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TARAN PUBLICATION
www.taranpublication.com
Email: taran.publication@gmail.com

ISBN 978-81-19295-67-8
9 788119 295678
INR : ₹500

Revitalising Global Trends in India

Dr. Minakshi Gupta

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12/23/2022

REVITALISING GLOBAL TRENDS IN INDIA

Editor- Dr. Minakshi Vijayant Gupta

Institute Name

URAN EDUCATION SOCIETY'S
COLLEGE OF MANAGEMENT &
TECHNOLOGY

Taran Publication
New Delhi

REVITALISING GLOBAL TRENDS IN INDIA

Edition : Dec 2022

ISBN: 978-81-19295-67-8

Price : ₹500/-

Published By
Taran Publiction
www.taranpublication.com
Email : taran.publication@gmail.com
Contact : 9996906285

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CHAPTER-6

EXPLORING THE WUMPUS WORLD: A STUDY OF AI TECHNIQUES IN SOLVING A CLASSIC PROBLEM

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ABSTRACT

The Wumpus World is a classic artificial intelligence problem that challenges the capabilities of intelligent agents to navigate and make decisions in an uncertain and partially observable environment. In this research paper, we delve into the various techniques and approaches that have been employed to tackle the Wumpus World conundrum. We provide an overview of the problem, discuss the challenges it poses, and analyze the evolution of AI techniques used to solve it. We explore methods such as rule-based systems, propositional logic, search algorithms, and probabilistic reasoning, highlighting their strengths and limitations. Furthermore, we examine recent advancements and the potential applications of the insights gained from solving the Wumpus World problem.

KEYWORDS:*Wumpus, Grid Environment, Stench, Pit, Glitter, Gold*

INTRODUCTION:

The Wumpus world is a simple world example to illustrate the worth of a knowledge-based agent and to represent knowledge representation. It was inspired by a video game **Hunt the Wumpus** by Gregory Yob in 1973.The goal in Wumpus World is for an agent to navigate a dark cave and find gold while avoiding hazards like pits and the Wumpus, a dangerous monster.

Here are some key elements of Wumpus World:

- Grid Environment: The world is represented as a grid of rooms, and each room can contain hazards or items such as pits, gold, or the Wumpus.
- Agent's Knowledge: The agent has limited knowledge of the world, typically through a percept or sensor that provides information about adjacent rooms.
- Rules and Hazards: The agent must follow certain rules, like not walking into pits or shooting the Wumpus with an arrow. Falling into a pit or encountering the Wumpus results in failure.
- Exploration and Strategy: The agent must explore the environment intelligently, using its knowledge to make decisions about which rooms to enter and how to proceed.
- Goal: The ultimate goal is to find the gold and return to the starting position while avoiding hazards and defeating the Wumpus if necessary.

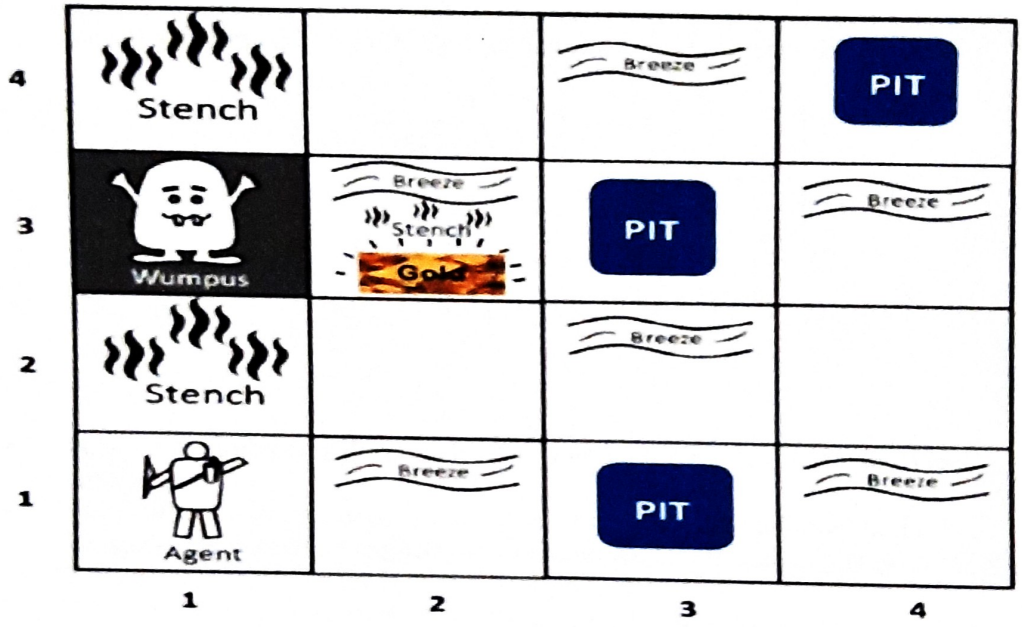
Wumpus World is used as a testbed for various AI search and planning algorithms, including algorithms for pathfinding, knowledge representation, and decision-making under uncertainty.

It challenges AI researchers to create agents that can efficiently explore and solve problems in a complex, uncertain environment.

PROBLEM STATEMENT

The Wumpus World is a classic artificial intelligence problem used for testing and developing intelligent agents. The problem statement is as follows:

"In the Wumpus World, an intelligent agent must navigate a grid-based cave system to find gold while avoiding dangers such as bottomless pits and a deadly Wumpus creature. The agent has limited information about its environment and must make decisions based on sensory perceptions (e.g., stench indicating the presence of the Wumpus or a breeze indicating a pit) to safely retrieve the gold and exit the cave. The goal is to develop an AI agent that can efficiently explore and conquer the Wumpus World, maximizing its score while minimizing risks and hazards."



Components of Wumpus World which can help the agent to navigate the cave which are as follows:

- The rooms adjacent to the Wumpus room are smelly, so that it would have some stench.
- The room adjacent to PITs has a breeze, so if the agent reaches near to PIT, then he will perceive the breeze.
- There will be glitter in the room if and only if the room has gold.
- The Wumpus can be killed by the agent if the agent is facing to it, and Wumpus will emit a horrible scream which can be heard anywhere in the cave.

PEAS description of Wumpus World

To explain the Wumpus world we have given PEAS description as below:

Performance Measure:

- +1000 reward points if the agent comes out of the cave with the gold.
- -1000 points penalty for being eaten by the Wumpus or falling into the pit.
- -1 for each action, and -10 for using an arrow.
- The game ends if either agent dies or came out of the cave.

Environment:

- A 4*4 grid of rooms.
- The agent initially in room square [1, 1], facing toward the right.
- Location of Wumpus and gold are chosen randomly except the first square [1,1].
- Each square of the cave can be a pit with probability 0.2 except the first square.

Actuators:

- Left turn
- Right turn
- Move forward
- Grab
- Release
- Shoot

Sensors:

- The agent will perceive the **stench** if he is in the room adjacent to the Wumpus. (Not diagonally).
- The agent will perceive **breeze** if he is in the room directly adjacent to the Pit.
- The agent will perceive the **glitter** in the room where the gold is present.
- The agent will perceive the **bump** if he walks into a wall.
- When the Wumpus is shot, it emits a horrible **scream** which can be perceived anywhere in the cave.
- These percepts can be represented as five element list; in which we will have different indicators for each sensor.
- Example if agent perceives stench, breeze, but no glitter, no bump, and no scream then it can be represented as:

  [Stench, Breeze, None, None, None].

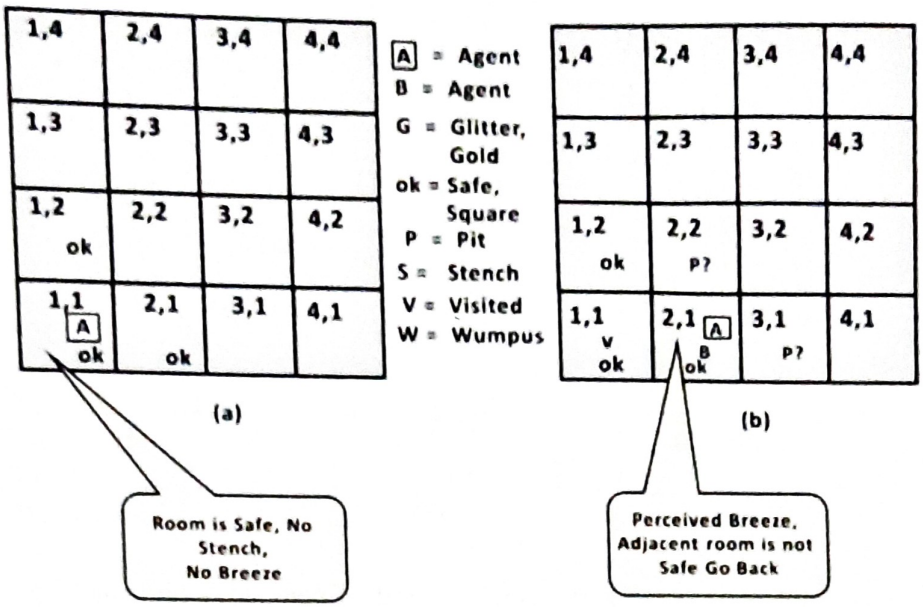
Exploring the Wumpus World

In this section we will explore the Wumpus World and determine how the agent will find its goal by applying logical reasoning.

Step 1:

Initially, the agent is in the first room or on the square [1,1], and we already know that this room is safe for the agent, so to represent on the below diagram (a) that room is safe we will add symbol OK. Symbol A is used to represent agent, symbol B for the breeze, G for Glitter

or gold, V for the visited room, P for pits, W for Wumpus. At Room [1,1] agent does not feel any breeze or any Stench which means the adjacent squares are also OK.



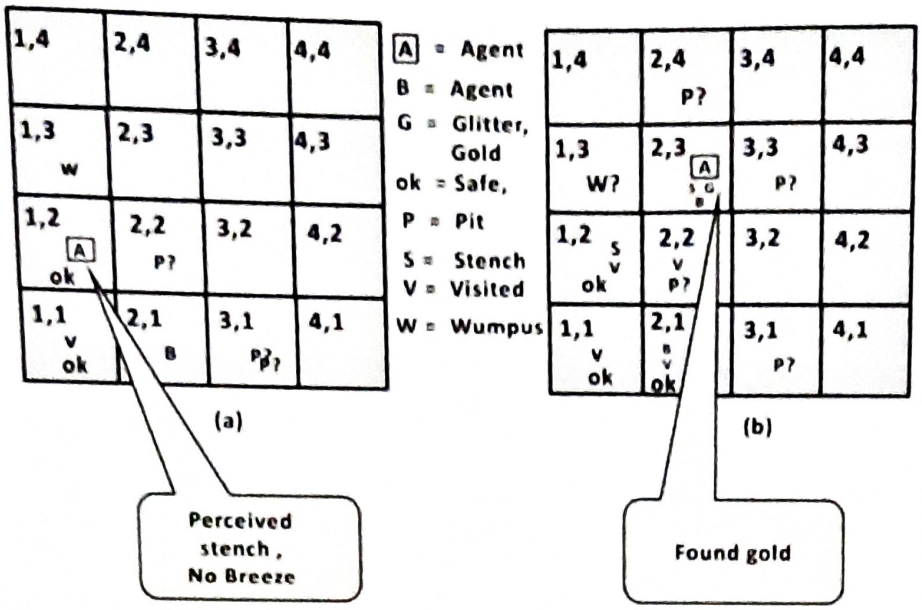
Step 2:

Now agent needs to move forward, so it will either move to [1, 2], or [2,1]. Let's suppose agent moves to the room [2, 1], at this room agent perceives some breeze which means Pit is around this room. The pit can be in [3, 1], or [2,2], so we will add symbol P? to say that, is this Pit room?

Now agent will stop and think and will not make any harmful move. The agent will go back to the [1, 1] room. The room [1,1], and [2,1] are visited by the agent, so we will use symbol V to represent the visited squares.

Step 3:

At the third step, now agent will move to the room [1,2] which is OK. In the room [1,2] agent perceives a stench which means there must be a Wumpus nearby. But Wumpus cannot be in the room [1,1] as by rules of the game, and also not in [2,2] (Agent had not detected any stench when he was at [2,1]). Therefore, agent infers that Wumpus is in the room [1,3], and in current state, there is no breeze which means in [2,2] there is no Pit and no Wumpus. So it is safe, and we will mark it OK, and the agent moves further in [2,2].



Step 4:

At room [2,2], here no stench and no breezes present so let's suppose agent decides to move to [2,3]. At room [2,3] agent perceives glitter, so it should grab the gold and climb out of the cave.

This problem is often used to test and demonstrate various AI techniques, including search algorithms, knowledge representation, reasoning, and decision-making in uncertain environments.

AI TECHNIQUES AND APPROACHES

- Rule-Based Systems: Early attempts at solving the Wumpus World involved rule-based systems, where agents followed predefined sets of rules to navigate and avoid dangers. However, this approach was limited by the complexity of handling uncertainty and partial observability.

- Propositional Logic: As AI advanced, propositional logic was applied to model the Wumpus World environment and agent's knowledge. Agents used logical inference to deduce the state of the world, allowing for more informed decision-making.

- Search Algorithms: Techniques like depth-first search, breadth-first search, and A* search have been used to explore the state space of the Wumpus World. These approaches enable agents to find paths to the gold while avoiding hazards.

- Probabilistic Reasoning: Bayesian networks and probabilistic reasoning models have been employed to model uncertainty in the Wumpus World. Agents use probability distributions to make decisions based on available evidence.

ADVANCEMENTS AND APPLICATIONS

Recent advancements in machine learning, deep learning, and reinforcement learning have opened new avenues for solving the Wumpus World problem. Reinforcement learning algorithms can learn optimal policies through trial and error, and neural networks can model complex relationships within the environment.

Insights gained from solving the Wumpus World problem have applications in various domains, including robotics, autonomous navigation, and decision-making in uncertain environments. Lessons learned from handling partial observability and uncertainty can be extended to real-world scenarios, such as disaster response and exploration of hazardous areas.

CONCLUSION

The Wumpus World remains a timeless benchmark for testing AI techniques in uncertain and hazardous environments. Over the years, approaches have evolved from simple rule-based systems to sophisticated reinforcement learning algorithms. This paper has provided an overview of the evolution of AI techniques applied to the Wumpus World, highlighting the challenges, strengths, and potential applications of these approaches.

As AI continues to advance, the insights gained from solving classic problems like the Wumpus World will contribute to the development of intelligent agents capable of making informed decisions in complex and uncertain environments.

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