



ATME
College of Engineering

GOLD

QS I-GAUGE
INDIAN COLLEGE RATINGS



MODULE-3

**COURSE NAME:ARTIFICIAL
INTELLIGENCE-BCS515B**



Knowledge-based agents

- The central component of a knowledge-based agent is its knowledge base, or KB. A knowledge base is a set of sentences.
- Each sentence is expressed in a language called a knowledge representation language and represents some KNOWLEDGE REPRESENTATION LANGUAGE AXIOM assertion about the world. Sometimes we dignify a sentence with the name axiom, when the sentence is taken as given without being derived from other sentences.
- Figure 7.1 shows the outline of a knowledge-based agent program. Like all our agents, it takes a percept as input and returns an action. The agent maintains a knowledge base, KB, which may initially contain some background knowledge.

Knowledge-based agents

function KB-AGENT(*percept*) **returns** an *action*

persistent: *KB*, a knowledge base

t, a counter, initially 0, indicating time

TELL(*KB*, MAKE-PERCEPT-SENTENCE(*percept*, *t*))

action $\leftarrow$ ASK(*KB*, MAKE-ACTION-QUERY(*t*))

TELL(*KB*, MAKE-ACTION-SENTENCE(*action*, *t*))

t $\leftarrow$ *t* + 1

return *action*

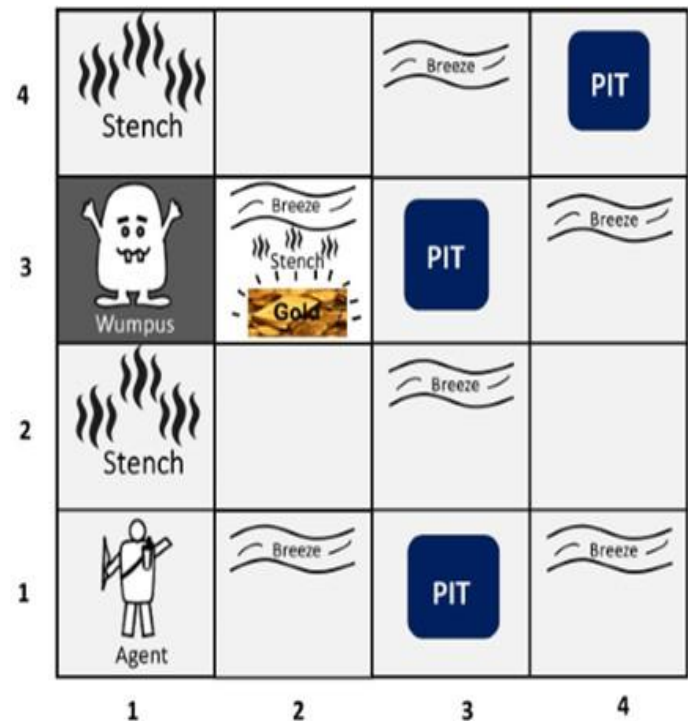
Figure 7.1 A generic knowledge-based agent. Given a percept, the agent adds the percept to its knowledge base, asks the knowledge base for the best action, and tells the knowledge base that it has in fact taken that action.

Knowledge-based agents

- Each time the agent program is called, it does three things.
- First, it TELLS the knowledge base what it perceives.
- Second, it ASKS the knowledge base what action it should perform. In the process of answering this query, extensive reasoning may be done about the current state of the world, about the outcomes of possible action sequences, and so on.
- Third, the agent program TELLS the knowledge base which action was chosen, and the agent executes the action.

Wumpus world

- The Wampus world is a simple world example to illustrate the knowledge based agent to represent knowledge representation
- The **Wumpus World** is a *cave* made up of small **rooms (a 4×4 grid)** that are connected by passageways. so there are total 16 rooms are connected with each other.
- It is a **logic-based game environment** used in Artificial Intelligence





1.Environment (The Cave)

The cave is a **4 × 4 grid** — that means there are **16 rooms** (4 rows × 4 columns).

The **agent (player)** always starts at the **bottom-left corner**, which is labeled **[1,1]**, and is initially **facing right** (toward [2,1]).

The rest of the rooms may contain:

- The Wumpus** (a monster)

- Pits** (dangerous holes)

- Gold** (the treasure)

2.The **Wumpus** is a **monster** that *eats* the agent if the agent enters its room.

The agent can **kill the Wumpus** using an arrow, but:

- It has **only one arrow**.

- The arrow travels in a straight line until it **hits the Wumpus or a wall**.

3.Pits (Bottomless holes)

Some rooms contain **bottomless pits**.

If the agent falls into one → it **dies instantly**.

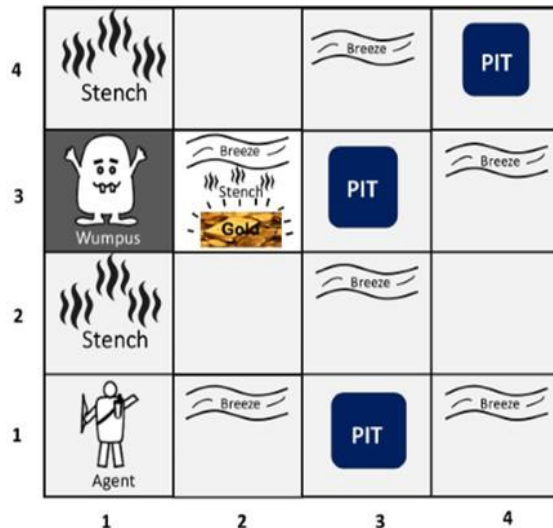
The Wumpus is too big to fall into a pit.

4. Gold

One room has a **heap of gold**.

The agent's goal is to **find the gold, grab it**, and **climb out safely** from the starting point [1,1].

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

PERFORMANCE MEASURE

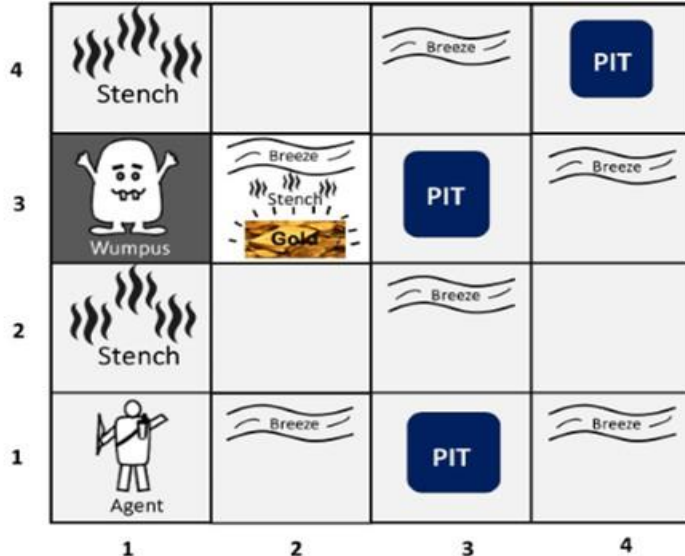
- +1000 reward points if the agent comes out of the cave with the gold.
- -1000 points penalty for being eaten by the Wumpus or falling into the pit.
- -1 for each action, and -10 for using an arrow.
- The game ends if either agent dies or came out of the cave.

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]**.

THE WUMPUS WORLD PROPERTIES

The Wumpus world Properties:

- **Partially observable:** The Wumpus world is partially observable because the agent can only perceive the close environment such as an adjacent room.
- **Deterministic:** It is deterministic, as the result and outcome of the world are already known.
- **Sequential:** The order is important, so it is sequential.
- **Static:** It is static as Wumpus and Pits are not moving.
- **Discrete:** The environment is discrete.
- **One agent:** The environment is a single agent as we have one agent only and Wumpus is not considered as an agent.

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Agent's second Step:

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.

Exploring Wumpus World

Agent's later steps:

1,4	2,4	3,4	4,4
1,3 W!	2,3	3,3	4,3
1,2 A S OK	2,2 OK	3,2	4,2
1,1 V OK	2,1 B V OK	3,1 P!	4,1

A

 = Agent

B

 = Breeze

G

 = Glitter, Gold

OK

 = Safe square

P

 = Pit

S

 = Stench

V

 = Visited

W

 = Wumpus

(a)

1,4	2,4 P?	3,4	4,4
1,3 W!	2,3 A S G B	3,3 P?	4,3
1,2 S V OK	2,2 V OK	3,2	4,2
1,1 V OK	2,1 B V OK	3,1 P!	4,1

(b)

AGENT'S THIRD STEP:

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].

Exploring Wumpus World

Agent's later steps:

1,4	2,4	3,4	4,4
1,3 W!	2,3	3,3	4,3
1,2 A S OK	2,2	3,2	4,2
1,1 V OK	2,1 B V OK	3,1 P!	4,1

A = Agent
 B = Breeze
 G = Glitter, Gold
 OK = Safe square
 P = Pit
 S = Stench
 V = Visited
 W = Wumpus

(a)

1,4	2,4 P?	3,4	4,4
1,3 W!	2,3 A S G B	3,3 P?	4,3
1,2 S V OK	2,2 V OK	3,2	4,2
1,1 V OK	2,1 B V OK	3,1 P!	4,1

(b)

Agent's fourth step:

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.

Exploring Wumpus World

Agent's later steps:

1,4	2,4	3,4	4,4
1,3 W!	2,3	3,3	4,3
1,2 A S OK	2,2 OK	3,2	4,2
1,1 V OK	2,1 B V OK	3,1 P!	4,1

(a)

A = Agent
B = Breeze
G = Glitter, Gold
OK = Safe square
P = Pit
S = Stench
V = Visited
W = Wumpus

1,4	2,4 P?	3,4	4,4
1,3 W!	2,3 A S G B	3,3 P?	4,3
1,2 S V OK	2,2 V OK	3,2	4,2
1,1 V OK	2,1 B V OK	3,1 P!	4,1

(b)

Propositional Logic

- A very simple logic, here the statements are made by propositions.
- The propositional logic is also called as Boolean Logic.
- The sentence / statement is declarative, which is either true or false, but can not be both.
- Questions, opinion, and comma(,) are not allowed in propositional logic.
- E.g.
 - Students are studying in college (True Proposition)
 - $5 + 3 = 8$ (True Proposition)
 - `printf("Hello World")` (True Proposition)
 - $4 + 2 = 5$ (False Proposition)
 - What is your name? (not accepted / syntax error)
 - Some students are intelligent (Syntax Error because this declares both true / false)

Propositional Logic

- Syntax - defines the allowable sentences
- The atomic sentences- the individual syntactic elements-consist of a single proposition symbol.
- Each such symbol stands for a proposition that can be true or false.
- We will use uppercase names for symbols: P, Q, R, and so on.
- For example,
- $W_{1,3}$ stand for the proposition that the Wumpus is in [1,3].

Propositional Logic

- Complex sentences : constructed from simpler sentences using logical connectives (logical operators)
- $\neg$ (not) : called the negation, A literal is either an atomic sentence (a positive literal) or a negated atomic sentence (a negative literal).
- $\wedge$ (and) : A sentence whose main connective is called a conjunction; its parts are the conjuncts.
- $\vee$ (or) : a disjunction of the disjuncts
- $\Rightarrow$ (implies) : is called an implication (or conditional).
- $\Leftrightarrow$ (if and only if) : The sentence is a biconditional.

A Formal Grammar of Propositional Logic

- A BNF (Backus-Naur Form) grammar of sentences in propositional logic

$$\begin{aligned}
 \textit{Sentence} &\rightarrow \textit{AtomicSentence} \mid \textit{ComplexSentence} \\
 \textit{AtomicSentence} &\rightarrow \textit{True} \mid \textit{False} \mid P \mid Q \mid R \mid \dots \\
 \textit{ComplexSentence} &\rightarrow (\textit{Sentence}) \mid [\textit{Sentence}] \\
 &\mid \neg \textit{Sentence} \\
 &\mid \textit{Sentence} \wedge \textit{Sentence} \\
 &\mid \textit{Sentence} \vee \textit{Sentence} \\
 &\mid \textit{Sentence} \Rightarrow \textit{Sentence} \\
 &\mid \textit{Sentence} \Leftrightarrow \textit{Sentence}
 \end{aligned}$$

OPERATOR PRECEDENCE : $\neg, \wedge, \vee, \Rightarrow, \Leftrightarrow$

Figure 7.7 A BNF (Backus–Naur Form) grammar of sentences in propositional logic, along with operator precedences, from highest to lowest.

Propositional Logic -Semantics

- The semantics defines the rules for determining the truth of a sentence with respect to a particular model.
- In propositional logic, a model simply fixes the truth value - true or false - for every proposition symbol.
- $m_1 = (P_1, 2 = \text{false}, P_2, 2 = \text{false}, P_3, 1 = \text{true})$.

Truth Tables for the Five Logical Connectives

P	Q	$\neg P$	$P \wedge Q$	$P \vee Q$	$P \Rightarrow Q$	$P \Leftrightarrow Q$
<i>false</i>	<i>false</i>	<i>true</i>	<i>false</i>	<i>false</i>	<i>true</i>	<i>true</i>
<i>false</i>	<i>true</i>	<i>true</i>	<i>false</i>	<i>true</i>	<i>true</i>	<i>false</i>
<i>true</i>	<i>false</i>	<i>false</i>	<i>false</i>	<i>true</i>	<i>false</i>	<i>false</i>
<i>true</i>	<i>true</i>	<i>false</i>	<i>true</i>	<i>true</i>	<i>true</i>	<i>true</i>

Figure 7.8 Truth tables for the five logical connectives. To use the table to compute, for example, the value of $P \vee Q$ when P is true and Q is false, first look on the left for the row where P is *true* and Q is *false* (the third row). Then look in that row under the $P \vee Q$ column to see the result: *true*.



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