

# UNIT IV

## Introduction



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## Knowledge-Based Agent



- An intelligent agent needs knowledge about the real world for taking decisions and reasoning to act efficiently.
- Knowledge-based agents are those agents who have the capability of maintaining an internal state of knowledge, reason over that knowledge, update their knowledge after observations and take actions. These agents can represent the world with some formal representation and act intelligently.
- Knowledge-based agents are composed of two main parts:
  - Knowledge-base and
  - Inference system.

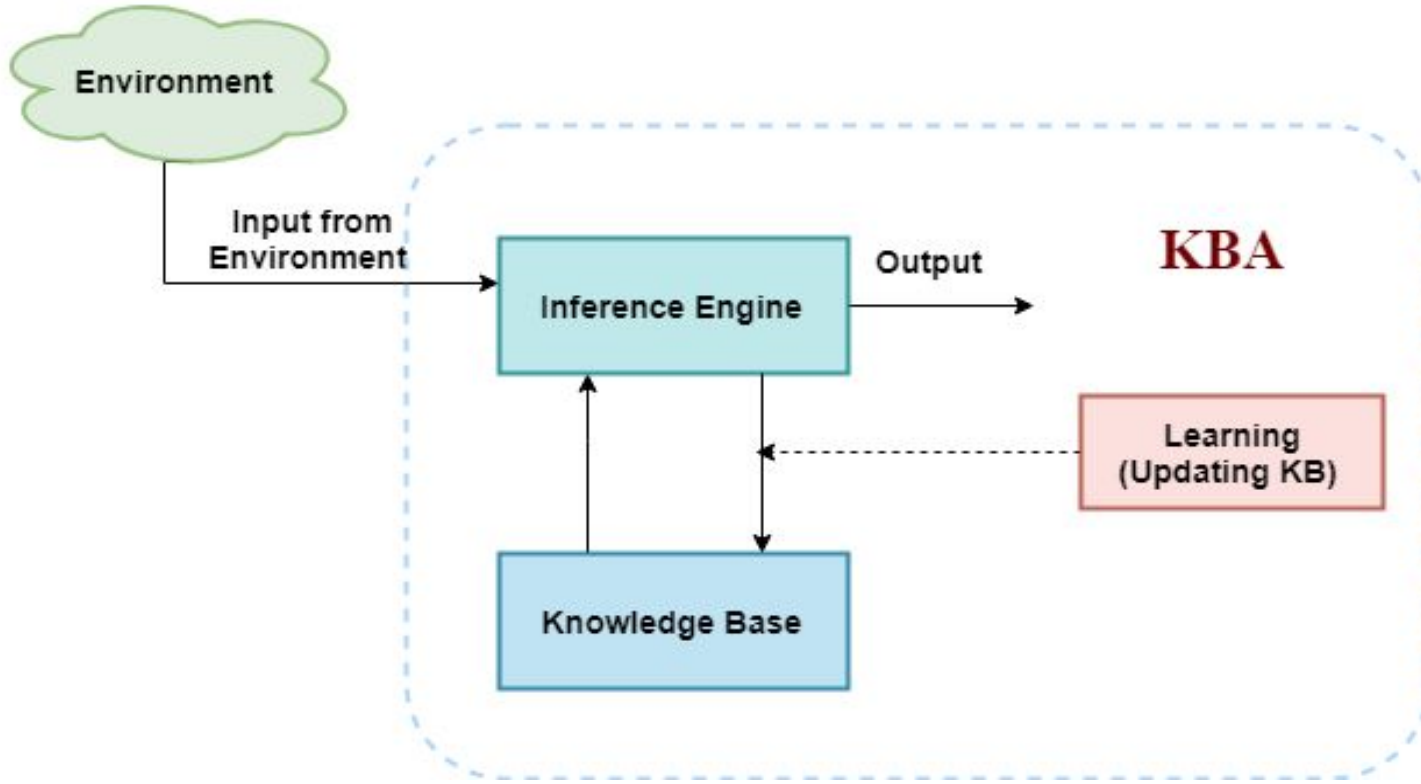
## Knowledge-Based Agent



A knowledge-based agent must be able to do the following:

- An agent should be able to represent states, actions, etc.
- An agent should be able to incorporate new percepts
- An agent can update the internal representation of the world
- An agent can deduce the internal representation of the world
- An agent can deduce appropriate actions.

# Knowledge-Based Agent



## Knowledge-Based Agent



- **Knowledge base:** Knowledge-base is a central component of a knowledge-based agent, it is also known as KB. It is a collection of sentences (here 'sentence' is a technical term and it is not identical to sentence in English). These sentences are expressed in a language which is called a knowledge representation language. The Knowledge-base of KBA stores fact about the world.
- **Inference** means deriving new sentences from old. Inference system allows us to add a new sentence to the knowledge base. A sentence is a proposition about the world. Inference system applies logical rules to the KB to deduce new information.
- Inference system generates new facts so that an agent can update the KB.



# Knowledge-Based Agent



- ▣ Various levels of knowledge-based agent:

- ▣ **1. Knowledge level**

- ▣ Knowledge level is the first level of knowledge-based agent, and in this level, we need to specify what the agent knows, and what the agent goals are. With these specifications, we can fix its behavior. For example, suppose an automated taxi agent needs to go from a station A to station B, and he knows the way from A to B, so this comes at the knowledge level.

- ▣ **2. Logical level:**

- ▣ At this level, we understand that how the knowledge representation of knowledge is stored. At this level, sentences are encoded into different logics. At the logical level, an encoding of knowledge into logical sentences occurs. At the logical level we can expect to the automated taxi agent to reach to the destination B.

## Knowledge-Based Agent



- Various levels of knowledge-based agent:

- **3. Implementation level:**

- This is the physical representation of logic and knowledge. At the implementation level agent perform actions as per logical and knowledge level. At this level, an automated taxi agent actually implement his knowledge and logic so that he can reach to the destination.



# Knowledge-Based Agent



## ▣ What is knowledge representation?

- ▣ Knowledge representation and reasoning (KR, KRR) is the part of Artificial intelligence which concerned with AI agents thinking and how thinking contributes to intelligent behavior of agents.
- ▣ It is responsible for representing information about the real world so that a computer can understand and can utilize this knowledge to solve the complex real world problems such as diagnosis a medical condition or communicating with humans in natural language.
- ▣ It is also a way which describes how we can represent knowledge in artificial intelligence. Knowledge representation is not just storing data into some database, but it also enables an intelligent machine to learn from that knowledge and experiences so that it can behave intelligently like a human.

# Knowledge-Based Agent



- Logical Representation

- **Syntax:**
















- Syntaxes are the rules which decide how we can construct legal sentences in the logic.
- It determines which symbol we can use in knowledge representation.
- How to write those symbols.

- **Semantics:**

- Semantics are the rules by which we can interpret the sentence in the logic.
  - Semantic also involves assigning a meaning to each sentence
- 
- Logical representation can be categorised into mainly two logics:
    - Propositional Logics
    - Predicate logics

# The Wumpus World



|   |   |   |   |   |
|---|---|---|---|---|
| 4 | <br>Stench |   | <br>Breeze | <br>PIT    |
| 3 | <br>Wumpus | <br>Breeze<br><br>Stench<br><br>Gold | <br>PIT    | <br>Breeze |
| 2 | <br>Stench |   | <br>Breeze |   |
| 1 | <br>Agent  | <br>Breeze   | <br>PIT    | <br>Breeze |
|   | 1   | 2   | 3   | 4   |

There are also some components which can help the agent to navigate the cave. These components are given as follows:

1. The rooms adjacent to the Wumpus room are smelly, so that it would have some stench.
2. The room adjacent to PITs has a breeze, so if the agent reaches near to PIT, then he will perceive the breeze.
3. There will be glitter in the room if and only if the room has gold.
4. 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

# The 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.

# The Wumpus World



## 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.

# The Wumpus World



## 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].

# The Wumpus World



## Applications of Wumpus World in AI:

- ▣ **Developing intelligent agents:** The Wumpus World in AI is an excellent platform for creating intelligent agents capable of navigating complicated environments, reasoning in uncertainty, and planning actions.
- ▣ **Testing AI algorithms:** Wumpus World is a benchmark issue for testing and comparing various AI algorithms, such as search, planning, and reinforcement learning.
- ▣ **Education and training:** Because it is simple to use and offers hands-on experience, the Wumpus World in AI is a popular tool for teaching AI concepts and algorithms to students.
- ▣ **Game Development:** Wumpus World can motivate developers to create challenging and engaging games requiring strategic thinking and problem-solving.
- ▣ **Robotics:** The Wumpus World can be used as a testing and development setting for robotics algorithms such as pathfinding and mapping.



# The Wumpus World



## Wumpus World Characterization:

- Partially Observable: knows only the local perceptions
- Deterministic: outcome is precisely specified
- Sequential: subsequent level of actions performed
- Static: Wumpus, pits are immobile
- Discrete: discrete environment
- Single-agent: The knowledge-based agent is the only agent whereas the wumpus is considered as the environment's feature.