

# CSCI 5582 Artificial Intelligence

Lecture 8  
Jim Martin

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## Today 9/26

- Review
- Knowledge-Based Agents
- Break
- Propositional logic

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## Review

- We studied search because it facilitates the creation of agents that can reason about hypothetical (future) states of the world.
- But... we haven't said much of anything about how those states should be represented.
- Or about how these future (successor) states can be generated from current states

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## Knowledge-Based Agents

- A knowledge-base is simply a repository of things you know represented in some useful way.
- A knowledge-based agent is one that chooses its actions at least in part on the basis of the contents of its knowledge-base.

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## Knowledge Representation

- A knowledge representation is a formal scheme that dictates how an agent is going to represent its knowledge.
  - Syntax: Rules that determine the possible strings in the language.
  - Semantics: Rules that determine a mapping from sentences in the representation to some particular state of affairs.

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## Reasoning

- The knowledge base can't be a simple table.
  - It has to be set up so that an agent can conclude facts about the world **that are not already represented** in the knowledge base.
  - In other words, it has to reason about unseen worlds

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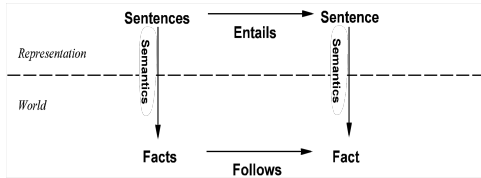
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## Reasoning



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## Wumpus World Description

- Percepts: *Breeze, Glitter, Smell*
- Actions: *Left, Right, Forward, Back, Shoot, Grab, Release*
- Goals: *Get the gold, get back to the start, (avoiding the Wumpus, and the pits).*

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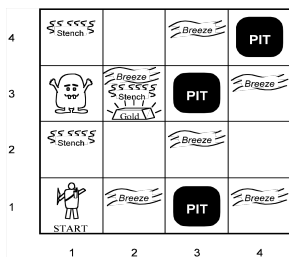
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## Wumpus World



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## Wumpus World

- Environment
  - One Wumpus
  - One or more pits
  - Squares adjacent to pits have a breeze
  - Squares adjacent to the Wumpus have a stench
  - Glitter is detected only in squares with the gold

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Start: Percept[None]

A			

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Start: Percept [None]

OK			
OK	OK		

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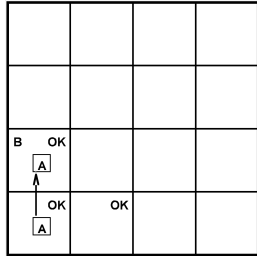
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### Percept [Breeze]



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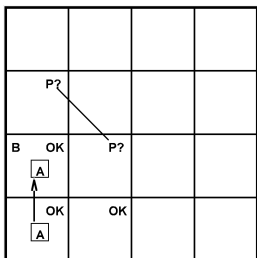
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### Percept [Breeze]



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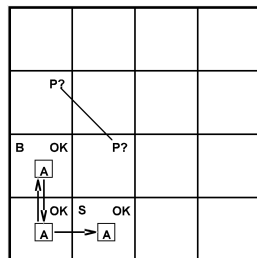
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### Percept [Stench]



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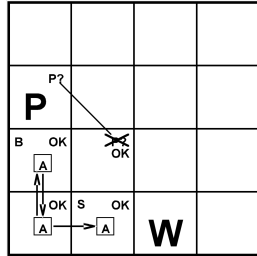
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## Percept []



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## Logic

- Lots of different logics
- Some differ primarily in their syntax
- More importantly they differ in how they view the world

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## Logics

- Propositional logic
- First order logic (predicate calculus)
- Probability theory

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## Admin/Break

- The quiz...
  - There were three clear categories of folks
    - Those who relied on their recollection of the lectures
    - Those who read the book (carefully)
    - Those who did both
  - I'll give back the quiz and the first HW on Thursday

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## Quiz 2

- Scheduled for Oct 19.
- Covers chapters ...7,8,9, 13 and 14.

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## Propositional Logic

- Atomic Propositions
- That are **true** or **false**
- Connectives to form sentences that receive truth conditions based on a compositional semantics

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## Inference

- Simple Compositional semantics
- Modus ponens
- Resolution
- Model-Checking

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## Compositional Semantics

- The semantics of a complex sentence is derived from the semantics of its parts

$$A \vee B$$

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## Compositional Semantics

- Syntactic Manipulations
  - And elimination
  - And introduction
  - Or introduction
  - Double negation removal

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## Compositional Semantics

- And introduction
- You know

$A$

$B$

- You can add

$A \wedge B$

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## Modus Ponens

- You know

$A$

- What can you conclude?

$A \rightarrow B$

$B$

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## Inference

- Why?
  - Because if  $A$  implies  $B$  and you know  $A$  then you know  $B$ 
    - (Wrong)
  - Because the truth table for the  $\rightarrow$  connective has  $B$  being true for all the entries where  $A \rightarrow B$  is true and  $A$  is true (right).

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## Resolution

- You know

$$A \vee B$$

- What can you conclude?

$$\neg B \vee C$$

$$A \vee C$$

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## Inference

- Inference must be a purely formal, syntactic, mechanical, dumb, physical (preferably fast) process

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## Modeling Wumpus World

- Environmental state
- No stench in 1,1

$$\neg S_{1,1}$$

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## Modeling Wumpus World

- Long term rules of the world
  - Breezes are found in states adjacent to pits
  - Stenches are found in states adjacent to Wumpi
  - No stench means no Wumpus nearby
- For example...
  - $\neg S_{1,1} \rightarrow \neg W_{1,1} \wedge \neg W_{2,1} \wedge \neg W_{1,2}$

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## Alternative Schemes

- Wumpi cause stenches

Or  $W_{1,1} \rightarrow S_{1,1} \wedge S_{1,2} \wedge S_{2,1}$

$S_{1,1}$  implies  $W_{1,1}$  or  $W_{1,2}$   
or  $W_{2,1}$  Causal rule

$S_{1,1} \rightarrow W_{1,1} \vee W_{1,2} \vee W_{2,1}$

Diagnostic rule

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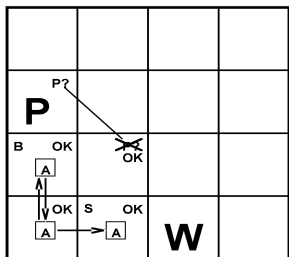
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## Inference in Wumpus World



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## Limitations

- Can we represent...
  - The breeze or stench rules with all their implications?
  - A pit, two pits, some pits, no pits?
  - A wumpus...

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## Next time

- Finish Chapter 7, start on 8

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