Intelligent Agents Utilized in Artificial Intelligence (AI)

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Abstract :

This paper aims to give data about Intelligent Agents utilized in Artificial Intelligence (AI). The absolute best guides to depict astute operators are Alexa and Siri. This paper accentuates on the definition, sorts of agents and models identified with kinds of operators in a decent illustrative way. The point of this paper will be to share data about the keen operators to give a concise comprehension about the theme. This paper additionally centres around rationalagents and their segments. Aside from rationalagents, this paper will likewise give some light on the historical backdrop of AI and how smart operators appeared. Additionally, this paper will likewise introduce some comprehension about PEAS (Performance, Environment, Actuators and Sensors) structure. The engineering of operators will likewise be depicted in this paper to have a decent understanding about ArtificialIntelligence, its agents and their design.

Keywords : PEAS, AI, Task Environment, Single Agent, Multi-Agent, Simple Reflex Agent, Goal Based Agent, Utility Based Agent.

1. **Introduction** :

Artificial Intelligence is a simulation of human intelligence in machines that can act and think like humans. Intelligence of a machine depends mainly on four factors as described below:

1.1 *Acting Humanly* – The Turing test approach

It mainly refers to machines that can act or perform tasks which would require intelligence when performed by humans.

1.2 *Thinking Humanly* – The cognitive modelling approach

Mapping of computer programs' reasoning steps to imitate a human's mind of solving the same problem.

1.3 *Acting Rationally* – The law of thought approach

Acting rationally is about building rational agents that can perform an action on the environment. Rational agent is one that acts to achieve the best outcome or, when there is anuncertainty, the best expected outcome.

1.4 *Thinking Rationally* – The rational agent approach

Thinking Rationally simply means right thinking. In other words, irrefutable reasoning process.

2 **Historical Backdrop of Artificial Intelligence (AI)**

2.1 Gestation of AI –

1943 – Warren McCulloch and Walter Pitts proposed artificial neuron
1949 – Donald Hebb invented the influential Hebbian rule to update neural connectivity
1950 – Marvin Minsky and Dean Edmonds built SNARC, first neural network computer
1950 – Alan Turing published "Computing Machinery and Intelligence" – introduced Turing

2.2 Birth of AI

1956 - John McCarthy along with Minsky, Claude Shannon, and Nathaniel Rochester organized a two-month workshop where AI was first coined

2.3 Great Expectations

1958 – John McCarthy invented Lisp programming language

1958 - John McCarthy invented Advice Taker

1959 - Newell and Simon invented General Problem Solver (GPS) - can solve problems with same reasoning steps as humans

2.4 *First AI Winter*

1966 – Overestimation of possibilities created a hype. Failed attempt at machine translation of scientific papers from Russian to English

US National Research Council cancelled funds for academic translation project

Also, intractability of many problems in higher dimensions added to the gloom

1973 – Lighthill reported about AI's failure to handle "combinatorial explosion"

Major reason behind British government's decision to end support for AI research

2.5 Knowledge Based Systems

1976 - MYCIN , a medical expert system to diagnose blood infections developed by Stanford performed better than many physicians

1972 – PROLOG was invented

2.6 *AI becoming an industry*

1982 – Digital Equipment Corporation (DEC) implemented R1 expert system to configure computer orders. By 1986, it saved estimated $40 million for DEC

1988 – AI industry boomed from million to billions of dollars again with high expectations

2.7 Second AI Winter

Late 1980s - LISP machines were costly when compared to general purpose machines by SUN, IBM, Apple

Early 1990s - Expert Systems were costly to maintain, unable to extend, learn.

2.8 Rise of Machine Learning

1990s - Machine Learning played a key role in building efficient internet tools like search engines, recommender systems, fraud, etc

2.9 Data deluge

2001 – Banko and Brill show that mediocre algorithms when trained on 100 million samples outperformed best algorithms when trained on 1 million samples

Data started to play crucial role, sometimes more than the algorithm

3.0 Compute Power

2012 – Geoff Hinton's group proved that GPUs can solve the computational bottleneck of using big data.

3.**Intelligent Agents**:

Agents take input from environment through sensors, use the input function to select an action and eventually acts upon the environment using actuators.

Intelligent agents key terms-

3.1 *Percept* – Agents perceptual inputs, e.g., eyes, ears for humans; keystrokes for software agent.

3.2 *Percept Sequence* - An agent's percept sequence is that the complete history of everything that has been perceived.

3.3 *Agent Function*: Mathematically speaking, we are saying that an agent's behavior is described by the agent function that maps any given percept sequence to an action.

Examples of Intelligent Agents-

1. Robotic Agent :
    - Input Sensors: Camera, infrared range finders
    - Inference: Control theory
    - Actuators: Motors

2. Software Agent :
    - Input sensors: Keystrokes, file contents and network packets
    - Inference: Operating System
    - Actuators: Display on screen, writing files and sending network packets

4. Understanding Rational Agents :

Being rational (or being right) at any given time depends on four aspects

- Performance measure that defines the success criteria
- Agent's prior knowledge of environment
- Actions that the agent can perform
- Agent's percept sequence till date

Being Rational means selecting an action from the possible set of actions based on the information of percept sequence and prior knowledge together so that the selected action would optimize the performance measure.

Components of a rational agent:

- P: Performance measure
- E: Environment's prior knowledge
- A: Actuators, i.e., actions
- S: Sensors, i.e., percept sequence (In short, it is referred to as PEAS)

For example-

	Performance	Environment	Sensors	Actuators
Medical diagnosis system	Healthy patient, reduced costs	Patient, hospital, staff	Keyboard entry of symptoms, findings, patient's answers	Display of questions, tests, diagnosis, treatments, referrals
Satellite Image analysis system	Correct image categorization	Downlink from orbiting satellite	Color pixel analysis	Display of scene categorization
Interactive English tutor	Student's score on test	Set of students, testing agency	Keyboard entry	Display of exercises, suggestions, corrections

Fig-1

A rational agent is formed to unravel a specific task. Each such task would then have a special environment which we can say as Task Environment.

4.1 *Fullyvs Partially Observable –*

Fully Observable - If an agent's sensors provides it access to the entire state of the environment at each point in time, then we say that the task environment is fully observable.

Partially Observable - An environment could be partially observable due to noisy and inaccurate sensors or because parts of the state are simply missing from the sensor data.

4.2 Single Agent vs Multi-Agent

Single Agent: For example, an agent solving a crossword puzzle by itself is clearly in a single-agent environment

Multi Agent: Whereas an agent playing chess is in a two agent environment.

4.3 Deterministic vs Stochastic

If subsequent state of the environment is totally determined by the present state and therefore the action executed by the agent, then we are saying the environment is deterministic; otherwise, it's stochastic.

Example: Chess board is deterministic and Carrom board is stochastic

4.4 Episodic vs Sequential

Episodic: The agent's current action doesn't impact the state of the environment for the next action. E.g., spam classifier

Sequential: The present action could affect all future actions. E.g., any board game

4.5 Static vs Dynamic

If the environment can change while an agent is deliberating, then we are saying the environment is dynamic for that agent; otherwise, it's static.

Example: Video game is a dynamic environment, whereas chess is a static environment

4.6 Discrete vs Continuous

The discrete/continuous distinction applies to the state of the environment, to the way time is handled, and to the percepts and actions of the agent.

Example: Chess environment has a finite number of distinct states. Self driving is a continuous-state and continuous-time problem

Considering, the instance taken in PEAS structure can imply how task environment effects the rational agents:

Task Environment	Fully vs Partially Observable	Single vs Multi-Agent	Deterministic vs Stochastic	Episodic vs Sequential	Static vs Dynamic	Discrete vs Continuous
Medical diagnosis system	Partially	Single	Stochastic	Sequential	Dynamic	Continuous
Satellite Image Analysis System	Fully	Single	Deterministic	Episodic	Static	Continuous
Interactive English tutor	Partially	Multi	Stochastic	Sequential	Dynamic	Discrete

Fig-2

5. Types of Agents and their architecture :

There are five sorts of rational agents :-

5.1 Simple Reflex Agent –

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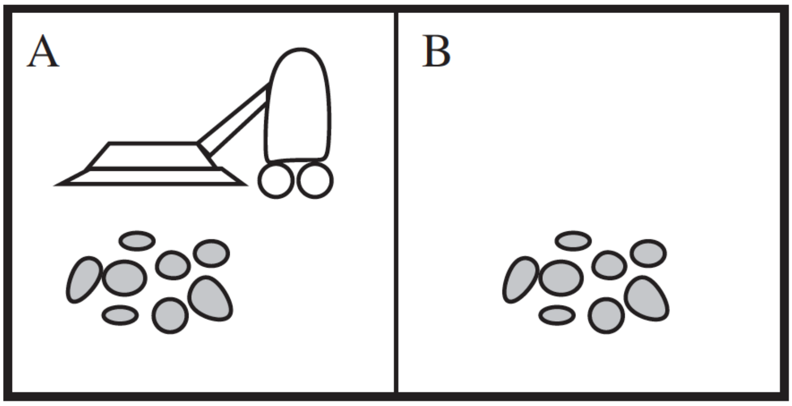
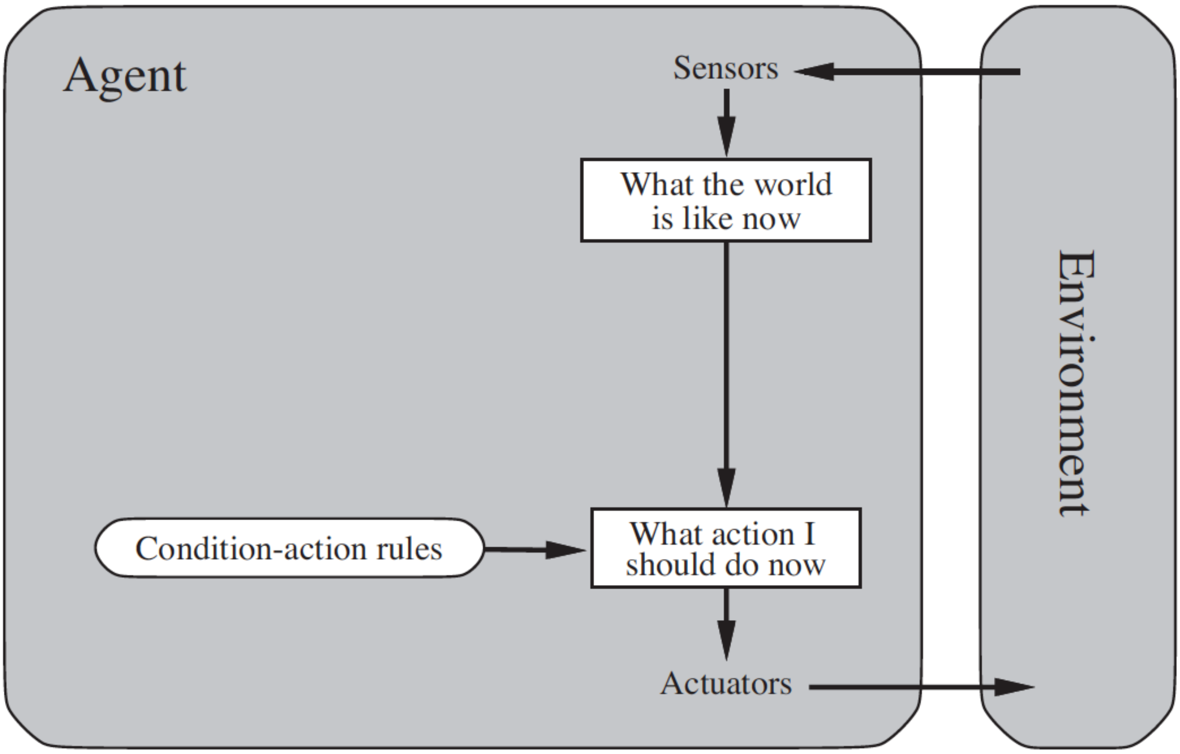
These agents select actions on the idea of the present percept, ignoring the remainder of the percept history.
Example:
If “car within the front is breaking” then “apply breaking”. Such rules are called condition-action rules, or simply if-else rules

E.g., Vacuum Cleaner, if not clean, then clean, else move



Simple Reflex Agent Architecture



5.2 Model based agent:

This knowledge about “how the whole world works”—whether implemented in simple Boolean circuits or in complete scientific theories—is called a model of the world .

- Limitation of Simple Reflex
  - Partial observability of the current state as it doesn’t store any state information

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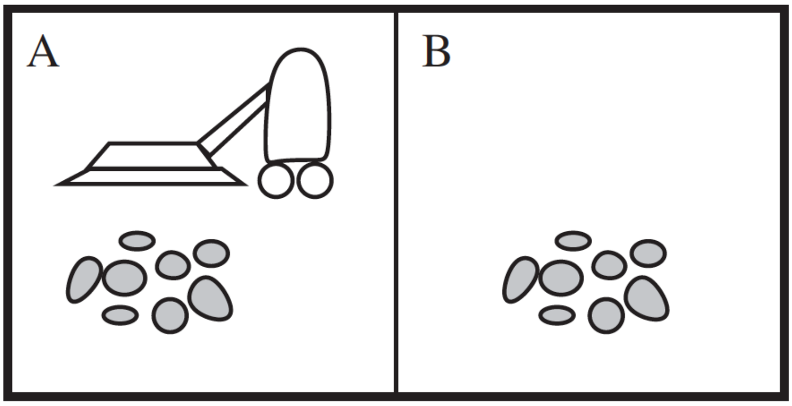
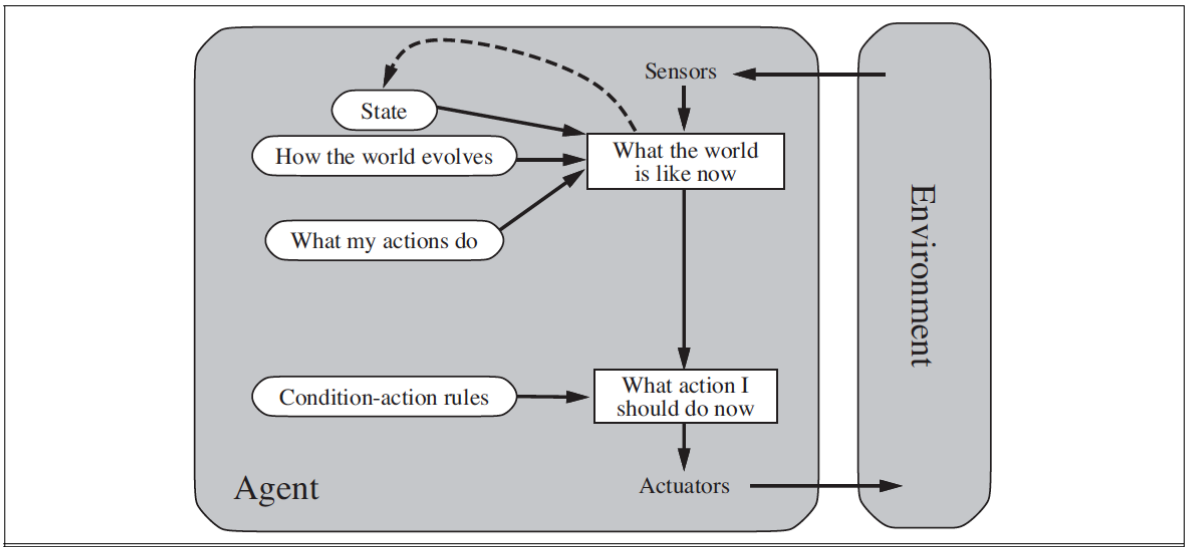
- E.g., Vacuum Cleaner



- Keep an internal state of the environment to solve for the partial observability environments

Model Based Agent Architecture



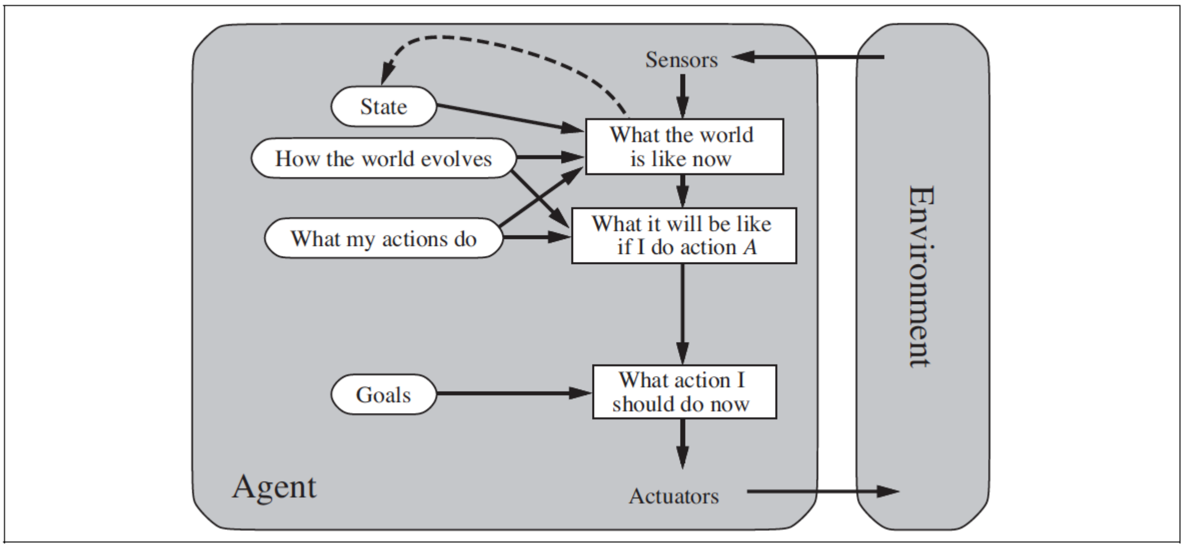
5.3 *Goal Based Agent-*

Limitations of Model based

Knowing the current state of environments is not always enough to decide next move. E.g., self driving car at a junction can take three directions, the decision to pick one should depend on the end destination, i.e., goal

Goal-based agent: Combining goal information with the model information to select actions.

Goal Based Agent Architecture



5.4 Utility Based Agent

Limitations of Goal based agent

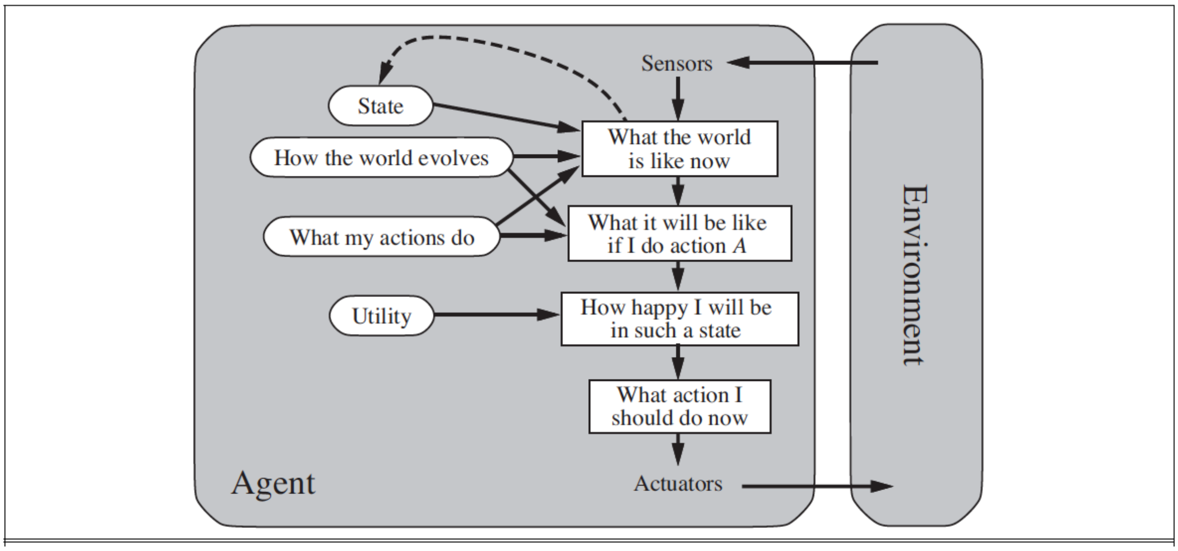
Goal info alone cannot disambiguate actions. Example: Reaching a destination sometimes would have multiple routes with different distances, time.

Solution: Have a performance measure that would assign a score to multiple solutions that can reach a goal.

Utility function: Internal implementation of performance measure that helps the agent to select actions

Utility-based agents: Any agent that optimizes its actions based on such utility functions are utility based agents.

Utility Based Agent Architecture



5.5 Learning Based Agent

Agent Program (mapping of current and historical percepts to actions) are predetermined in earlier agent architectures

Learning agent – learns the agent program based on data

Advantages above other methods. Initially operate in unknown environments and become more competent than its initial knowledge alone might allow.

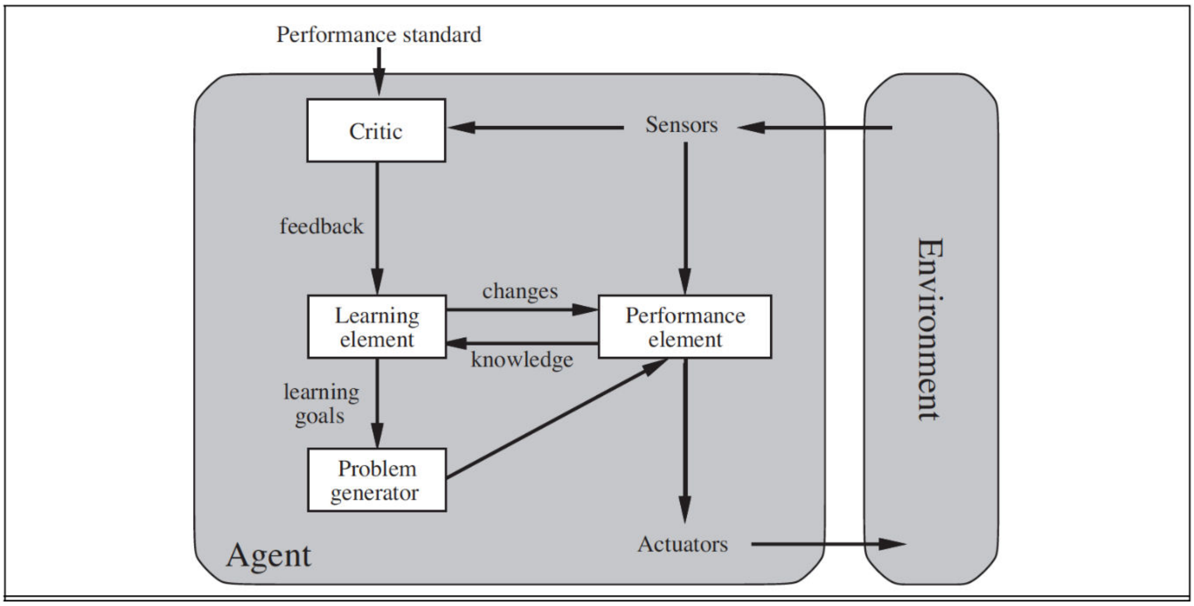
Preferred model to build state-of-the-art systems.

It has four conceptual components

- Learning element – modifies the agent program
- Performance element – liable for selecting external actions
- Critic – It evaluates the actions and gives it as feedback to Learning element
- Problem generator – Performs exploration on different actions possible in order to gain information to discover much better actions in the long run.

E.g., learning about the steering of vehicle at corners.

Learning Based Agent Architecture



6 Conclusion :

The basic idea behind this paperis to promote the solid foundation for designing intelligent agents and learn the representation and use of data in inference-based problem solving approaches. Also, to use applied mathematics to explain and model agents operating in uncertain environments and helps to find out the optimization models of computation and processing in world application of intelligent agents.

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