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Exploring Artificial Intelligence PEAS Framework for Enhanced Decision-Making

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Abstract

An agent can refer to any device employed as a sensor to detect environmental elements and entities, providing responses based on that information. The cycle of agents can include perception, action, processing, and performance, while the environment around us is populated with agents such as temperature sensors, CCTV cameras, mobile phones, and more. Humans, software, and robots around us also function as AI agents. Using artificial intelligence we can create advanced systems with human-like behaviour. This research study represents a comprehensive view of existing literature and an analysis of methods designed to enhance Artificial Intelligence decision-making possibilities. By studying the facts and details of PEAS models of AI, a better idea can be gained on how AI can make decisions similar to human intelligence. This study includes a literature review of some related research. Objective of this study is to discuss the framework, elements, and challenges of the PEAS model in Artificial Intelligence and to simulate the model of control agents for traffic light control systems, its framework with entities and parameters, and limitations.

Keywords: AI, Agent, PEAS, Traffic Light Control, Sensors.

1. Introduction

To understand human like intelligent behaviour, effective decision making is very important for artificial intelligent systems to behave responsibly and efficiently. The PEAS model can analyse the problem more efficiently and can enhance the decision-making capabilities of the algorithms applicable to AI models. In PEAS framework, P stands for Performance, E represents Environment, A represents Actuators, and S represents Sensors. By considering each of these elements, we can enhance our AI systems. This research study will investigate and discuss the PEAS model, which offers a guiding framework to integrate various AI components.

PEAS model can represent and discuss about functional components of AI agents that are dynamic and will depend on the real-time elements to make decisions. The agents are responsible for the overall performance of the systems. AI PEAS helps to enable AI expert dynamic systems by adapting feedback from external real-time environments. This article helps to understand the elements and framework of the PEAS model.

To process decision-making in artificial intelligence the sensors and actuators play an essential independent role and different agents act as fundamental elements to coordinate among actions. The impact of AI agents and their effect is responsible and plays a crucial role in defining AI frameworks. By discussing and understanding PEAS elements in detail we can relate their impact in decision making process.

The literature on the agent systems have discussed multiple agent systems for allocation of resources. He has discussed the development of agents responsible for the allocation of resources by communicating with other resources like CPU, memory allocation etc [1]. The authors in [3] discussed intelligent agents on different production units. So, that agents can identify automatic configuration of the system. They find relationships between cognitive and quantitative processing with intelligent agents. Scientists need to spend lots of effort and time to process and interpret the data generated from radars. This multi-agent system does the management and visualization of data by extracting the statistical features and predicting the weather conditions. The agent design was also able to identify the dangerous events and provide warning services through email.

2. Literature Review

Table 1, summarizes the literatures reviewed in the study.

Table 1. Literature Review

Study Title	Discussion
The PEAS Framework in Artificial Intelligence Systems [2]	This research study discussed PEAS with intelligent agents, dynamic environments, and decision-making. Also about the flexibility of Artificial intelligence with various systems. PEAS framework and applications of AI have been highlighted.
PEAS in Human-Robot Interaction [3]	This study focuses on artificial intelligence for human-robot collaboration. The authors discussed the interaction of the PEAS model with human-robotic systems and emphasis on real-time environments.
A PEAS-Based Approach to Multi-Agent Systems [4]	Authors in this study focus on collaborative AI and multi-agent artificial intelligence systems and PEAS models with various factors like environment, actuators, and performance.
Sensor Fusion in Autonomous Vehicles Using PEAS Model [5]	This study discussed the role of sensors in self-driven car systems using the PEAS framework. Also taken into consideration about the perception and environmental factors.
Autonomous Maritime Navigation with PEAS-Based AI [6]	This study focuses on sensors and real-time systems with environmental factors.
Autonomous Vehicle Control Using PEAS Model [7]	Highlights about the PEAS framework for self-driven systems and their control. Discussed the role of actuators and sensors in the performance.
Analyzing Real-Time Feedback in PEAS Model Autonomous Agents [8]	This study focuses on real-time feedback with artificial intelligent systems. Authors discussed the impact on the performance of real-time feedback, actuators, and sensors.

Perception-Action Cycles in Autonomous Systems: A PEAS-Based Approach [9]	This study describes the role of actuators, perceptions, and sensors in the PEAS model for automatic car systems.
The Role of Sensors in the PEAS Model for Autonomous Navigation [10]	This study discussed the role of sensors in auto-drive car systems with the PEAS model.
Enhancing Autonomous Decision Making with PEAS Model [11]	This study took into consideration the integration of Reinforcement Learning with the PEAS framework and discussed decision-making in self-driven cars.
PEAS-Based Intelligent Agents in Dynamic Environments [12]	The authors discussed sensors, actuators, and adaptive systems. Also about the role of dynamic artificial intelligent agents.

3. Agents

Artificial intelligence (AI) agents come in various forms. The architecture, or design, that a computer scientist develops to build an AI agent will outline the various divisions and how they are structured. [4] Various agent architecture types are addressed in this section.

3.1 Simple Reflex Agent

A reflex-based system is the most basic form of agent architecture. This idea is fairly straightforward and not very intelligent. Any prior perceptions are disregarded by this reflex agent, which solely reacts to the current perception. The function is based on the condition action rule, which stipulates that if a specific circumstance is present (for example, an object is in front of you), then a particular action should be executed. [5] Even if certain areas are concealed from view, this agent will constantly loop until it has fully observed its environment.

3.2 Model based Reflex Agent

This is a better iteration of the first kind of agent that can be controlled and used differently depending on the environment. Model-based reflex agents, like all other types of agents, need to know the status of the world right now through their sensors. Such agents can maintain an internal state that reflects certain overlooked aspects of the present situation. In

other words, we might say that insights from previous experiences provide us with an implicit understanding of the current context, even if we are not consciously aware of it.[6]

3.3 Goal based Reflex Agent

The information backing a decision is clearly illustrated in the goal-oriented approach to decision making, which enables modifications. This makes it more adaptable than a reflex agent. This agent differs from the other two in that it does not have any guidelines for what to do in response to a certain circumstance or if anything has occurred. Because the agent isn't as precise about what it intends to achieve, it sometimes takes less effective actions because it just considers its own aims and present state while operating. This agent, however, is more adaptable since it is aware of how changes in the environment will influence its objective and may adjust its behaviors appropriately. [7]

3.4 Utility-based Reflex Agent

Utility-based agents assess an action's possible influence on a person's general pleasure, taking it a step further than goal-based agents. This may be thought of as the degree of fulfilment that an act may have in connection to achieving a particular goal. [8]

3.5 Learning Agents

The learning agent is an illustration of the kind of agent that can learn from the past or has the capacity to learn. As it learns more, it naturally adapts its behavior, starting with the fundamentals.

Learning agents primarily consist of four components. The learning element is the first, and it improves by absorbing knowledge from its environment. The performance element, the second component, determines which external actions to take based on feedback from the critic. The third component is the problem generator, responsible for suggesting new and educational scenarios that can help improve performance. Lastly, there is the Support Element, tasked with assisting in these various stages of development. [9]

4. PEAS Framework

Using the PEAS framework (Figure 1), we can understand the basic operations of AI agents and their interactions. It helps to show the flow of information to achieve different goals

and about the limitations of the system. It provides a structural approach to discuss the environment with distinct AI roles.

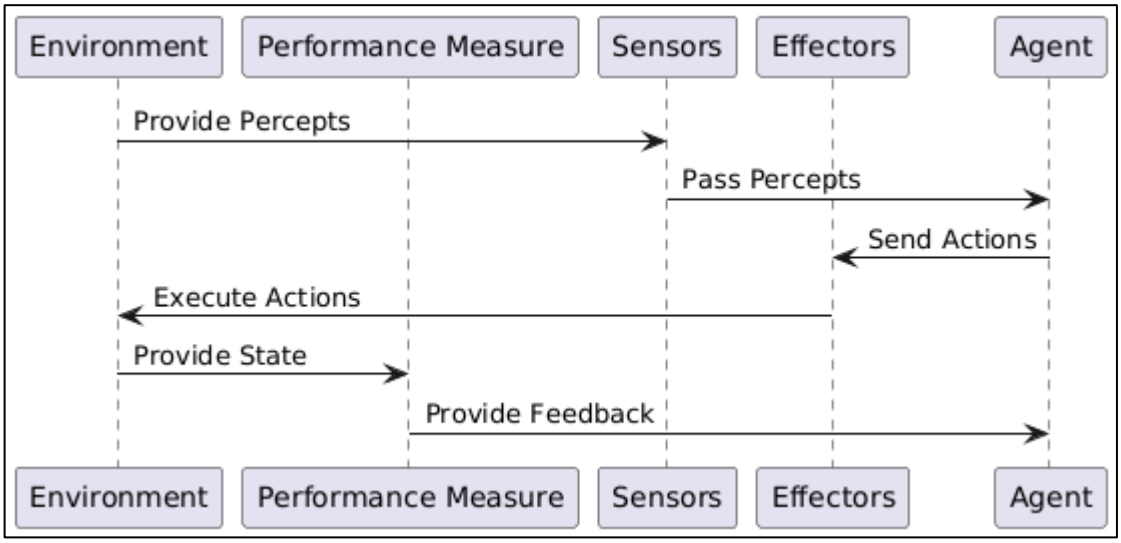

Figure 1. PEAS of AI

4.1 Understanding PEAS Components

1. P (Performance): The performance component discusses different parameters that we can use to evaluate the impact and correctness of the models according to the performance of various actions made by it.

2. E (Environment): this component of PEAS model is responsible for analyzing different environmental factors that can be dynamic or static impacting the changes in real-time scenarios.

3. A (Actuators): this component is responsible for showing the interaction among variable agents that are responsible for making distinct decisions to perform different tasks.

4. S (Sensors): sensors are responsible for providing the input into the system according to distinct scenarios and environmental factors.

4.2 Applications of PEAS Model

PEAS modeling can be used to drive cars using artificial intelligence. So that, cars are able to interact with obstacles, traffic signals, weather etc different measures with safety and

navigation while driving without having drivers in it. PEAS modelling can be used to create virtual assistants based on AI technology, so that by taking input from users the system is able to solve queries and access information from various web platforms. To provide recommendations to patients on the basis of their reports and symptoms PEAS framework would be very useful and effective. Using which more accurate results can be produced [10-12].

4.3 Challenges of PEAS in AI

PEAs components like performance, environment, sensors, actuators and sensors are depending on each other for smooth and effective execution. In complex scenarios they might not interact and relate to each other which can result in inefficient AI systems. Component values and requirements of PEAS framework would be different while modelling different types of applications. The PEAS model is a flexible framework that adjusts according to the needs and categories of key agents in AI. PEAS modeling offers feedback to the system, enabling modifications and updates to the behavior of AI agents, which can act positively or negatively based solely on the input received. Given the diverse and dynamic nature of environmental scenarios, it can be quite challenging for AI systems to effectively access, interpret, and react [13,14].

5. Proposed Model: Traffic Light Controlling System

Peas model helps to identify and clear the aims, objectives, and frameworks of traffic light controlling systems. We can better understand the framework by discussing various factors like performance, environment, sensor, and actuators with real-time scenarios.

1. **Performance**: To identify the performance of the model various measures can be evaluated.

   Traffic flow count: To measure the maximum number of vehicles passing the intersection.

   Safety: To measure the number of accidents.

   Waiting time: To measure and reduce the waiting time for vehicles.

   Emergency delay: To measure and reduce the waiting time in case of emergency to any direction.

2. Environment: There are certain factors taken into consideration

Intersection: The present signal control and input is required

Traffic: The vehicles present according to variable directions

Delay Time: Variability of delay time to control traffic

Nearby intersection: Response from nearby traffic to analyze the approximate waiting time and control the traffic.

3. Actuator

Traffic light: To control the state of signal light (Red, Yellow, Green).

Traffic control: To adjust waiting timings based on real time traffic.

4. **Sensors**

Camera: To monitor frequency of traffic.

Environmental Sensor: To analyze whether conditions.

Vehicle Sensor: To count total number of vehicles to control the flow of traffic.

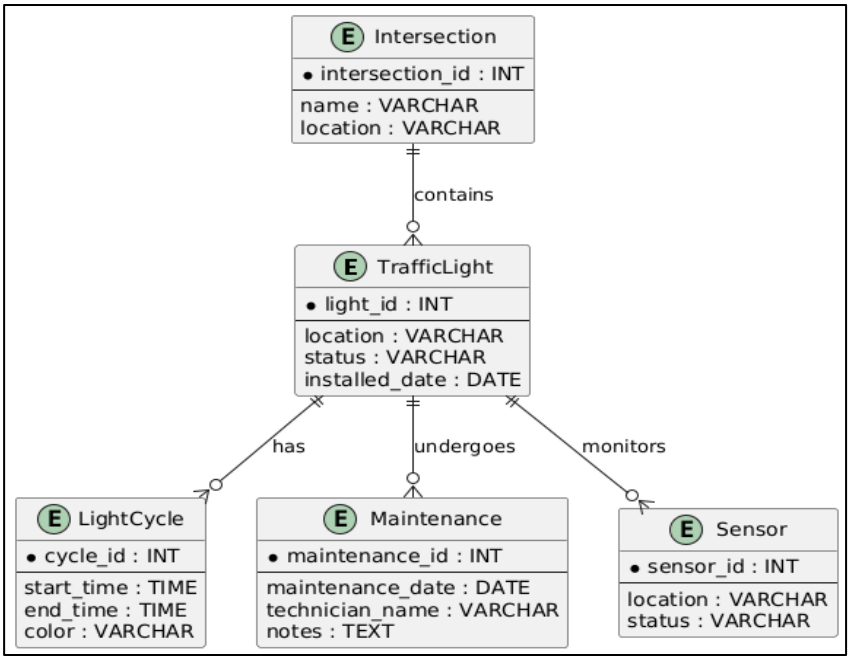

Figure 2. Traffic Control System

1. Traffic Light: Here in the above Figure 2 the traffic light entity represents traffic lights to control in the system. Each traffic light has to interact with the intersection.
2. Intersection: Interaction includes unique id number, name and location of that intersection. Each intersection may have multiple connections of traffic lights.
3. Light Cycle: The light represents the waiting time allocated to each light color. it may have attributes like, unique id, light id, color of traffic light, start time, ending time
4. Maintenance: The maintenance entity keeps the records of maintenance of traffic light, working condition etc. it may include the traffic light's unique id, date of maintenance, key notes etc parameters.
5. Sensor: Sensor monitors traffic light real-time conditions like status (active or inactive), location, unique id etc.

5.1 Discussion

Using python, a controlling agent has been designed to control the traffic having four intersections, simulation has been done in two directions. The design of traffic flow splits into two directions north-south or west-east, when one direction is moving other stops automatically.

Assuming the current traffic light colour is red and 3 vehicles are waiting in direction 1 and 5 are waiting in direction 2. If the waiting vehicle count is more or less comparatively then the controlling agent will readjust the timing of the red light. Assuming after 5 seconds of time duration the light is in red color then it will change to green color, green color allows traffic to pass if the count of waiting vehicles is high else readjust the timing of the green light. After a green light, it will change to yellow for 2 seconds before changing to red.

5.2 Result of Simulation

Traffic Light State: RED, Vehicles in Direction 1: 1, Vehicles in Direction 2: 5

Traffic Light State: RED, Vehicles in Direction 1: 2, Vehicles in Direction 2: 3

Traffic Light State: RED, Vehicles in Direction 1: 7, Vehicles in Direction 2: 4

Traffic Light State: RED, Vehicles in Direction 1: 6, Vehicles in Direction 2: 2

Traffic Light State: RED, Vehicles in Direction 1: 6, Vehicles in Direction 2: 1

Traffic Light State: GREEN, Vehicles in Direction 1: 6, Vehicles in Direction 2: 4

Traffic Light State: GREEN, Vehicles in Direction 1: 9, Vehicles in Direction 2: 7

Traffic Light State: GREEN, Vehicles in Direction 1: 8, Vehicles in Direction 2: 7

Traffic Light State: GREEN, Vehicles in Direction 1: 5, Vehicles in Direction 2: 1

Traffic Light State: GREEN, Vehicles in Direction 1: 2, Vehicles in Direction 2: 5

Traffic Light State: YELLOW, Vehicles in Direction 1: 2, Vehicles in Direction 2: 1

Traffic Light State: YELLOW, Vehicles in Direction 1: 5, Vehicles in Direction 2: 7

Traffic Light State: RED, Vehicles in Direction 1: 6, Vehicles in Direction 2: 0

Traffic Light State: RED, Vehicles in Direction 1: 5, Vehicles in Direction 2: 7

Traffic Light State: RED, Vehicles in Direction 1: 3, Vehicles in Direction 2: 7

Traffic Light State: RED, Vehicles in Direction 1: 7, Vehicles in Direction 2: 1

Traffic Light State: RED, Vehicles in Direction 1: 6, Vehicles in Direction 2: 9

Traffic Light State: GREEN, Vehicles in Direction 1: 0, Vehicles in Direction 2: 4

Traffic Light State: GREEN, Vehicles in Direction 1: 6, Vehicles in Direction 2: 4

Traffic Light State: GREEN, Vehicles in Direction 1: 6, Vehicles in Direction 2: 6

Traffic Light State: GREEN, Vehicles in Direction 1: 0, Vehicles in Direction 2: 5

Traffic Light State: GREEN, Vehicles in Direction 1: 5, Vehicles in Direction 2: 5

Traffic Light State: YELLOW, Vehicles in Direction 1: 5, Vehicles in Direction 2: 9

Traffic Light State: YELLOW, Vehicles in Direction 1: 0, Vehicles in Direction 2: 7

Traffic Light State: RED,Vehicles in Direction 1: 3,Vehicles in Direction 2: 1

Traffic Light State: RED, Vehicles in Direction 1: 8, Vehicles in Direction 2: 2

Traffic Light State: RED, Vehicles in Direction 1: 1, Vehicles in Direction 2: 6

Traffic Light State: RED, Vehicles in Direction 1: 4, Vehicles in Direction 2: 7

Traffic Light State: RED, Vehicles in Direction 1: 9, Vehicles in Direction 2: 8

Traffic Light State: GREEN, Vehicles in Direction 1: 5, Vehicles in Direction 2: 5

5.3 Limitations:

Fix time duration of 5 seconds has been taken into consideration, with a total count of vehicles in that direction, to take decisions. Real-time data can be taken using sensors, maintenance can be another parameter of consideration with safety. Reinforcement Learning can be taken into consideration to relearn from real-time scenarios.

6. Conclusion

Using the PEAS model we are able to create and implement the concept of artificial intelligence in various sectors. Using this we may have smarter systems that can be used as a tool to increase the efficiency and effectiveness of today's system. But we have to take into consideration various challenges like security threats and data leakage while implementation so that we can get more secure and accurate systems. The PEAS modeling framework plays a vital role in designing, thinking, implementing, and constructing solutions for various sectors like healthcare, education, NLP, and many more. With the continuous growth of artificially intelligent systems in the current era PEAS framework plays an important role in defining different components and understanding the system to make decisions optimal to given scenarios. By understanding the given framework, the developers can create optimal models with a better understanding of the environmental factors impacting decision-making. By understanding the given simulated model of controlling agents, its framework, elements, parameters, working, and limitations of the traffic controlling system we can understand the system in a better way.

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Dr. Shikha Gupta is currently working as Professor (Computer Science) and Head of Department (Computer Science) at Shaheed Sukhdev College of Business Studies, University of Delhi. She is a member of Skill Enhancement Council of University of Delhi under New Education Policy (NEP) 2020. With more than 25 years of experience spanning industry and academia, her recent interests include Bioinformatics, Educational Technology, Social network analysis, and Process mining. She has published and presented more than 30 research studys in journals and international conferences. Author and editor of books, she has been invited as a reviewer and editorial board member for journals, and technical committee member for international conferences.

Dr. Rama Bansal has many years of teaching experience in Computer Science, during this period she has had the opportunity to teach a diverse range of subjects like Machine learning, Data Mining, Full Stack Development, Python etc. During her studies, she stood first in college and fifth in the University. Additionally, She also excelled in various programming competitions by standing first during her academic tenure. She has also conducted numerous workshops on Web Development using React, Machine Learning, Data Mining and Python Programming at various colleges and Universities and has published research studys in various academic journals.