

# Artificial Intelligence Foundation – JC3001

## Lecture 16: Logic Agents I

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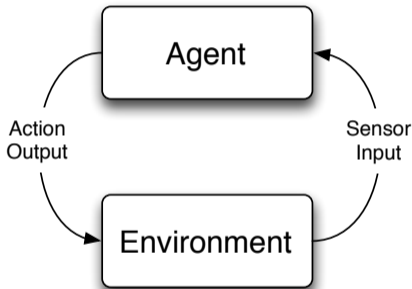
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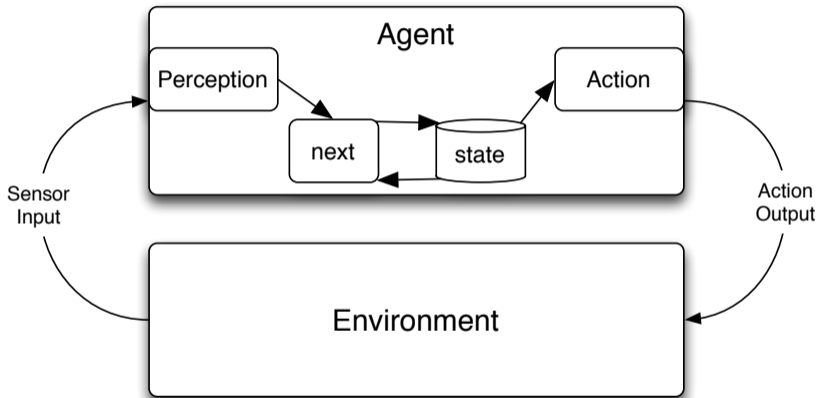
Material adapted from:  
Russell and Norvig (AIMA Book): Chapters 7 and 9

- Part 1: Introduction
  - ① Introduction to AI ✓
  - ② Agents ✓
- Part 2: Problem-solving
  - ① Search 1: Uninformed Search ✓
  - ② Search 2: Heuristic Search ✓
  - ③ Search 3: Local Search
  - ④ Search 4: Adversarial Search ✓
- Part 3: Reasoning and Uncertainty
  - ① Reasoning 1: Constraint Satisfaction ✓
  - ② **Reasoning 2: Logic and Inference**
  - ③ Probabilistic Reasoning 1: BNs
  - ④ Probabilistic Reasoning 2: HMMs
- Part 4: Planning
  - ① Planning 1: Intro and Formalism
  - ② Planning 2: Algos and Heuristics
  - ③ Planning 3: Hierarchical Planning
  - ④ Planning 4: Stochastic Planning
- Part 5: Learning
  - ① Learning 1: Intro to ML
  - ② Learning 2: Regression
  - ③ Learning 3: Neural Networks
  - ④ Learning 4: Reinforcement Learning
- Part 6: Conclusion
  - ① Ethical Issues in AI
  - ② Conclusions and Discussion

- Knowledge-based agents
- Logic - models and entailment
- Propositional and Lifted Inference
  - Resolution
  - Forward and Backward Chaining

- The main point about agents is they are **autonomous**: capable of acting independently, exhibiting control over their internal state
- Thus: an agent is a computer system capable of autonomous action in some environment in order to meet its design objectives





- These agents have some internal data structure, which is typically used to record information about the environment state and history. Let  $I$  be the set of all internal states of the agent.
- The perception function  $see$  for a state-based agent is unchanged:

$$see : E \mapsto Per$$

The action-selection function  $action$  is now defined as a mapping

$$action : I \mapsto A$$

from internal states to actions. An additional function  $next$  is introduced, which maps an internal state and percept to an internal state:

$$next : I \mapsto Per \mapsto I$$

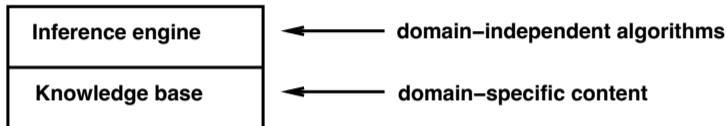


# Outline

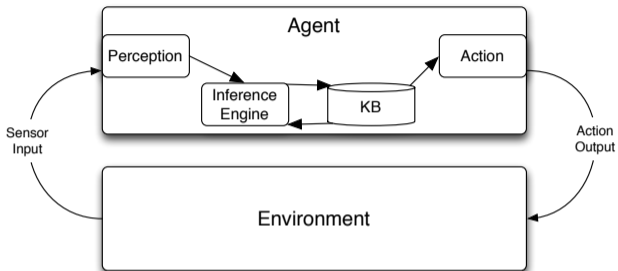
## 2 Knowledge-based Agents

► Knowledge-based Agents

► Wumpus World



- **Knowledge base** is a set of **sentences** in a **formal** language
- Declarative approach to building an agent:
  - **Tell** it what it needs to know
  - So it can **Ask** itself what to do (answers should follow)



- **Knowledge base** is a set of **sentences** in a **formal** language
- Agents can be viewed:
  - At the **knowledge level** (what they know, regardless of implementation); or
  - At the **implementation level** (data structures in the KB and algorithms that manipulate them)

# A simple knowledge-based agent

## 2 Knowledge-based Agents

**function** KBAgent(*percept*)

**static:** *KB*

*t* ▷ //a counter, initially 0, indicating time

tell(*KB*, makePerceptSentence(*percept*), *t*)

*action* ← ask(*KB*, makeActionQuery(*t*))

tell(*KB*, makeActionSentence(*action*), *t*)

*t* ← *t* + 1

**return** *action*

- The agent must be able to:
  - Represent states, actions etc
  - Incorporate new percepts
  - Update internal representations of the world
  - Deduce hidden properties of the world
  - Deduce appropriate actions



# Outline

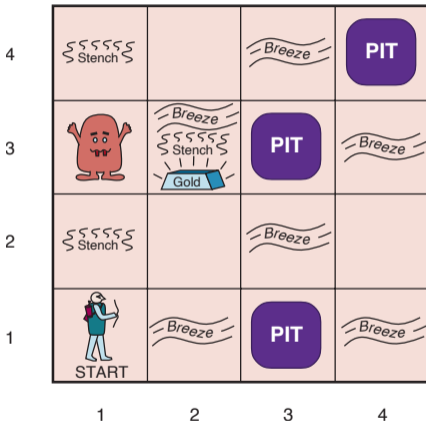
## 3 Wumpus World

► Knowledge-based Agents

► Wumpus World

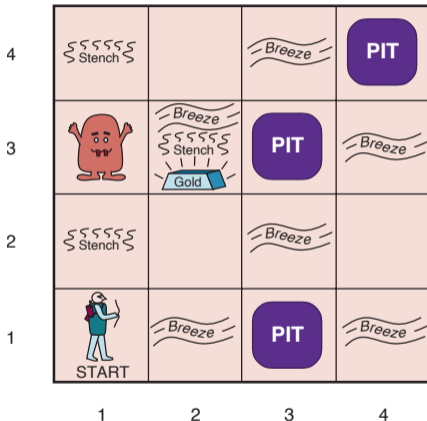
- Performance Measure

- gold = 1000
- death = -1000
- step = -1
- arrow = -10



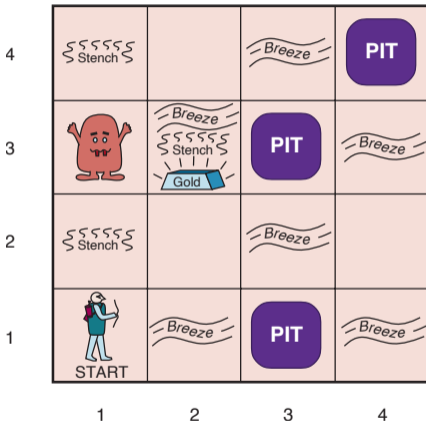
### • Environment

- Squares adjacent to wumpus have a **stench**
- Squares adjacent to pits are **breezy**
- Square where gold is **glitters**
- **Shooting** kills wumpus if you are facing it (only one arrow, though)
- **Grabbing** picks up gold if in same square



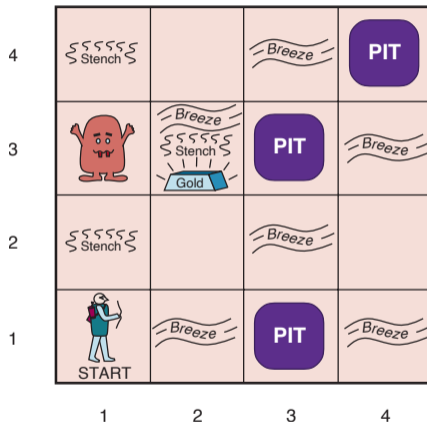
### Actuators

- Left turn (90°)
- Right turn (90°)
- Forward
- Grab
- Shoot (only once)
- Climb



### • Sensors

- Stench
- Breeze
- Glitter
- Bump
- Scream



# Wumpus World Characterisation

## 3 Wumpus World

- Observable?
- Deterministic?
- Static?
- Discrete?
- Single-agent?

- Observable? No - only local perception
- Deterministic? Yes - outcomes exactly specified
- Static? Yes - Wumpus and Pits do not move
- Discrete? Yes
- Single-agent? Yes - Wumpus essentially a natural feature

1,4	2,4	3,4	4,4
1,3	2,3	3,3	4,3
1,2  <b>OK</b>	2,2	3,2	4,2
1,1 <b>A</b> <b>OK</b>	2,1  <b>OK</b>	3,1	4,1

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

### Percepts

[None, None, None, None, None]

1,4	2,4	3,4	4,4
1,3	2,3	3,3	4,3
1,2 OK	2,2	3,2	4,2
1,1 A OK	2,1 OK	3,1	4,1

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

### Percepts

[None, None, None, None, None]

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

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

### Percepts

[None, Breeze, None, None, None]

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

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

### Percepts

[Stench, None, None, None, None]

1,4	2,4 P?	3,4	4,4
1,3 W!	2,3 <b>A</b> 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

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

### Percepts

[Stench, Breeze, Glitter, None, None]

To continue in the next session.