For Wednesday

- Finish chapter 7
- Homework
  - Chapter 7, exercise 1

Program 1

- Any questions?

What about the games we play?

Knowledge

- Knowledge Base
  - Inference mechanism (domain-independent)
  - Information (domain-dependent)
- Knowledge Representation Language
  - Sentences (which are not quite like English sentences)
  - The KRL determine what the agent can “know”
  - It also affects what kind of reasoning is possible
- Tell and Ask

Getting Knowledge

- We can TELL the agent everything it needs to know
- We can create an agent that can “learn” new information to store in its knowledge base

The Wumpus World

- Simple computer game
- Good testbed for an agent
- A world in which an agent with knowledge should be able to perform well
- World has a single wumpus which cannot move, pits, and gold

Wumpus Percepts

- The wumpus's square and squares adjacent to it smell bad.
- Squares adjacent to a pit are breezy.
- When standing in a square with gold, the agent will perceive a glitter.
- The agent can hear a scream when the wumpus dies from anywhere
- The agent will perceive a bump if it walks into a wall.
- The agent doesn't know where it is.

Wumpus Actions

- Go forward
- Turn left
- Turn right
- Grab (picks up gold in that square)
- Shoot (fires an arrow forward--only once)
  - If the wumpus is in front of the agent, it dies.
- Climb (leave the cavern--only good at the start square)

Consequences

- Entering a square containing a live wumpus is deadly
- Entering a square containing a pit is deadly
- Getting out of the cave with the gold is worth 1,000 points.
- Getting killed costs 10,000 points
- Each action costs 1 point

Possible Wumpus Environment

Stench		*Breeze*	**Pit**
Stench **Wumpus**	*Breeze* Stench Gold	**Pit**	*Breeze*
Stench		*Breeze*	
Agent	*Breeze*	**Pit**	*Breeze*

Knowledge Representation

- Two sets of rules:
  - Syntax: determines what atomic symbols exist in the language and how to combine them into sentences
  - Semantics: Relationship between the sentences and “the world”--needed to determine truth or falsehood of the sentences

Reasoning

- Entailment
- Inference
  - May produce new sentences entailed by KB
  - May be used to determine which a particular sentence is entailed by the KB
- We want inference procedures that are sound, or truth-preserving.

What Is a Logic?

- A set of language rules
  - Syntax
  - Semantics
- A proof theory
  - A set of rules for deducing the entailments of a set of sentences

Distinguishing Logics

Language	**Ontological Commitment (what exists in the world)**	**Epistemological Commitment (What an agent believes about facts)**
Propositional Logic	facts	true/false/unknown
First-order logic	facts, objects, relations	true/false/unknown
Temporal logic	facts, objects, relations, times	true/false/unknown
Probability theory	facts	degree of belief 0…1
Fuzzy logic	degree of truth	degree of belief 0…1

Propositional Logic

- Simple logic
- Deals only in facts
- Provides a stepping stone into first order logic

Syntax

- Logical Constants: true and false
- Propositional symbols P, Q ... are sentences
- If S is a sentence then (S) is a sentence.
- If S is a sentence then ¬S is a sentence.
- If S_1 and S_2 are sentences, then so are:
  - $S_1 \wedge S_2$
  - $S_1 \vee S_2$
  - $S_1 \Rightarrow S_2$
  - $S_1 \Leftrightarrow S_2$

Semantics

- true and false mean truth or falsehood in the world
- P is true if its proposition is true of the world
- ¬S is the negation of S
- The remainder follow standard truth tables
  - $S_1 \wedge S_2$: AND
  - $S_1 \vee S_2$: inclusive OR
  - $S_1 \Rightarrow S_2$: True unless S_1 is true and S_2 is false
  - $S_1 \Leftrightarrow S_2$: bi-conditional, or if and only if

Vocabulary

- An interpretation is an assignment of true or false to each atomic proposition
- A sentence true under any interpretation is valid (a tautology or analytic sentence)
- Validity can be checked by exhaustive checking of truth tables

Rules of Inference

- Alternative to truth-table checking
- A sequence of inference rule applications leading to a desired conclusion is a logical proof
- We can check inference rules using truth tables, and then use to create sound proofs
- We can treat finding a proof as a search problem

Propositional Inference Rules

- Modus Ponens or Implication Elimination
- And-Elimination
- Unit Resolution
- Resolution