



AUTOMATA, FORMAL LANGUAGES AND LOGIC

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MODULE 5

Propositional Logic & First-Order Logic

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Outline

Propositional logic - A very Simple Logic

- Syntax and Semantics
- A Simple Knowledge Base
- A Simple Inference Procedure

- ◆ Knowledge-based agents
- ◆ Wumpus world
- ◆ Logic in general—models and entailment

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Propositional Logic & First-Order Logic



Many
Others

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Propositional Logic & First-Order Logic



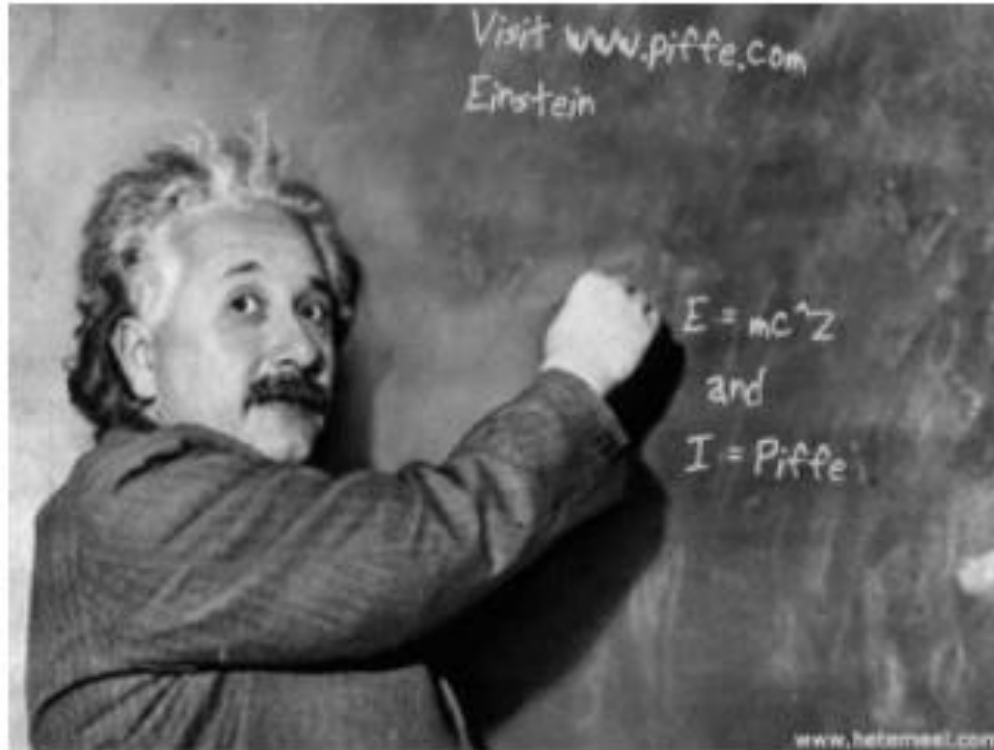
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Propositional Logic & First-Order Logic



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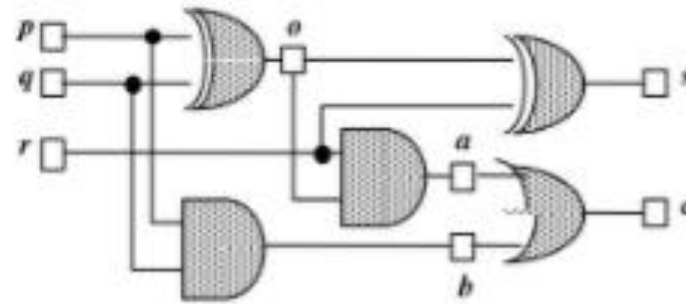
PROPOSITIONAL LOGIC

The propositional logic is a branch of logic that deals with the logical relationships between propositions. It is a formal system that allows us to represent and analyze logical arguments in a precise and systematic way.

Key concepts in propositional logic include:

- Propositions: Statements that can be either true or false.
- Connectives: Logical operators that combine propositions to form new propositions. The most common connectives are AND, OR, NOT, and IMPLIES.
- Truth Tables: A systematic way to determine the truth value of a compound proposition based on the truth values of its components.
- Logical Equivalence: Two propositions are logically equivalent if they have the same truth value in all possible scenarios.
- Normal Forms: A way to represent a proposition in a standard form, such as Disjunctive Normal Form (DNF) or Conjunctive Normal Form (CNF).

Propositional logic is a fundamental tool in computer science, particularly in the design of digital circuits and the verification of algorithms.



Knowledge

- “She threw a stone at mango & ran to catch it.”
 - What she ran to catch?
 - Is it stone or mango!!!
 - It is of course “MANGO” but how do you know??

Prior Knowledge



- Representing such knowledge is a tedious task!!

Knowledge & Reasoning plays a crucial role in handling **partially observable environment**.

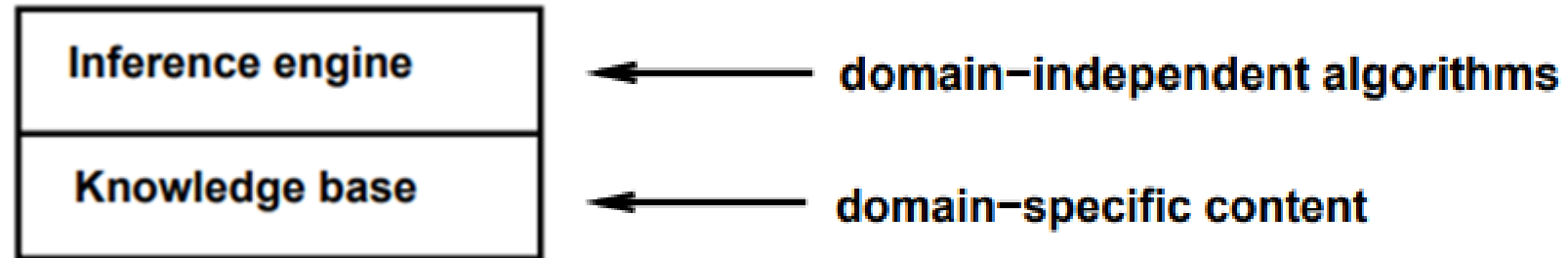
• Knowledge → Intelligence

Once acquired

Must be organized

- Knowledge based Agents work on LOGIC.
- LOGIC is used for representing Knowledge.
- Knowledge of Logical Agent is definite- a stmt/proposition/formula that has to be either true or False.

Knowledge Based Agent



Knowledge base = set of sentences in a **formal** language

- » Each sentence is expressed in a language called *knowledge Representation Language* and represent some assertion about the world.
- » Sentence is called *axiom* if the sentence is taken as given without being derived from other sentences.

Knowledge Base

- Sentence can be added to knowledge base or can be queried what is known, called **TELL** and **ASK**
- Both operations may involve **inference** – i.e. deriving a new sentence from old

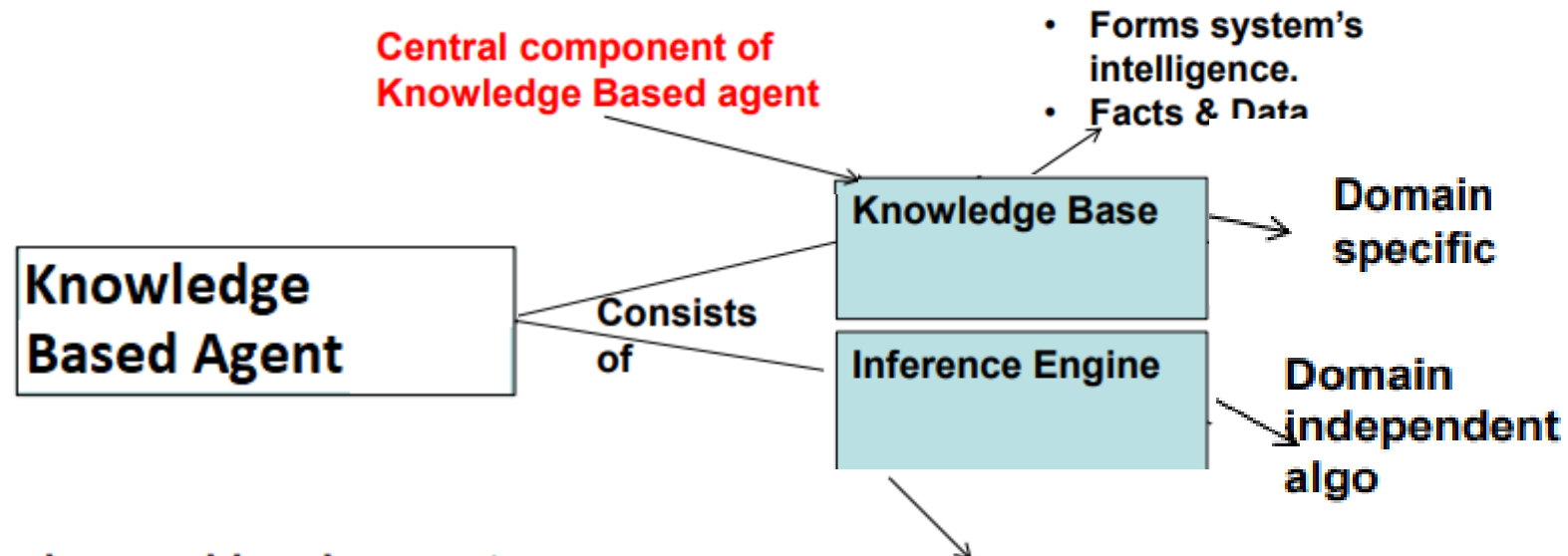
Each time the agent program is called, It does three things:-

1. It **TELLS** the knowledge base what it perceives.
2. It **ASKS** the knowledge base what action it should perform
3. The agent program **TELLS** the knowledge base which action was chosen and the agent executes the action.

Knowledge base agent takes a **percept** as input and returns an **action**, KB agent also maintains a KB which might contain some **background knowledge**.

Knowledge Based Agent

Central component of
Knowledge Based agent



- A KB can be considered as a set of sentences.
- Sentences in Knowledge representation Language.

- Chks the KB to ans questions or solve problems or make decisions within the problem domain

Knowledge Level / Representation

Declarative Approach

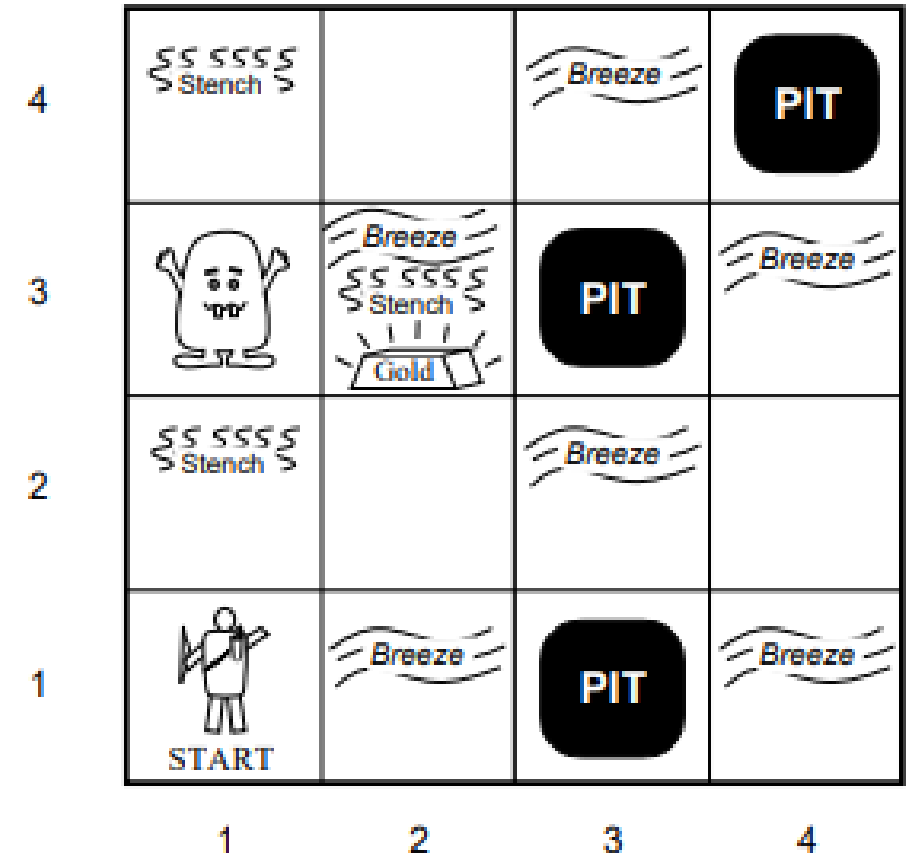
Procedural Approach

- **Declarative** approach to building an agent (or other system):
 - **Tell** it everything one by one, what it needs to know
- Then it can **Ask** itself what to do - answers should follow from the KB
- **Procedural Approach** at the **implementation level**
 - i.e., data structures in KB and algorithms that manipulate them

Wumpus World

The Wumpus world is a cave consisting of rooms connected by passageways.

- Lurking somewhere in the cave is the terrible Wumpus, a **beast** that eats anyone who enters in the room*



Wumpus World Description

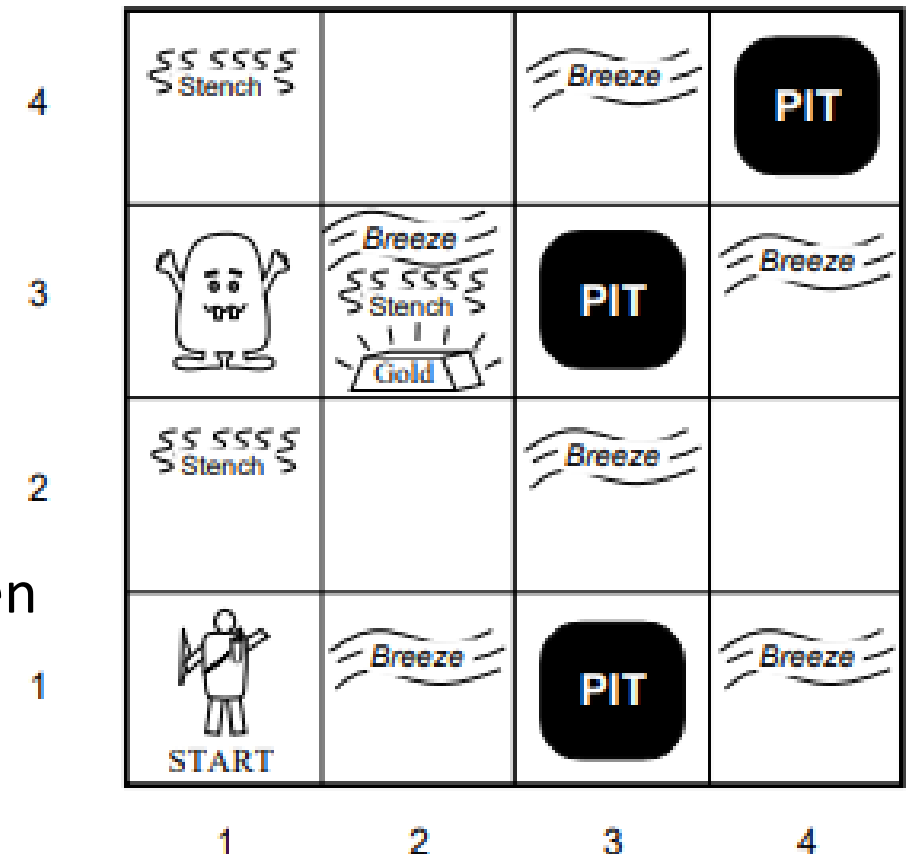
The game ends when the agent dies or climbs out of the cave

- Environment

- A 4X4 grid of rooms. The agent always starts in the square labeled [1,1], facing to the right.

The location of the gold and the wumpus are chosen randomly

The main objective is to find a **heap of gold.**

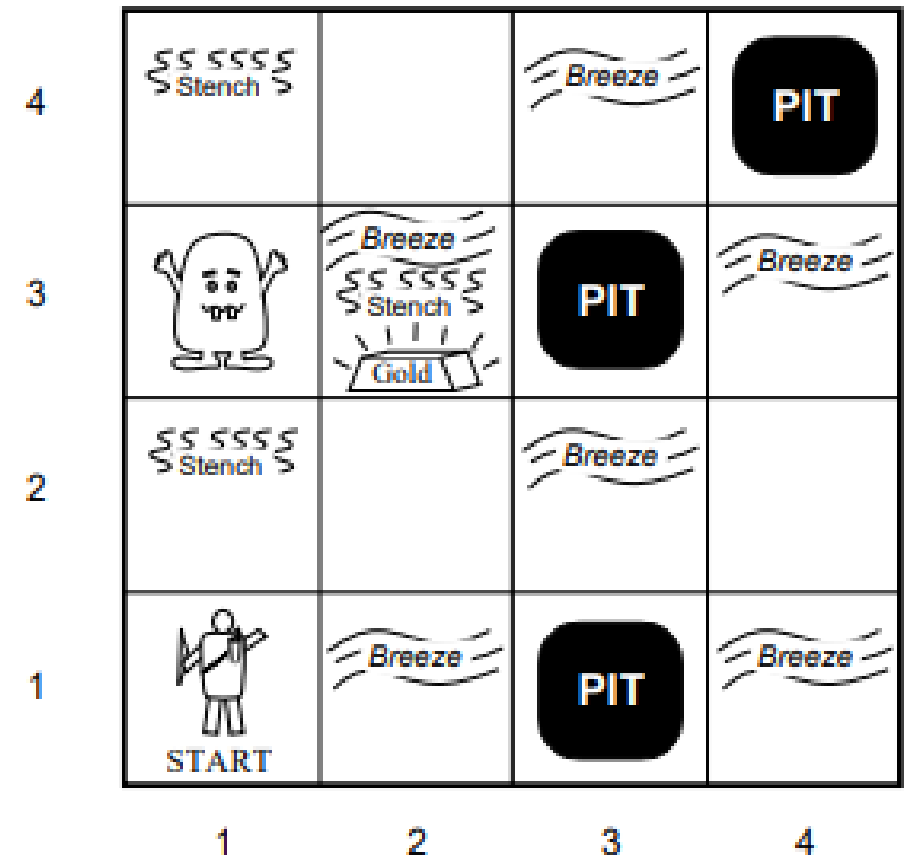


Wumpus World Description

- Actuators:

- Left turn, Right turn, Forward, Grab, Shoot, Climb

- Grab can be used to pick up the gold
 - Shoot is used to fire an arrow
 - Climb is used to climb out of the cave.

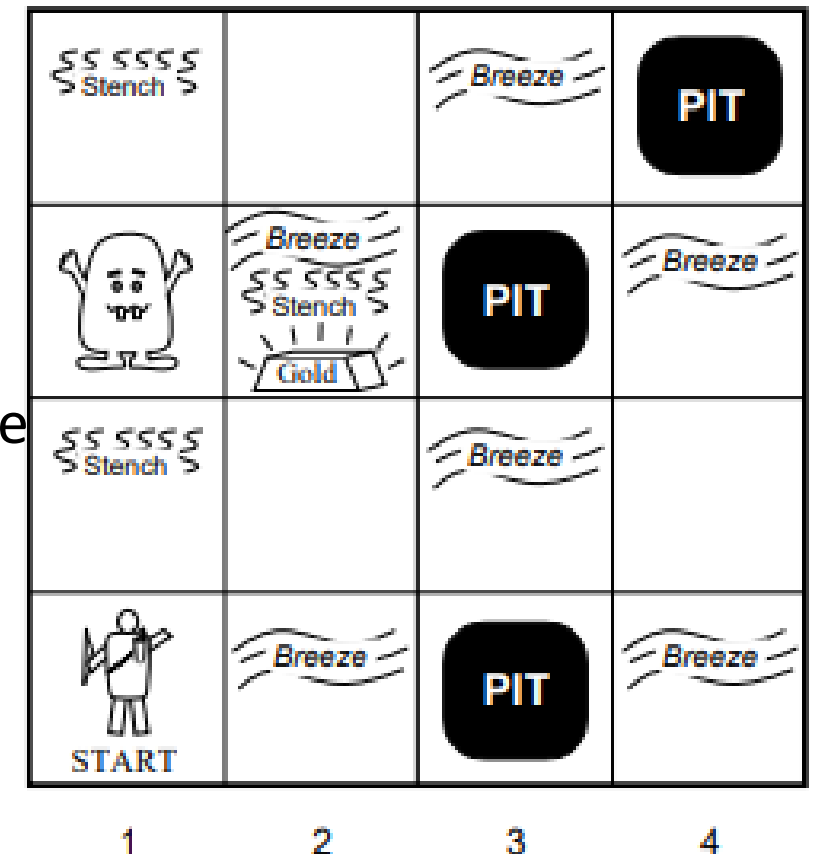


Wumpus World Description

- **Sensors:**












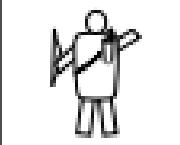



- Stench, Breeze, Glitter, Bump, Scream

- ➔ In the square containing the Wumpus and in the directly (not diagonal) adjacent squares, the agent will perceive a **Stench**,₃
- ➔ In the square directly adjacent to a pit, the agent will perceive a **Breeze**.₂
- ➔ 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**.₁
- ➔ When the Wumpus is killed, it emits a woeful **Scream** that can be perceived any-where in the cave.














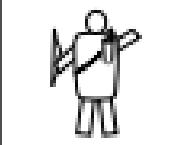



Exploring a Wumpus World

OK 1,2			
OK A 1,1	OK 2,1		

4	 Stench		 Breeze	
3		 Breeze  Stench  Gold		 Breeze
2	 Stench		 Breeze	
1	 START	 Breeze		 Breeze
	1	2	3	4
















Exploring a Wumpus World

1,4	2,4	3,4	4,4
1,3	2,3	3,3	4,3
1,2	2,2	3,2	4,2
OK			
1,1	2,1	3,1	4,1
V	A		
OK	B		
OK	OK		

4	 Stench		 Breeze	
3		 Breeze  Stench  Gold		 Breeze
2	 Stench		 Breeze	
1	 START	 Breeze		 Breeze
	1	2	3	4











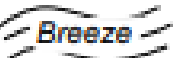




Exploring a Wumpus World

1,4	2,4	3,4	4,4
1,3	2,3	3,3	4,3
1,2	2,2 P?	3,2	4,2
1,1	2,1 A B OK	3,1 P?	4,1

4	 Stench		 Breeze	 PIT
3		 Breeze  Stench  Gold	 PIT	 Breeze
2	 Stench		 Breeze	
1	 START	 Breeze	 PIT	 Breeze
	1	2	3	4












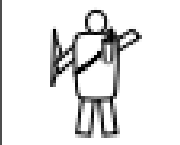



Exploring a Wumpus World

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

4	 Stench		 Breeze	
3		 Breeze  Stench  Gold		 Breeze
2	 Stench		 Breeze	
1	 START	 Breeze		 Breeze
	1	2	3	4












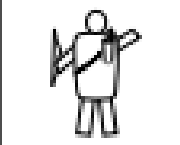



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1,4	2,4	3,4	4,4
1,3 W!	2,3	3,3	4,3
1,2 A S OK	2,2 OK	3,2	4,2
1,1 W V OK	2,1 B V OK	3,1 P!	4,1

4	 Stench		 Breeze	
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1	 START	 Breeze		 Breeze
	1	2	3	4












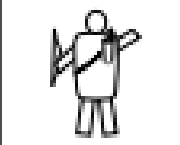



Exploring a Wumpus World

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

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Exploring a Wumpus World

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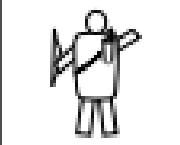



Exploring a Wumpus World

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

4	Stench	Breeze	PIT
3	Wumpus	Breeze Stench Gold	PIT Breeze
2	Stench	Breeze	
1	START	Breeze	PIT Breeze
	1	2	3 4


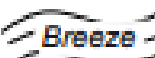









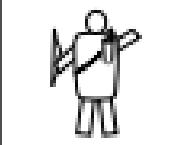



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1,2 S OK	2,2 A OK	3,2	4,2
1,1 V OK	2,1 B V OK	3,1 P!	4,1

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Exploring a Wumpus World

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

4	 Stench		 Breeze	
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	1	2	3	4



THANK YOU

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