

Artificial Intelligence Foundation - JC3001

Lecture 16: Logic Agents I

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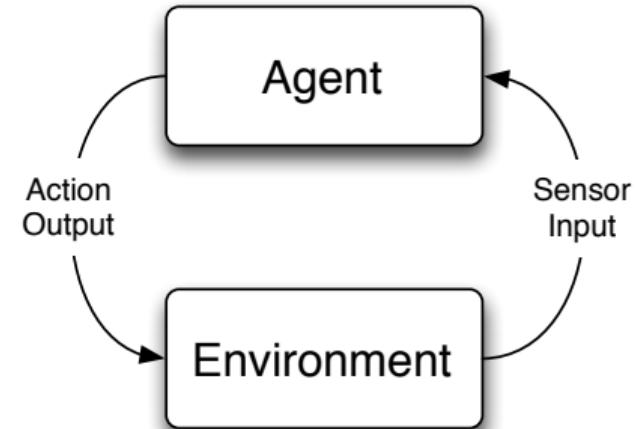


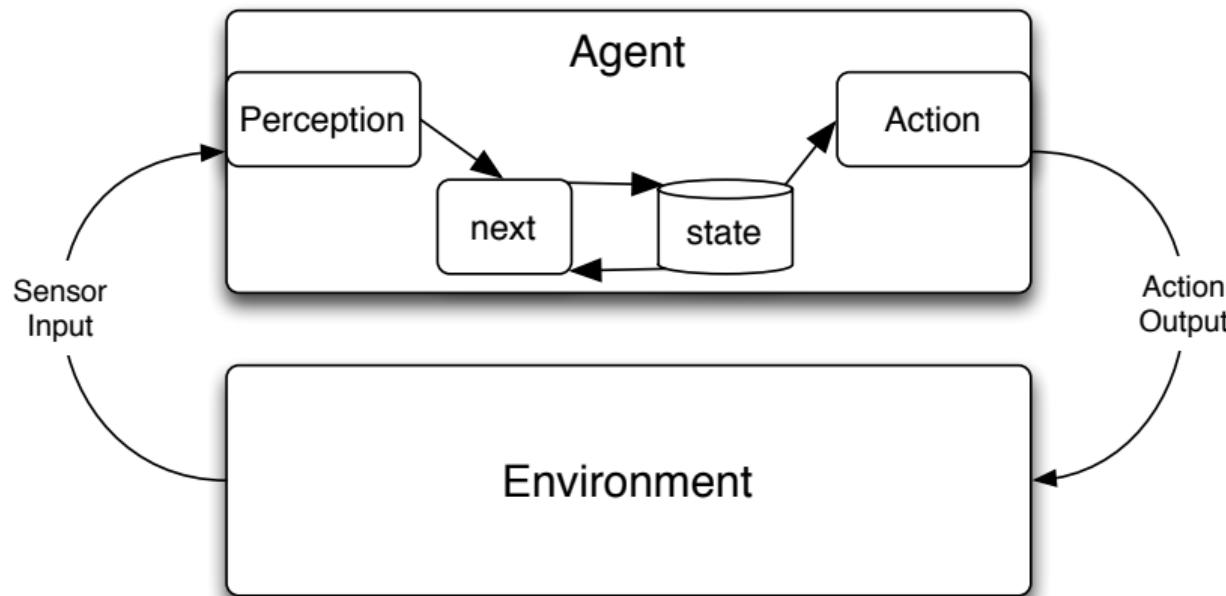
Material adapted from:
Russell and Norvig (AIMA Book): Chapters 7 and 9

- 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:

$$\text{see} : E \mapsto \text{Per}$$

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

$$\text{action} : I \mapsto A$$

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

$$\text{next} : I \mapsto \text{Per} \mapsto I$$

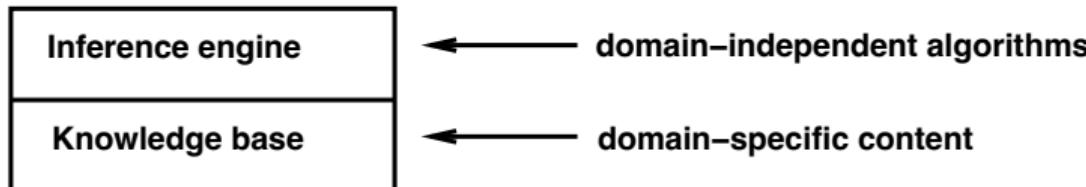


Outline

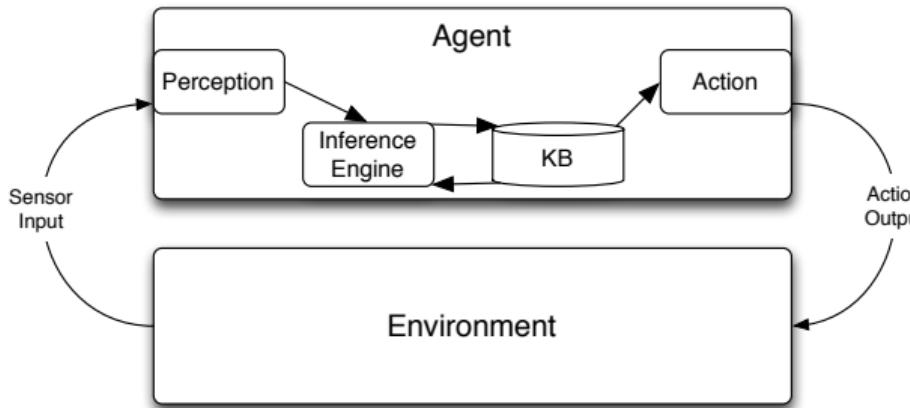
2 Knowledge-based Agents

► Knowledge-based Agents

► Wumpus World



- **Knowledge base** is a set of **s**entences in a **f**ormal 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)

```
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



- ▶ Knowledge-based Agents
- ▶ Wumpus World



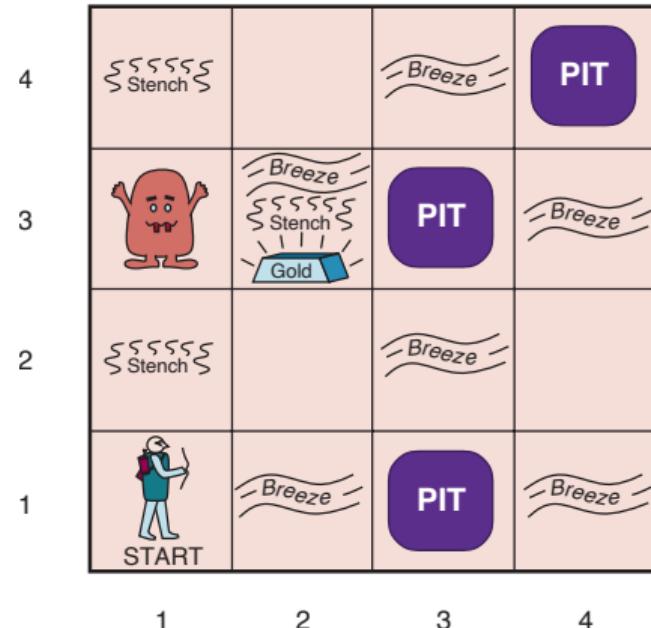
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Wumpus World

3 Wumpus World

- **Performance Measure**

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





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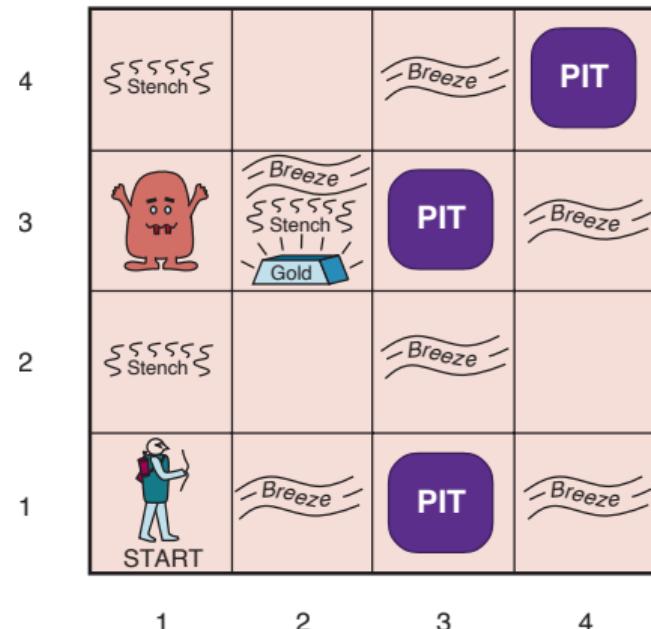


Wumpus World

3 Wumpus World

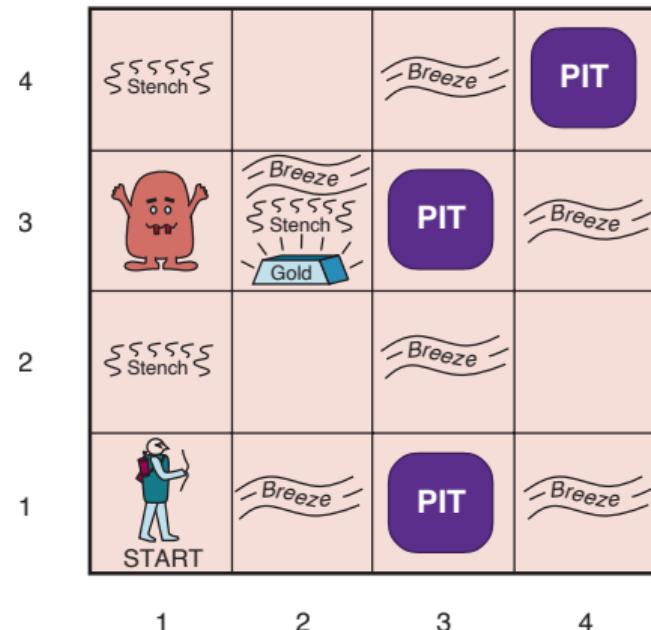
- Environment

- 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

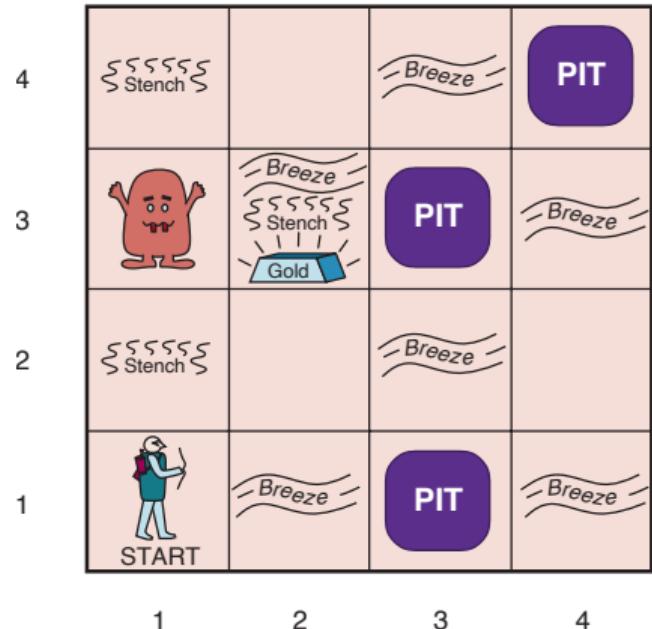


- Actuators

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



- Sensors
 - Stench
 - Breeze
 - Glitter
 - Bump
 - Scream



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

- 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 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

Percepts
 [Stench, None, None, None, None]

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

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

Percepts
 [Stench, Breeze, Glitter, None, None]



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To continue in the next session.