LU-10	**Wumpus world, Logic and Propositional logic**	**Period: 2**

LU Outcomes	**Level:**	A	**CO Number:**	2

1	Formulate PEAS for Wumpus world
2	Express any sentences using Propositional logic

Wumpus World Problem Statement

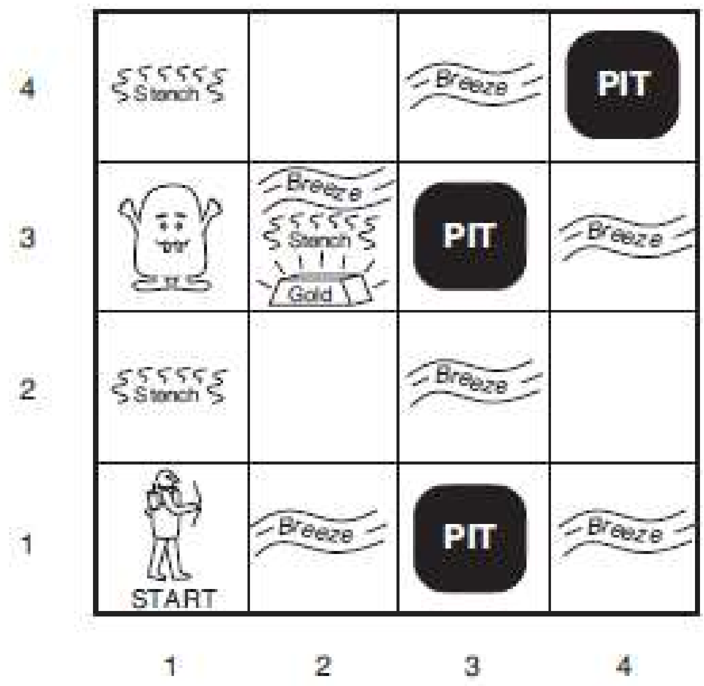

Figure 7.2 A typical wumpus world. The agent is in the bottom left corner, facing right.

PEAS of Wumbus world

Performance measure

Environment: A 4×4 grid of rooms. Each grid can have

- **Wumbus**
- **PIT**
- **Breeze Air**
- **Gold**

Actuator

Agent movements: Forward, Turn left, Turn Right, Grab, Shoot

Sensor: The agent has five sensors, each of which gives a single bit of information:

- In the square containing the wumpus and in the directly (not diagonally) adjacent squares, the agent will perceive a *Stench.*
- In the squares directly adjacent to a pit, the agent will perceive a *Breeze.*
- In the square where the gold is, the agent will perceive a *Glitter.*
- When an agent walks into a wall, it will perceive a *Bump.*
- When the wumpus is killed, it emits a woeful *Scream that can be perceived anywhere* in the cave.

Wumbus world Properties

- Partially observable
- Deterministic
- Sequential
- Static
- Discrete
- One agent

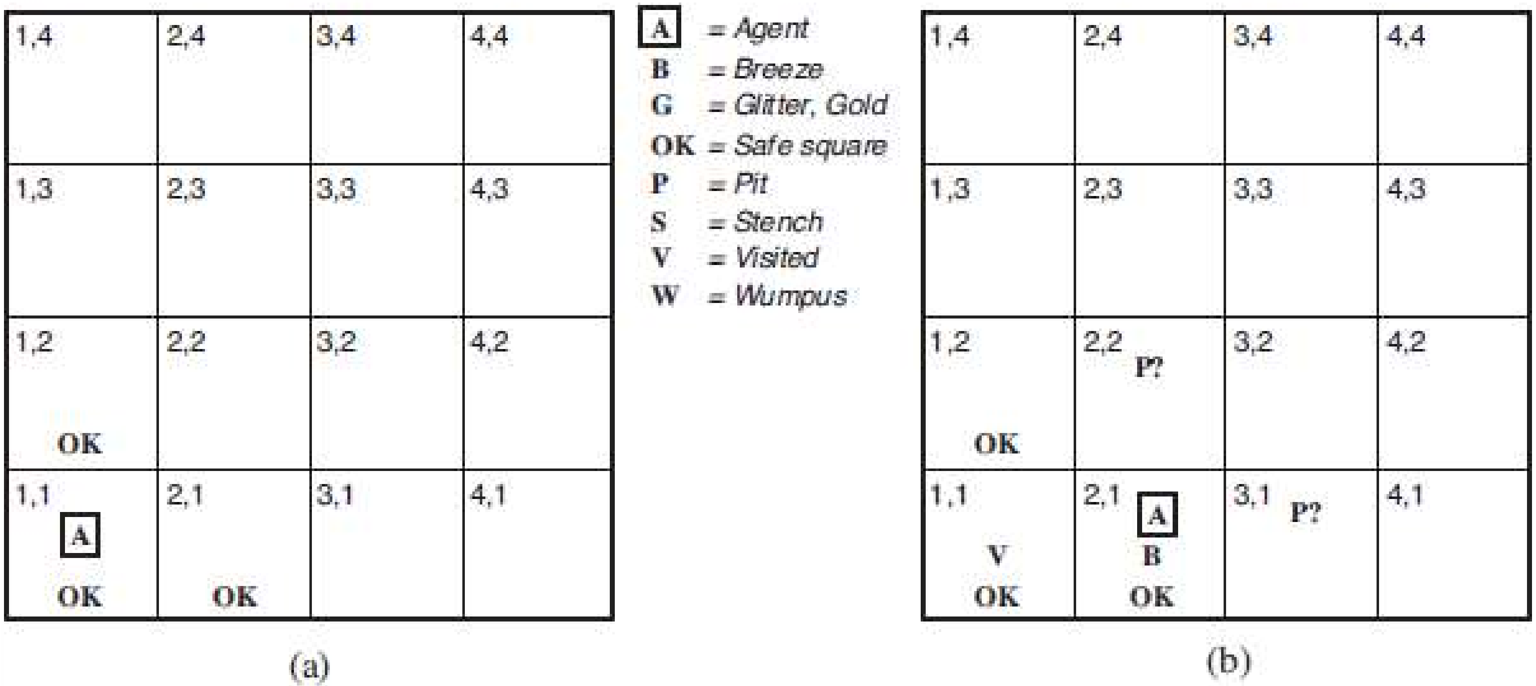

Figure 7.3 The first step taken by the agent in the wumpus world. (a) The initial situation, after percept $[None, None, None, None, None]$. (b) After one move, with percept $[None, Breeze, None, None, None]$.

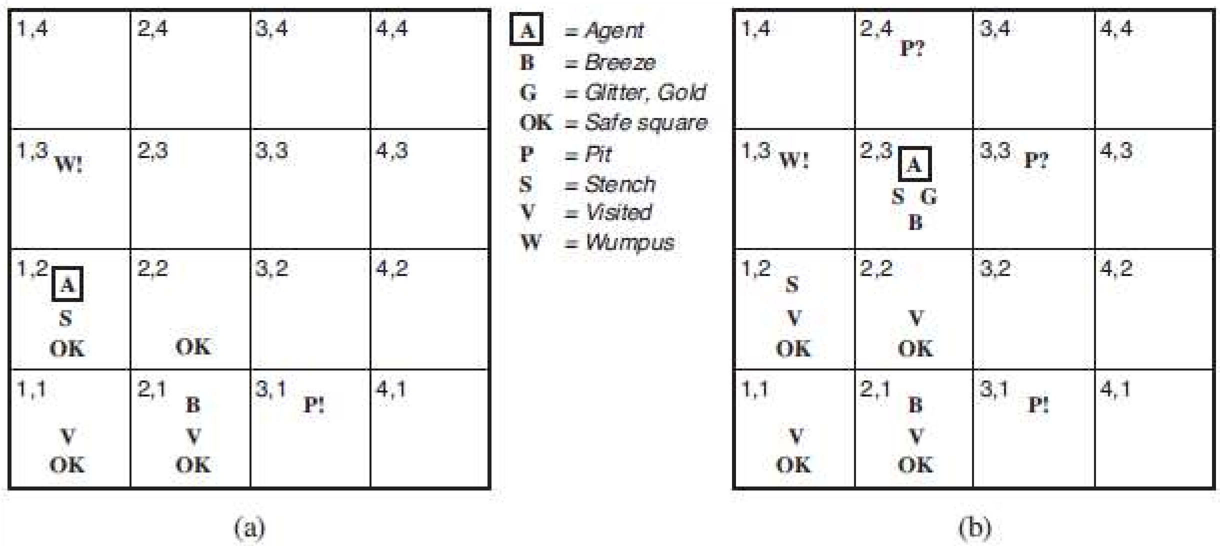

Figure 7.4 Two later stages in the progress of the agent. (a) After the third move, with percept $[Stench, None, None, None, None]$. (b) After the fifth move, with percept $[Stench, Breeze, Glitter, None, None]$.

Logic

- Knowledge bases consist of sentences.

- These sentences are expressed according to the syntax **of the representation language (If so it is well formed)**
- **Eg:** “x + y = 4” is a well-formed sentence, whereas “x4y+ =” is not.

Logic ..contd

- A logic must also define the **semantics** or **meaning** of sentences.
- The semantics defines the **truth** of each sentence with respect to each possible world
- In standard logics, every sentence must be either true or false there is no “in between”
- **Eg:** “x + y =4”
  - is **true** in a world where x is 2 and y is 2
  - but **false** in a world where x is 1 and y is 1.

Logic ..contd

- model is used in place of "possible world."
- **possible worlds** might be **real environments** that the agent might or might not be in whereas **models** are **mathematical abstractions.**
- If a sentence α is true in model m, we say that m **satisfies α or sometimes m is a model of α.**
- M(α) is the set of all models of α

Logical reasoning

- **Entailment** is the relation between sentences
- It is the idea that a sentence *follows logically from another sentence*
- $\alpha \models \beta$ is notation for α entails β

Π

Formal definition of **Entailment**

- $\alpha \models \beta$ if and only if, in every model in which α is true, β is also true

- i.e., $\alpha \models \beta$ if and only if $M(\alpha) \subseteq M(\beta)$

Logical reasoning

- The percepts, combined with the agent's knowledge of the rules of the wumpus world, constitute the **KB**
- Consider the situation where the agent has detected nothing in [1,1] and a breeze in [2,1].
- Each of the three squares [1,2], [2,2], and [3,1] might or might not contain a pit, so there are $2^3 = 8$ possible models

Logical reasoning

- KB is a set of sentences or as a single sentence that asserts all the individual sentences
- The KB is false in models that contradict what the agent knows
- **Eg:** The KB is false in any model in which [1,2] contains a pit, because there is no breeze in [1,1].
- In fact in just three models the KB is true

Logical reasoning

- Let us consider two possible conclusions:

  $\alpha 1$ = "There is no pit in [1,2]."

  $\alpha 2$ = "There is no pit in [2,2]."

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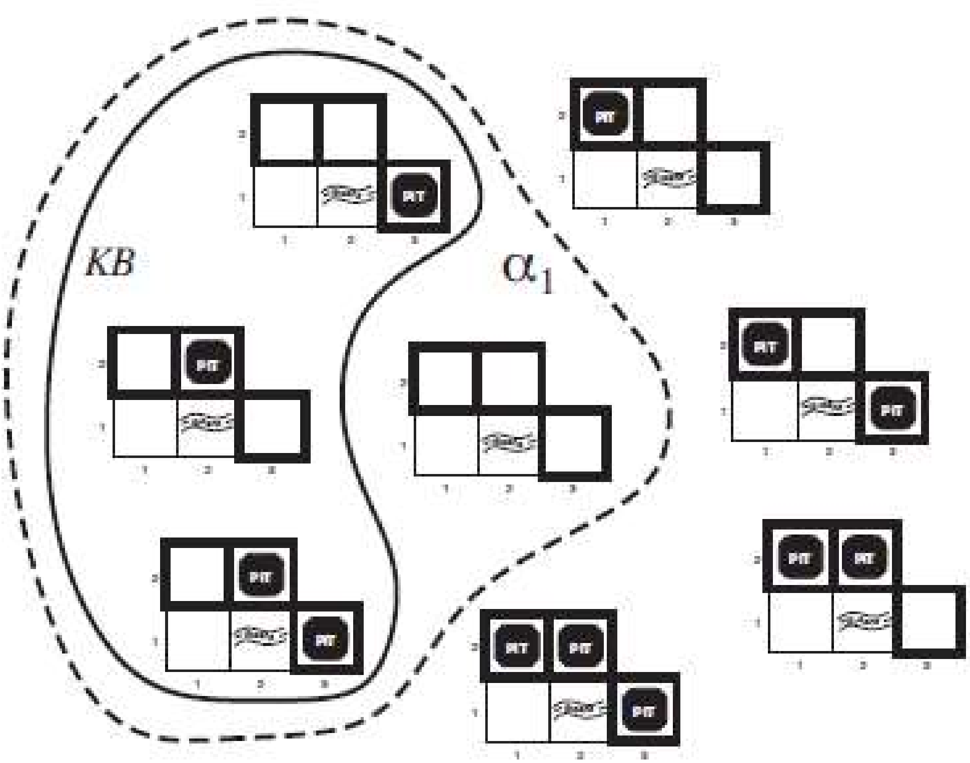
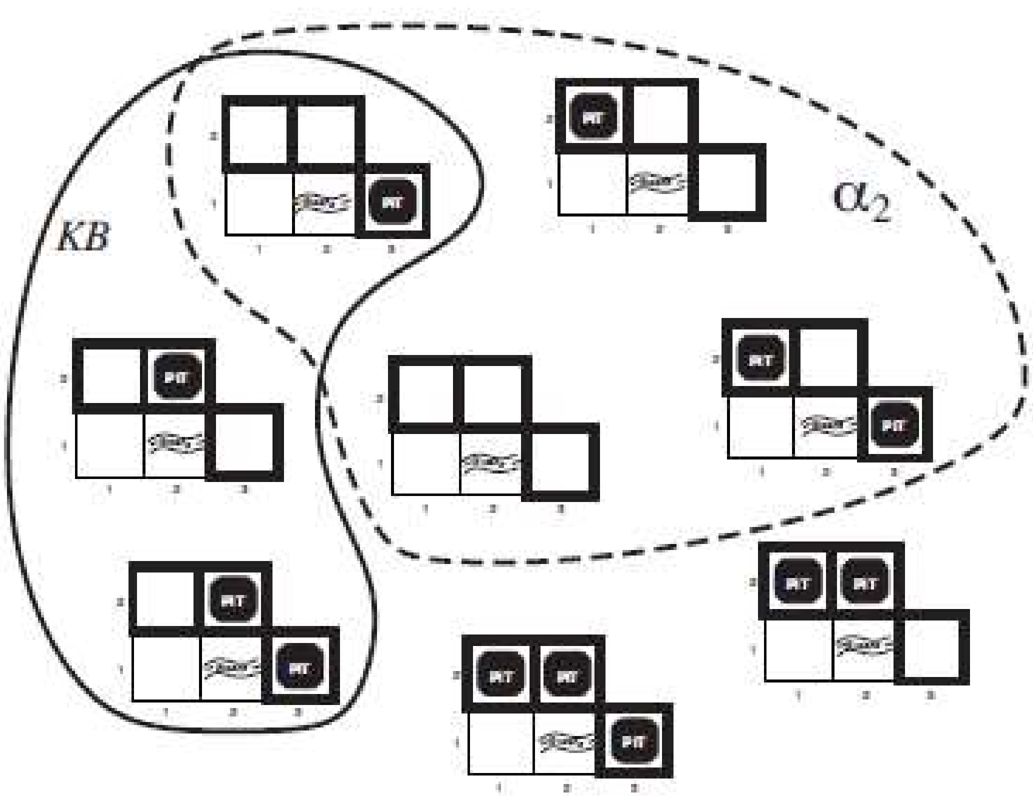
Logical reasoning



In every model in which KB is true, α1 is also true.

Hence, **KB |= α1**
(So there is no pit in [1,2])

Logical reasoning



In some models in which KB is true, α2 is false.

Hence, KB $\not\models$ α2

So the agent *cannot conclude that there is no pit in [2,2].*

Model Checking

- Entailment can be applied to derive LOGICAL INFERENCE conclusions—that is, to carry out **logical inference**
- Model checking enumerates all possible models to check that α is true in all models in which KB is true, i.e. **$M(KB) \subseteq M(\alpha)$**
- If an inference algorithm i can derive α from KB, we write

$$KB \models_i \alpha$$

Model Checking

- An inference algorithm that derives only entailed sentences is called **sound or truth preserving**
- An inference algorithm is **complete** if it can derive any sentence that is entailed.
- If an inference algorithm i can derive α from KB, we write

$$KB \models_i \alpha$$

Sl.No	Test Questions	Level
1	Write the grammar for propositional logic.	K1
2	Define entailment	K1
3	Define logical equivalence in propositional logic.	K1
4	Give the five logical connectives used to construct complex sentences and give the formal grammar of propositional logic.	K2
5	Express the following sentence in propositional logic. If not write the reason. *“Every mammal has a parent”*	K4
6	State and explain the Wumpus world problem	K2
7	Describe syntax and semantics of propositional logic	K2
8	Explain the enumeration algorithm for deciding propositional entailment	K2
	What is meant by truth preserving?	K1