Agents of this type are going to act on how the world will likely be.



3.5) Learning Agent:

A learning agent is a type of agent that learns from past experiences. This agent has the learning capabilities. Initially this agent will be in an unknown state with no knowledge in it, later on it will learn from that particular environment and try to make decisions based on that experience. By this process the agent eventually improves its decision making capabilities. This process has four components Critics, Learning element, Performance element and Problem generator. With the help of these four components the learning process will take place in this agent. Critics is the one who compares the sensor's input specifying the agent's action on the environment with the performance standards and generates feedback for learning elements. Learning element is the component responsible to learn from the difference between performance standards and the feedback from critics. Performance element is responsible to choose the action to act upon the external environment. Based on the new goal learned by the learning agent, Problem Generator will suggest new or alternative action which will lead to new and instructive understanding.



4. Applications:

The intelligent agents are used in almost every industry. They have too many applications. Intelligent agents are one of the major components in Artificial Intelligence. These are new paradigms in developing the software applications. The agent-based computing field has been hailed as the ‘The new revolution in Software’. In the present generation these agents applications are considered in almost every field from a small email filter to a large air traffic control system. Here we discuss a few applications of Intelligent Agents in different fields:

4.1) Improving Software Development Efficiency

Intelligent Agents give us the tools which are used to build an application which were previously unable to build. Intelligent agents can also provide a better means of conceptualising and implementing an application.

Few characteristics are:

- a) Data control, expertise or resources are inherently distributed.
- b) The system is naturally regarded as a society of autonomous cooperating components, or

- c) The system contains legacy components, which must be made to interact with other components, possibly new software components.

4.2) Industrial Applications

In the present generation of technology agents are being applied in a wide range of applications. I'll be mentioning a few domains below:

4.2.1) Process Control

Process controllers are the autonomous reactive systems. And the process control is the natural application for intelligent agents and the multi-agent systems. ARCHON is one such example for a software platform building multi-agent systems. ARCHON has been applied in several process control applications like electricity transportation and management and particle accelerator control. Agents in ARCHON are mostly computational systems, with four main components: a high level communication module(HLCM), which is used to manage the interagent communication; a planning and coordination module(PCM), which decides what agent has to do; an agent information management module(AIM), which is responsible for maintaining the agents intelligent system.

4.2.2) Air Traffic Control

OASIS is a sophisticated agent-realized air traffic control system described by Kinny et al(1996). In this system agents are used to represent both aircraft and the various air traffic control systems in operation. When the aircraft enters the airspace, an agent is allocated to it and that agent is instantiated with the information and goals corresponding to the real-world aircraft. For example consider the operation of landing an airplane. These air traffic control agents are responsible for managing the systems.

4.3) Commercial Applications

4.3.1) Electronic Commerce

Commerce is driven by human interaction. It's the human who decides when and what goods to buy and at what price. In some cases there is no particular notion for why some commerce cannot be automated. With this we can understand that some commercial decision making can be placed in the hands of an agent. If we consider there are many stock applications which suggest which stocks to buy and also at what time and also when to sell them. So this entire process is run by a computer application. Commercial transactions take place by interactions of these agents.

4.3.2) Business Process Management

For a company its manager will take the decisions based on the inputs from the different departments. For those departments to give those information they should have information about what's going on in the department, like workflow, project resources etc., Inorder to get this information manually is a complex process and time consuming. To avoid this problem the companies are developing various IT systems that assist with various aspects of the management of their business process. Project ADEPT is one such software solution to view the business process as a community of negotiation, service providing agents. Each agent has a distinct department assigned to it and will be capable of providing one or more services. For example, a design department may provide the service of designing, a legal department may provide a service in checking if the design is legal or not.

4.4) Medical Applications

As the technology is increasing, the impact of computer science is everywhere. There are many domains available for the medical field. Therefore, agents also should be applied in this domain. In the medical field the two main applications are health care and the patient monitoring.

4.4.1) Patient Monitoring

The Guardian System is the patient monitoring system which is widely responsible to manage the patient care in the surgical intensive care(SICU). There are two motivations for this system: first, the patients who are in the SICU are under the supervision of a group of people, which is a collection of experts of different specialties cooperate to organise the patients health care: second, there should be sharing of the information regarding the patients health and the regular update about the patient's response towards the treatment among the team members who are taking care of the patient in the hospital. As there will be a number of patients it will be difficult for the nurses to take care of all the patients minute-to-minute responses. So, the Guardian System distributes the SICU patient monitoring function among a number of agents, which are of three different types:

- a) Action agents - These agents are responsible for the interface between Guardian and the world, mapping the raw sensor input into a usable symbolic form, and translating action requests from Guardian raw effector control commands.
- b) Reasoning agents - The agents are responsible for the decision making by the system.

- c) Control agents - There will be only one control agent for the overall system, which controls all the other agents.

4.4.2) Health Care

The prototypical agent-based distributed medical care system was described by the Huang et al.(1996). The main theme of this design is to integrate the patients management process. For example, a general practitioner may suspect that a patient has breast cancer, but this suspicion cannot be the final decision. That decision can be rejected without the assistance of the hospital specialities. If the specialities confirms that suspicion , then a care program must be devised for treating the patient involving the resources of the other individuals. Here the agent mapped onto the individual involved in the care process. Agents in this prototype contain intelligent systems. The main motive of this system is the natural representation of the process. This system also contains the domain expertise of the agent and also the human-computer interface. Thus it enables the message parsing functionality, and users can add or remove or view the system goals.

4.5) Entertainment

The intelligent agents have a vast impact in the entertainment industry. If we consider the gaming industry, there are many games which are built on the basis of rational agents which involve AI techniques in it. Consider the games like Chess, tic-tac-toe etcThe computer program for that game is designed in such a way that the level of the game will be determined by the user, according to the users input the system itself will predict the moves and plays accordingly. Even if we consider in the movies also there are many characters which are created using CGI which creates the visual illusion to the audience.

5) Conclusion

This article is a comprehensive study about the intelligent agents, and also about the different types of intelligent agents based on their functionalities and their different definitions. We also discussed the various applications of the intelligent agents. However, as the coin has two phases, there will be both the good and bad uses of these agents. It depends on how the engineer designs a system using these agents.

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