Intelligent Agents & Conversational AI

Goals

Define the terms ‘intelligent agent’, ‘algorithm’, and ‘chatbot’

Explain what the Loebner Prize entails

Provide an example of an intelligent agent, and give a PEAS description of the task environment

Compare, and contrast the main (conversational) agent types/architectures

Create a simple rule-based chatbot with Google Forms, and Fobi.io

What is PEAS

PEAS stands for Performance, Environment, Actuators and Sensors

**Performance Measure** refers to the criterion an AI agent uses to evaluate its actions,

= A core concept within the PEAS framework of AI. It signifies the yardstick an AI agent employs to gauge the effectiveness of its actions in achieving its goals. This measure can vary according to the specific application. For instance, in a recommendation system, the performance measure might be user satisfaction or click-through rates. In healthcare diagnostics, accuracy and sensitivity could be crucial performance metrics.

The Performance Measure guides the AI agent’s decision-making by assessing the success or failure of its endeavours, driving to optimize its actions towards the desired outcomes.

**The Environment** encompasses the external context it operates within,

In the PEAS framework, the environment refers to the external context where the AI agent operates. This encompasses all the factors and variables the agent cannot directly control but needs to interact with to achieve its objectives. For instance, an autonomous drone’s environment includes elements such as wind conditions, obstacles, and changing terrain.

Understanding the environment is critical as its dictates the challenges the AI agents faces and the data it needs to collect to make informed decisions. The agent’s ability to adapt to and navigate this environment is pivotal in determining its success.

**Actuators** are the mechanisms enabling the agent to interact with the environment,

Actuators represent the physical or digital mechanisms through which an AI agent executes actions in its environment. They are tools that bridge the gap between the agent’s decision-making process and its tangible impact on the surroundings.

These mechanisms could range from robotics arms and sensors in industrial automation to text-to-speech conversion in virtual assistants. The efficiency and precision od actuators directly influence the agent’s ability to carry out its intended actions effectively. Selecting appropriate actuators is essential to ensure that the agent’s decisions translate into meaningful changes in the environment it operates.

**And Sensors** provide the agent with the means to perceive and gather information.

Sensors are vital components within the PEAS framework, serving as the agent’s sensory organs to perceive and gather information from its environment. They gather environmental data, including temperature, sound light, and movement. The AI agent uses this knowledge to decide wisely and modify its behaviour in response to changing circumstances.

For example, in an agricultural AI system, sensors might collect data about soil moisture levels and weather patterns to optimize irrigation strategies. The accuracy and range of sensors directly impact the quality of information the agent receives, influencing the accuracy of its decisions and actions.

2.1a

Performance measure – The goal of Deep Blue is to win chess games against human opponents. Primarily by maximizing winning chances or forcing a draw if victory is unlikely.

* Defeat its opponent (preferably in the shortest number of moves)
* Making optimal moves based on chess heuristics and strategies
* Minimizing errors or blunders (as rated by chess evaluations)

Environment – The environment in which Deep Blue operates is:

* A chessboard with fixed rules
* A two-player environment: one player being Deep Blue, the other being a human opponent.
* The game has deterministic outcomes
* It operates in a static environment, meaning that the game does not change unexpectedly outside of the rules of chess

Actuators – Deep Blues actuators consist of:

* Outputting chess moves in the form of algebraic notation
* Interfacing with a physical chessboard in some cases, by communication
* Internal actuators involve processing complex algorithms, such as evaluating game positions, determining move sequences, and choosing the optimal move.

Sensors – Deep Blue’s sensors consist of:

* Input from the chessboard, it senses the current board position and updates its internal model of the game state.
* Human opponent moves, these moves are fed into the system either manually or through a digital interface, allowing Deep Blue to react.
* Additionally, Deep Blue uses internal evaluation functions to sense the strength or weakness of different board positions in real time.

**Properties of the task environment:**

1. a) **Fully observable** or b) partially observable
2. a) Deterministic or b) **stochastic**
3. a) Episodic or b) **sequential**
4. a) **Static**, b) dynamic or c) semi-dynamic
5. a) **Discrete** or b) continuous
6. a) Single agent or b) **multi-agent**

2.1b Autonomous vehicles

Fully observable, Stochastic, co-operative, Sequential, Dynamic environment, Continuous, Multi-agent

2.1c

**Simple reflex agents, (basic thermostats)**

Respond to current perceptions using predefined rules or condition-action pairs, they do not maintain any internal state or history of past actions. Decisions are purely based on the current state of the environment

They use straightforward rules like “if condition A, then action B” (rule-based)

**Model-Based reflex agents, (advanced robotic vacuum cleaner)**

These agents maintain an internal model of the world, which allows them to keep track of the state of the environment and the results of their actions. They use enhanced decision making to handle partial observability and to make better decisions based on both the current perception and the internal state.

They use condition-action rules but also consider the internal state to determine the appropriate action. (decision making)

**Goals-based agents, (GPS navigation systems)**

These agents are purpose driven; they have a specific goal they aim to achieve. They consider the current state and the desired goal state to plan their actions. They use goal-based planning to determine a sequence of actions that will lead to the achievement of their goals.

They evaluate actions based on whether they help achieve the desired, often involving search or planning algorithms. (goal-orientated)

**Utility-Based agents, (Product recommendation system)**

These agents use a utility function to evaluate and compare different states based on how well they satisfy the agent’s preferences. They aim to maximize their overall utility or satisfaction, considering various trade-offs between different possible actions.

They choose actions that maximize their expected utility, allowing them to handle more complex scenarios and preferences. (utility maximization)

2.2a

Siri, ChatGPT, Sephora Chatbot

2.2b

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| rule-based (rely on predefined rules or conditions) | |
| these systems are straightforward to design and understand, its behaviour is predictable, making it easier to debug and control. | Rule-based systems can only respond to scenarios covered by the predefined rules. |
| Rule based system are highly accurate | As the number of possible interactions grows, maintaining and updating the rule set becomes increasingly more complexed |
| Due to the response being predetermined, it can generate replies quickly | The system cannot learn from past interactions or improve over time |
| With well-designed rules, the system will not deviate from its intended scope | Not suitable for complex conversations |

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| Retrieval-based systems (use a database of predefined responses and retrieve the most appropriate) | |
| Since the responses are pre-authored, retrieval-based systems can deliver grammatically correct well-constructed replies | Limited by dataset, if an appropriate response doesn’t exist in the system, it may fail to provide a relevant response |
| Responses remain consistent in tone and content, maintaining a coherent user experience | They are not ideal for personalized or open-ended conversations |
| These systems are easier to deploy than generative models | Like rule-based systems, these systems do not inherently learn from interactions unless paired with some additional learning mechanisms |
| Retrieval-based systems are less likely to generate irrelevant or illogical answers (than generative models) | Complex or nuanced queries may not match well with predefined responses |

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| Generative (Often powered by machine learning models, generate responses dynamically based on the user’s input). | |
| These systems can handle a wide range of queries and respond dynamically, even to input they’ve never encountered before | They can occasionally generate illogical, irrelevant, or factually incorrect answers. |
| Many generative models can maintain context across multiple turns in a conversation, allowing for natural and coherent dialogues | Training and running generative models require significant computational power and large datasets |
| These systems can learn from large amounts of data | Response quality can vary widely |
| Excel in open-ended conversations where predefined responses might be limited | If not properly controlled may produce inappropriate or harmful responses |

2.2c

Rule based

2.2d

Generative chatbot