



# AUTOMATA, FORMAL LANGUAGES AND LOGIC

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# AUTOMATA, FORMAL LANGUAGES AND LOGIC

## MODULE 5

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### 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

# AUTOMATA, FORMAL LANGUAGES AND LOGIC

## Propositional Logic & First-Order Logic

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Many  
Others

# AUTOMATA, FORMAL LANGUAGES AND LOGIC

## Propositional Logic & First-Order Logic

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# AUTOMATA, FORMAL LANGUAGES AND LOGIC

## Propositional Logic & First-Order Logic

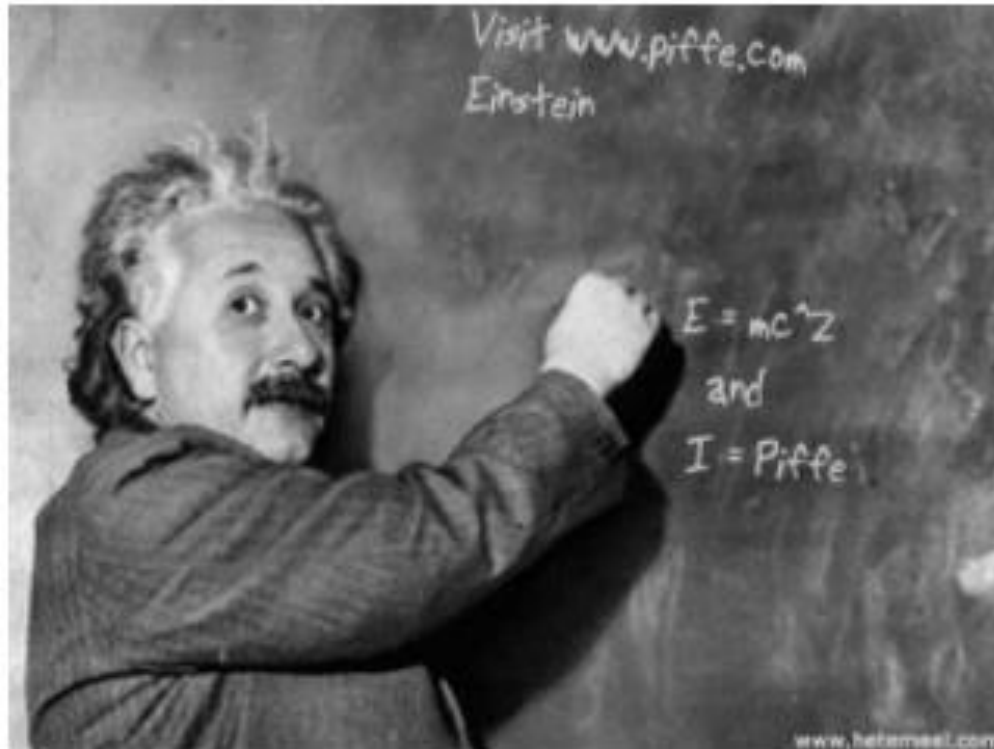
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# AUTOMATA, FORMAL LANGUAGES AND LOGIC

## Propositional Logic & First-Order Logic

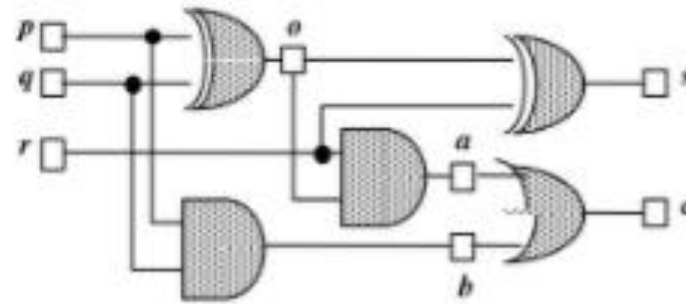
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# AUTOMATA, FORMAL LANGUAGES AND LOGIC

## Propositional Logic & First-Order Logic

PROPOSITIONAL LOGIC  
The propositional logic is a branch of logic that deals with the logical relationships between propositions. It is a formal system that uses symbols to represent propositions and logical connectives to combine them. The basic symbols used in propositional logic are propositional variables (usually denoted by letters like  $p, q, r$ ) and logical connectives (usually denoted by symbols like  $\neg$  for negation,  $\wedge$  for conjunction,  $\vee$  for disjunction,  $\rightarrow$  for implication, and  $\leftrightarrow$  for biconditional). The rules of propositional logic are used to derive new propositions from existing ones. The main result of propositional logic is the truth table, which is a table that lists all possible combinations of truth values for the propositional variables and the corresponding truth value of the proposition. The truth table is used to determine the validity of a logical argument.





## 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**.

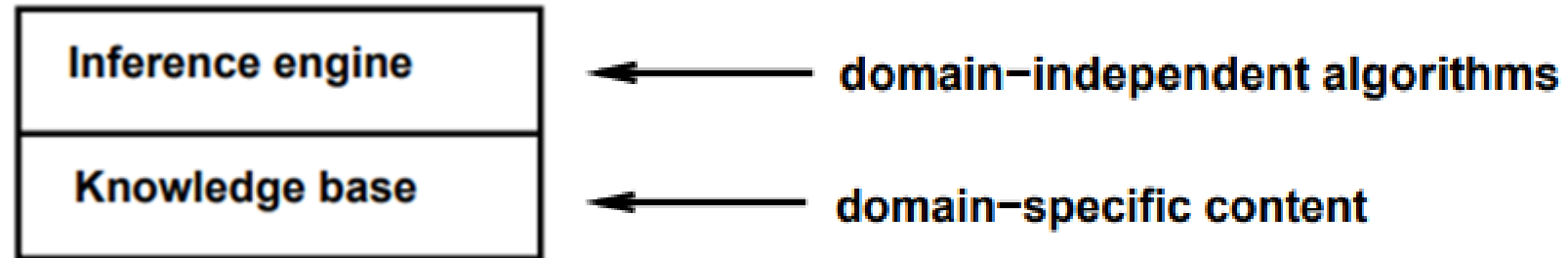
• Knowledge → Intelligence

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

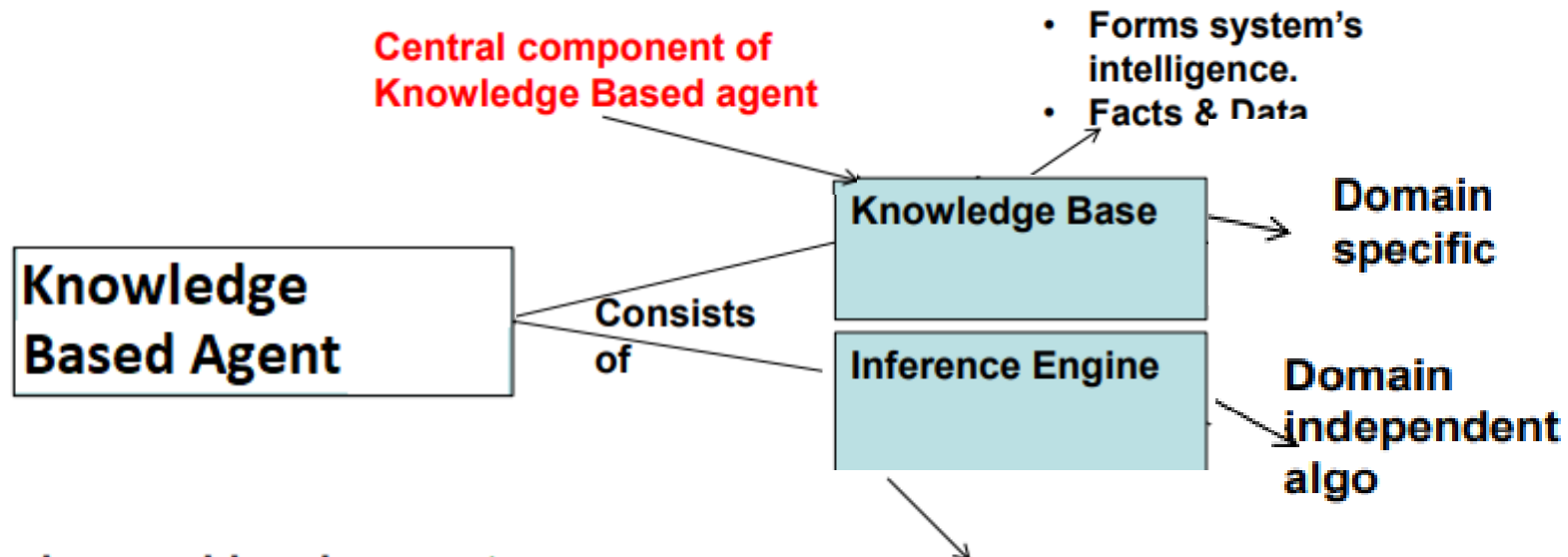
Each time the agent program is called, It does three things:-

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

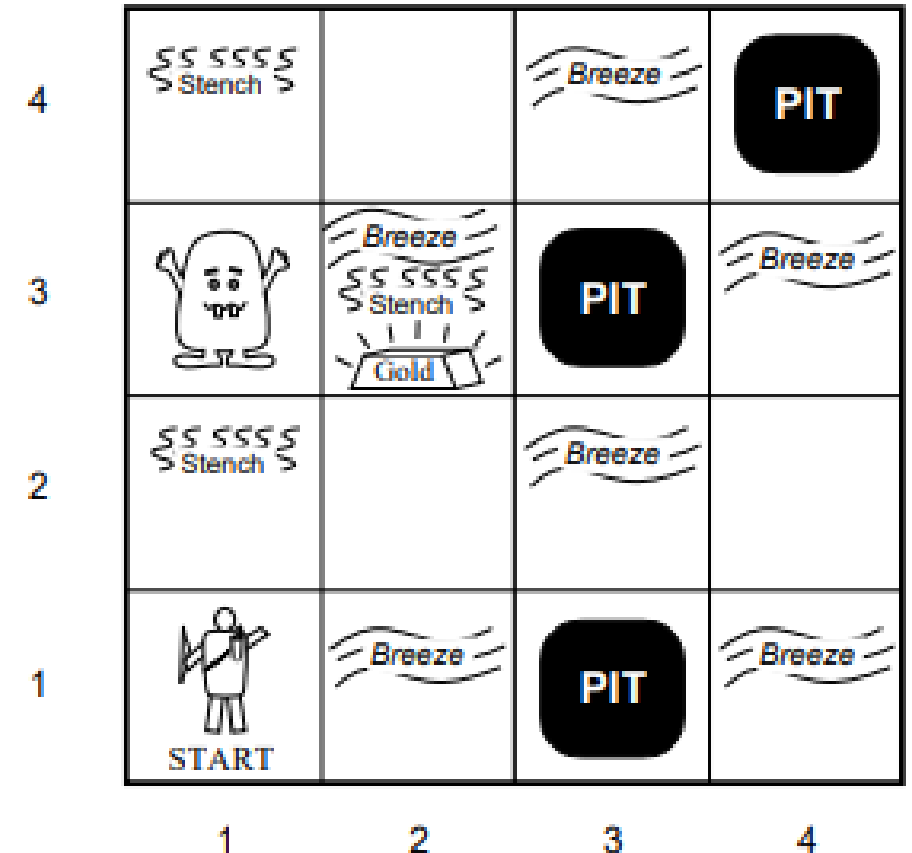
Procedural Approach

- **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







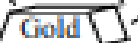








The game ends when the agent dies or climbs out of the cave

- **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.**

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

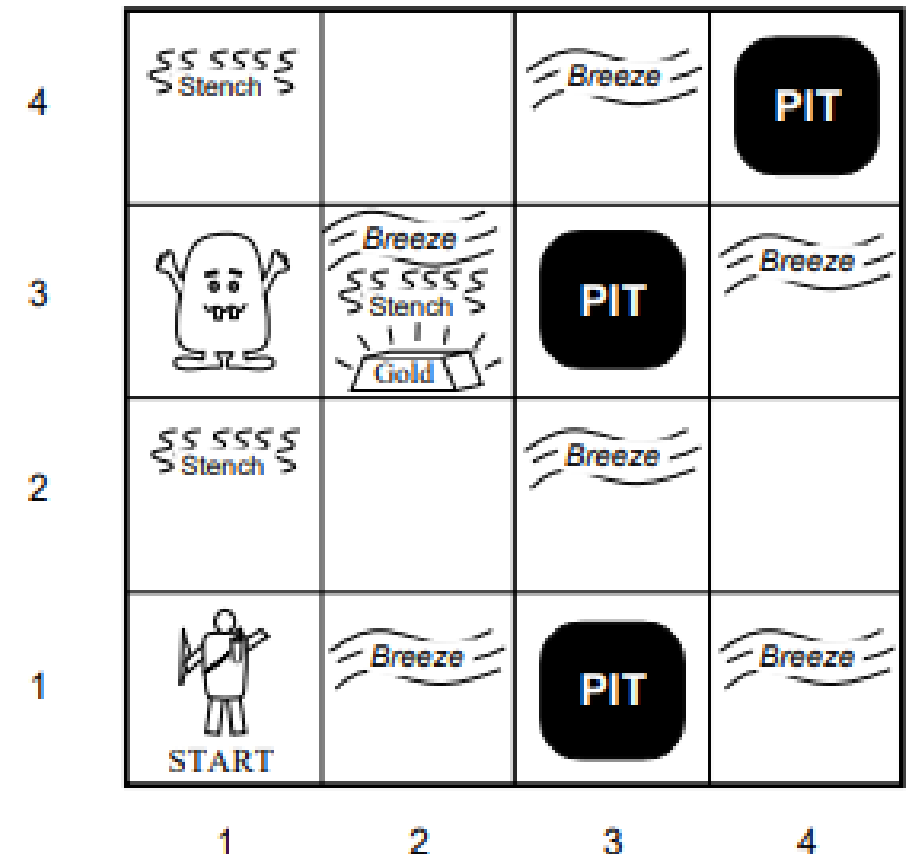


## Wumpus World Description

- 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.

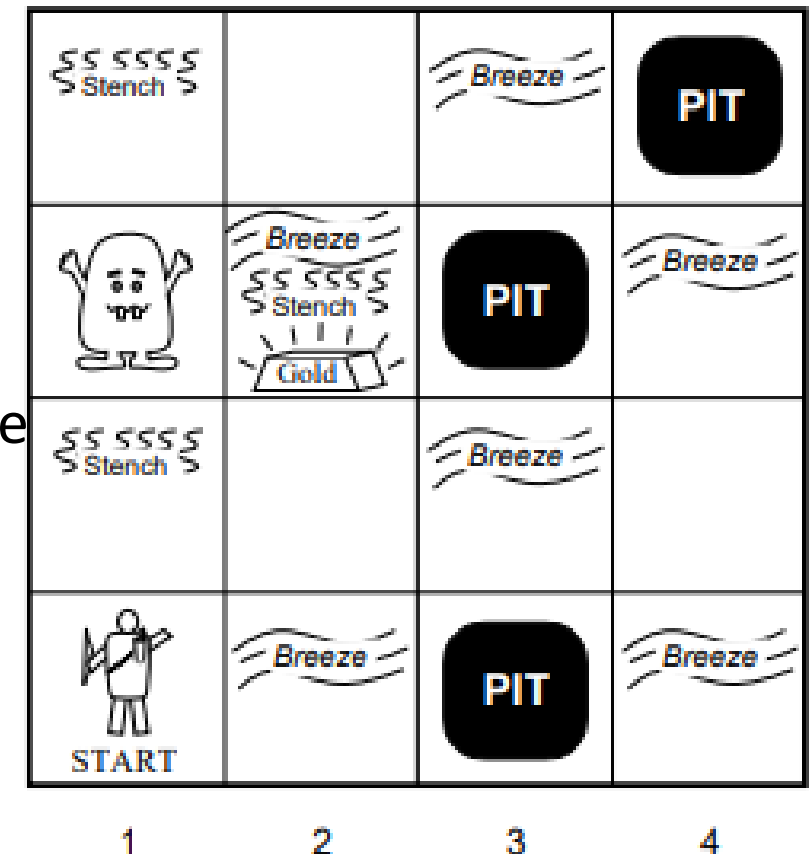


## Wumpus World Description

- **Sensors:**












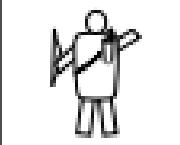



- Stench, Breeze, Glitter, Bump, Scream

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














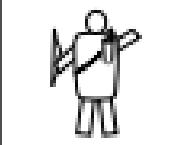



# Exploring a Wumpus World

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












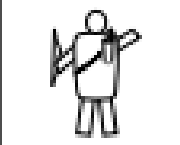



# Exploring a Wumpus World

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

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





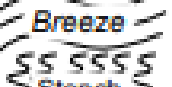










# Exploring a Wumpus World

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












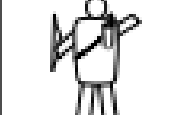



# Exploring a Wumpus World

1,4	2,4	3,4	4,4
1,3 W!	2,3	3,3	4,3
1,2 <div>A</div> 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
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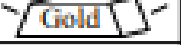




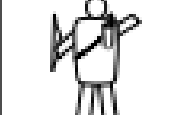



# Exploring a Wumpus World

1,4	2,4	3,4	4,4
1,3 W!	2,3	3,3	4,3
1,2 A S OK	2,2  OK	3,2	4,2
1,1 <del>W</del> <del>V</del> OK	2,1 B V OK	3,1 P!	4,1

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

# Exploring a Wumpus World












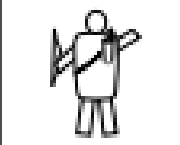



1,4	2,4	3,4	4,4
1,3 W!	2,3	3,3	4,3
1,2 A S OK	<del>2,2 W OK</del>	3,2	4,2
<del>1,1 W Y OK</del>	2,1 B V OK	3,1 P!	4,1

4	 Stench		 Breeze	
3		 Breeze  Stench  Gold		 Breeze
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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	<del>2,2 W P OK</del>	3,2	4,2
<del>1,1 W V OK</del>	2,1 B V OK	3,1 P!	4,1

4	 Stench		 Breeze	
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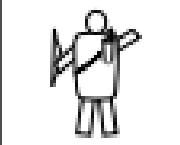



# Exploring a Wumpus World

1,4	2,4	3,4	4,4
1,3 W!	2,3	3,3	4,3
1,2 A S OK	<del>2,2 W P OK</del>	3,2	4,2
<del>1,1 W V OK</del>	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


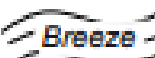









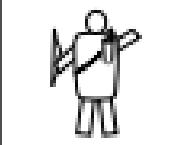



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1,3 W!	2,3	3,3	4,3
1,2 S OK	2,2 A OK	3,2	4,2
1,1 V OK	2,1 B V OK	3,1 P!	4,1

4	 Stench		 Breeze	
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	1	2	3	4

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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2	 Stench		 Breeze	
1	 START	 Breeze		 Breeze
	1	2	3	4



# THANK YOU

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