Journal of Research and Innovation in Technology, Commerce and Management
Vol. 2 Issue 10, October 2025, pp. 21073-21077
ISSN: 3049-3129(Online)

Rule-Based Object Pattern Game: A Knowledge Representation and Simple Reflex Agent Model in Educational Gameplay

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Cite as : Ayushman Behera. (2025). Rule-Based Object Pattern Game: A Knowledge Representation and Simple Reflex Agent Model in Educational Gameplay. Journal of Research and Innovation in Technology, Commerce and Management, Vol. 2(Issue 10), 21073–21077. https://doi.org/10.5281/zenodo.17406650

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Abstract

This paper presents the development of a rulebased educational game, ”Rule-Based Object Pattern”, designed to introduce the concepts of Knowledge Representation and Simple Reflex Agents in artificial intelligence. The game utilizes structured object attributes such as color and shape, and a simple agent applies predefined if-then rules to predict object sequences. The aim is to demonstrate how AI agents can use represented knowledge for decision-making and reasoning, fostering early AI literacy through interactive gameplay. The system was developed using Unity 3D and evaluated via student feedback and agent performance metrics.

Keywords

Knowledge Representation, Reflex Agent, RuleBased System, AI Education, Game-Based Learning, Unity 3D.

I. INTRODUCTION

Artificial Intelligence (AI) education often requires learners to understand abstract concepts such as Knowledge Representation (KR), rule-based reasoning, and decision-making agents [1], [2]. These topics can be conceptually dense for early learners. To simplify these ideas, this research introduces an interactive, gamified environment that visually and interactively demonstrates how agents can reason based on structured data and predefined rules. By combining intuitive game mechanics with AI learning outcomes, this work contributes to the growing field of AI education tools [3], [4].

The Rule-Based Object Pattern game presents objects with attributes like color and shape in a sequence. Both a player and a simple reflex agent attempt to predict the next object based on rules derived from the object’s attributes,

providing an intuitive representation of AI reasoning mechanisms [1], [2]. The game aims to foster a practical understanding of AI processes, making theoretical AI concepts more accessible through gameplay.

II. LITERATURE REVIEW

Numerous studies have highlighted the significance of game-based learning in computer science education. Gee [5] emphasized the cognitive benefits of interactive play, while Papert [6] introduced constructionist learning frameworks promoting AI education through digital games. Projects like Scratch [7] and Alice [8] have successfully engaged students in computational thinking through visual game environments.

Wooldridge [3] and Russell and Norvig [1] established foundational frameworks for multi-agent systems and reflex agents. Further, Mitchell [2] and Nilsson [4] provided comprehensive discussions on AI learning mechanisms including reflexive reasoning. Dennett [9] explored cognitive simplicity in agentbased AI systems.

Interactive AI education tools have shown significant improvements in student comprehension [10]. This study integrates these ideas into a gamified AI teaching tool built in Unity 3D, guided by earlier research on rule-based systems [11].

III. KNOWLEDGE REPRESENTATION AND REFLEX AGENTS

A. Knowledge Representation

Knowledge Representation (KR) refers to structuring information in a formalized way that a computer system can utilize to solve complex tasks [1]. In this game, object attributes such as color: red, shape: square are encoded into structured formats. These are then processed by the AI agent to predict subsequent object attributes. The structured knowledge allows for efficient, consistent reasoning by applying predefined decision rules.

B. Simple Reflex Agents

A Simple Reflex Agent operates by observing its current environment state and performing an action based on predefined if-then rules without maintaining an internal model or memory [4]. Reflex agents are ideal for beginner AI demonstrations because of their straightforward logic structures [9]. The game agent uses such rules to predict the next object in a sequence by considering current object attributes.

C. Graphical Representation of Agent Performance

IV. GAME CONCEPT, IMPLEMENTATION AND EVALUATION

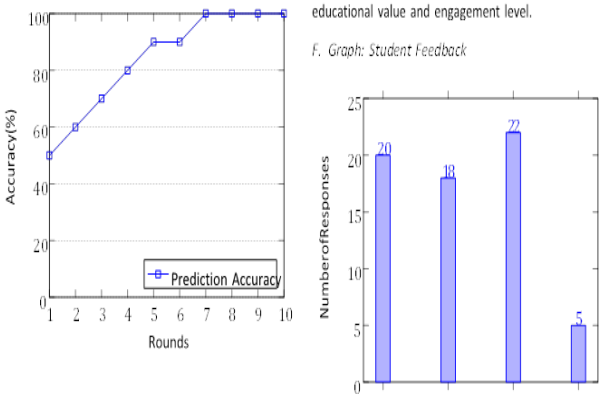
A. Gameplay Overview

The game sequentially presents objects with clearly defined attributes:

- Color: Red, Blue
- Shape: Square, Circle

Players are asked to observe the sequence and predict the next object's

attributes based on inferred patterns. Simultaneously, a reflex agent applies its rule set to make predictions [1].



Agent Prediction Accuracy Over Rounds

Fig. 1. Accuracy improvement of agent predictions across game rounds

B. Rule-Based AI Agent Algorithm

Algorithm 1 Simple Reflex Agent for Pattern Prediction

1: Initialize object attributes: color, shape
2: Observe current object attributes
3: if currentColor == 'red' then
4: nextColor ← 'blue'
5: else
6: nextColor ← 'red'
7: end if
8: if currentShape == 'square' then
9: nextShape ← 'circle'
10: else
11: nextShape ← 'square'
12: end if
13: Output nextColor, nextShape

C. System Implementation

The game was developed using Unity 3D due to its versatility and cross-platform capabilities [12]. The AI agent logic was scripted in C# using MonoBehaviour components. The system features an interactive UI where both human players and the agent make predictions on upcoming objects.

D. Evaluation Metrics

Evaluation was conducted through two key metrics: agent prediction accuracy and student feedback on the game's educational value. Agent performance was logged per round, while student opinions were gathered using a structured questionnaire.

E. Feedback and Results

Figure 1 illustrates how agent accuracy improved across rounds. Additionally, Figure 2 presents survey results from 30 undergraduate students who tested the game, confirming the

Engaging Informative Easy to UsNeeds Improvement
Feedback Category

Fig. 2. Feedback survey results from 30 participants.

V. CONCLUSION AND FUTURE WORK

The *Rule-Based Object Pattern* game presents an effective and innovative approach to teaching artificial intelligence concepts in a gamified environment. By utilizing the

foundational concepts of Knowledge Representation (KR) and Simple Reflex Agents, the game enables learners to engage with AI principles in a hands-on, interactive manner. The gameplay mechanics allow players to visually understand how agents use structured knowledge to make predictions, bridging the gap between theoretical AI concepts and real-world applications. The game not only makes AI more accessible to beginners but also fosters a deeper understanding of how agents reason and make decisions based on simple rules.

One of the key strengths of this project is its ability to provide immediate feedback to users, allowing them to see the agent's decision-making process and compare it with their own predictions. This fosters a more immersive learning experience and helps learners internalize AI concepts through iterative play. Additionally, the inclusion of a simple reflex agent within the game highlights the significance of rule-based systems in decision-making, a core idea in the study of artificial intelligence.

Future work on the Rule-Based Object Pattern game will focus on several enhancements to increase its educational value and broaden its applicability. First, we plan to integrate probabilistic reasoning into the gameplay. This would allow the agent to move beyond deterministic decision-making and handle situations where uncertainty and probability are important. For example, rather than always predicting the next object based on a strict if-then rule, the agent could make predictions based on probabilities derived from previous game states, which would mimic more advanced AI behavior.

Additionally, exploring multi-agent environments will enable a more complex and dynamic interaction between agents. Multi-agent systems are a critical area of AI research, and incorporating this into the game would allow students to explore how agents collaborate, compete, and share information to solve problems. This could also lead to the introduction of cooperative or adversarial agent strategies, adding depth to the gameplay and providing a platform to teach concepts like negotiation, collaboration, and strategic reasoning.

The game could also be extended to allow students to create their own rule sets and knowledge representations, providing a deeper level of engagement. This would turn the game into a creative platform where learners can design their own challenges, thereby reinforcing the principles of rulebased reasoning and knowledge encoding. This customization aspect could be particularly beneficial in a classroom setting, as it would encourage active participation and collaborative learning.

Moreover, integrating the game into curricula for introductory AI courses would allow for a more structured and focused approach to learning. Teachers could use the game as a teaching tool for demonstrating AI principles in real time,

supplementing traditional lectures with an interactive and engaging experience.

Another key area of development would be to adapt the game for mobile platforms, making it more accessible to a broader range of students. A mobile version would allow learners to practice AI concepts at their own pace and convenience, further enhancing the game's potential as an educational tool. Additionally, incorporating adaptive difficulty levels into the game could cater to a wider range of learning paces and abilities, ensuring that students of all levels can benefit from the game.

Finally, future versions of the game could incorporate more advanced agent types, such as learning agents that adapt their behavior over time based on experience. This would introduce students to concepts such as reinforcement learning and supervised learning, making the game a comprehensive platform for learning a wide range of AI techniques.

In conclusion, the Rule-Based Object Pattern game represents a significant step forward in gamifying AI education, offering students a practical and engaging way to understand complex AI concepts. With ongoing improvements and expansions, the game holds great potential to become a core tool in AI education, providing both theoretical and practical insights into how AI systems are developed and deployed in real-world applications.

ACKNOWLEDGMENT

The author expresses gratitude to Lovely Professional University and the Department of Computer Science for their support and resources.

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