**Agents in Artificial Intelligence**

**Overview**

Artificial Intelligence (AI) is not a futuristic concept anymore, and several industries have been revolutionized by its capability to analyze large datasets, identify patterns, and perform predictions. This technology has become a game-changer, and different businesses use it, regardless of size. At the core of these AI systems are intelligent agents that impart machines with autonomous capabilities. Studying these agents is critical to advancing AI, resulting in more intuitive and efficient technology for human-machine interaction. We can train advanced agents in AI to handle sophisticated tasks, and they can be deployed in challenging applications to assist humans.

**Introduction**

In today's AI-driven world, organizations are highly competitive as they continuously look for methods to improve their operations and gain a competitive advantage. Hence, the relevance of AI has grown in the business domain, establishing it as an essential tool for growth in the digital era. Any idea of leveraging AI can only be helpful if we implement it on a system and deployed it. So, an AI system comprises two entities, an Intelligent Agent (IA) and its environment. We can train an Intelligent Agent to make a decision and act upon it. There can be multiple intelligent agents within an environment at a given time to perform specific actions.

Let us understand what is agent in AI, the basics, and how the agents in AI work in the next section.

**What is an Agent in AI?**

We know that an AI system comprises an agent and its environment. A machine, a piece of hardware, or a software program having sensors to perceive the environment and actuators to act on the environment can be termed an AI agent. Depending upon the task they are deployed to perform, these AI agents can be simple or complex.

The environment is the area of proximity to the agent on which the agent performs actions. Agents in AI undergo three phases - **perception**, **thought**, and **action**. It is also essential to consider that the AI agent makes a decision rationally and performs actions leading to the best possible outcome considering past and present perceptions. Sensors, actuators, and effectors are essential parts of AI agents.

Now that we have understood what is agent in ai let us take a look at the different parts of an AI agent.

Agent and its environment (Original Image generated with Stable Diffusion AI)

1. **Sensors**:  
   Sensors are devices capable of detecting changes in the environment and collecting data from it (e.g., temperature, humidity, speed) and transmitting it to the AI agent or other electronic devices. An AI agent uses these sensors to observe its environment.
2. **Actuators**:  
   Actuators impart machines the ability to perform actions by converting energy into motion. This way, actuators can move and control a system. A few examples of actuators are electric motors, gears, etc.
3. **Effectors**:  
   AI agents use effectors to generate the output or response from the agent (displaying a message, adjusting a variable to control a system, etc.) and to interact with the environment. Hence, effectors are the devices, such as robotic arms, legs, wheels, or a simple information display screen.

So, it is essential to understand that sensors, actuators, and effectors together constitute an AI agent.

**Intelligent Agents**

As discussed earlier, an intelligent agent in AI has the potential to perceive the environment's status through the information or data provided by the sensors. It is further capable of taking action through actuators and effectors, which results in expected outcomes on the environment optimally. It is evident that while deciding on designing an intelligent agent, a few guidelines or rules must be considered. These are as follows:

* An ability to perceive the environment.
* Provision for adequate and suitable Sensors.
* Provision for right quality Actuators and effectors.
* Provision for performance evaluation of the action on the environment, which may further help in improvement if required.

The above rules help to cause a rational effect on the environment, which further necessitates understanding what rational or rationality is.

**Rationality**

A well-accepted definition of rationality can be the ability to think wisely, considering the pros and cons of any action to be taken. When the outcome is as desired, we call it a rationally taken decision or otherwise. When we need agents to act rationally, which is preferred in AI applications, we refer to them as rational agents in AI. The rationality can be evaluated based on performance achievement, which further considers the perceiving ability, sensor effectiveness, suitable actions of actuators, and finally, the optimized performance.

**Rational Agents**

These are intelligent agents that behave rationally like human beings, and their actions are based on perceived sequence and logical reasoning. They can be machines, software programs, or actuating programmable devices or mechanisms. Their characteristics can be summarized as listed below.

* Ability to make correct decisions based on previous experience or information and logical thinking.
* Ability to take action on clear and sound preferences apt to existing environmental status.
* A clear understanding of the effect on the environment by the performed actions.
* Ability to monitor and act promptly, even in a few uncertain situations.
* Well-informed about the rewards and penalties based on successes or failures and hence the ability to learn for improvements, if needed.

Some examples can be cited, like robotic vacuum cleaners, controlling programs of an air conditioner, and the gate opening mechanism of water storage dams, etc. In the case of an air conditioner, for example, the software program automatically responds to fluctuations in the set values. It takes corrective actions bringing these parameters to reference values whenever the values of temperature and humidity deviate up or down.

**How are IAs Structured?**

The Intelligent Agents (IAs) have a specific structure independent of the IA type. Agents in AI have a structure that can be represented with a simple formula-

**Agent = Architecture + Agent program (includes an agent function)**

* **Architecture**:  
  It is machinery with sensors and actuators (e.g., self-driving car, camera, computer, etc.) that an AI agent executes on.
* **Agent Function**:  
  It is a mathematical expression f:P\* → A where a sequence of percept histories (P\*)is mapped to an action (A) taken by the AI agent.
* **Agent program**:  
  It executes on the physical architecture to generate function f and is considered an implementation of the agent function.

**What is PEAS Representation?**

The PEAS framework is used to provide a high-level description of agents. **PEAS** stands for:

* **P** = Performance Measure
* **E** = Environment
* **A** = Actuators
* **S** = Sensors

It is a valuable method for creating and evaluating intelligent systems. Now, let us see how the PEAS representation can be implemented in self-driving cars.

* **Performance Measure**:  
  The performance measure for a self-driving car is typically a blend of **safety, time, legal regulations, and passenger comfort**. Safety is the most crucial performance metric, as the car must prevent accidents. Next, the time factor is vital since the agent must respond quickly to situations (timely application of brakes, the opening of airbags, etc.). It must also follow traffic signals and drive legally. Also, it is expected for the agent to ensure passenger comfort by maintaining optimal internal atmospheric conditions as well as minimizing the effects of vibrations and shocks.
* **Environment**:  
  A self-driving car's environment refers to the exterior circumstances in which it operates. It must be capable of driving on a variety of terrains (hilly roads) or road conditions (wet surfaces). **Traffic signals, road signs** (speed limits, exits, bends, etc.), **pedestrians**, and other vehicles on the road also influence driving conditions.
* **Actuators**:  
  Actuators enable self-driving cars to interact with the environment. The steering wheel, accelerator, brake pedals, indicators, and horn are **examples of actuators**. The steering wheel is an important actuator as it enables the car to move and change directions. The accelerator and brake pedals are also significant since they allow control of the car's speed. Moreover, indicators and the horn are important as they will enable the car to communicate lane changes to drivers or pedestrians.
* **Sensors**:  
  Sensors are essential for self-driving cars to sense their environment. **Cameras, GPS, speedometers, accelerometers, and sonars** are examples of sensors. Cameras are especially important as they allow the car to detect objects such as other vehicles, pedestrians, and traffic signs. Another essential sensor is the GPS, which assists the car in determining its location and planning its route. The speedometer also monitors the vehicle's speed, while the accelerometer measures its acceleration. Moreover, the sonar detects items in the vicinity of the car using sound waves, allowing the car to drive the road safely and quickly, particularly for identifying objects outside the camera's range.

**Examples of Agents**

Agents in AI can be considered in three different categories.

1. **Human agent**:  
   A human agent possesses sensors in the form of eyes, ears, etc., while the hands, legs, mouth, and other bodily parts act as actuators.
2. **Software agent**:  
   A software agent is a pre-programmed agent that can display values on the screen, accept inputs, and store data. Keystrokes for typed inputs and microphone inputs for speech can be examples of sensors while responding with information to voice commands, or a screen displaying a file can be considered actuators.
3. **Robotic agent**:  
   A robotic agent is configured with several sensors to execute tasks in the environment. Cameras are used as sensors, while motors and links work as actuators to perform actions.

**Types of Agents**

Various types of agents find applications based on their capability and performance as follows:

* **Simple Reflex agents**:  
  They can take action by reflex on perceiving the current status of the environment. They don't have any previous information or knowledge but can instantly take suitable action, e.g., application of car brakes on seeing an obstacle.
* **Model-based Reflex agents**:  
  They are an improved or modified version of simple reflex agents. They are models based on previous experience and can take necessary action when required. e.g., a speedometer control device that can monitor speed as per the limit set.
* **Goal-based agents**:  
  They are trained to achieve a particular goal based on a previous set program with some specific inputs: A searching robot, for example, can find a lift located in a building or a particular address for postal delivery.
* **Utility-based agents**:  
  They are like goal-based agents but have the additional capability to try options for better performance: for example, a navigation program to find the path of the shortest distance to reach a particular destination.
* **Learning agents**:  
  These are advanced types of agents as they can learn new options to improve performance by avoiding unwanted things based on current and previous experiences. For example, an autonomous car can avoid traffic jam routes or automatically change controlling parameters like speed, cabin temperature, etc.
* **Multiple agents**:  
  They are more in numbers and work in a homogeneous or heterogeneous manner, dividing work amongst them. This helps the parallel processing of tasks. e.g., multiple mobile robot systems in which several robots work together to achieve the required target by division of work.
* **Hierarchical agents**:  
  This category includes agents into higher and lower levels by distributing work based on their capability and complexity of the work. The higher-level agents monitor the lower ones and together achieve the target. For example, in the manufacturing industry, the work is shared based on the expertise and complexity of jobs like designers and operators.

**Conclusion**

In conclusion, what is agent in AI can be summarized as -

* The building blocks of intelligent systems, allowing machines to observe and interact with their surroundings autonomously.
* Devices that utilize sensors to collect data, make choices, and conduct actions similar to human behavior.
* An important component of AI systems because they enable robots or hardwares to interact with their surroundings and perform tasks autonomously.
* The behavioral analysis of agents in AI is critical to the growth of AI since it leads to the creation of more intelligent and efficient technologies for human-machine interaction.

Hence, as AI progresses, the function of AI agents in the field will become increasingly crucial, resulting in more efficient, intuitive, and competent intelligent systems.