

Class 3: First-Order Logic

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Misc. Logistical Issues

- Again: class pictorial roster, w/ email addresses & web sites_w
- TA Selim's info now in syllabus, w/ office hrs_w
- My office hrs now in syllabus as well_w
- Go page_w
- “The Lost Episode” (propositional calculus)...

GUESS WHO?

Foundation for Logic-Based Agents

- Knowledge-Based Agent pseudo-code_h
- The wumpus-world sequence 6.2 → 6.4_h
- Two central equation-schemas:
 - $\text{KB} \models \alpha$
 - $\text{KB} \vdash_i \alpha$

The Golden Concepts

- We've mentioned the three programming paradigms
- Two AI paradigms: logicist or symbolicist vs. connectionist or sub-symbolicist
- A list of key “golden” concepts for logicist paradigm:
 - soundness; proof; completeness; proof theory; interpretation; compositionality; deduction; validity ($\models \alpha$); satisfiability; unsatisfiability

Getting Help From Hyperproof

- HYPERPROOF *Hyperproof*
 - Selmer's World...
 - NBA 1999

ENGLISH	FOL
<p>Names:</p> <p><i>Selmer</i></p> <p><i>Conrad</i></p> <p><i>Olga</i></p> <p><i>Katherine</i></p> <p><i>Alexander</i></p>	<p>a</p> <p>c</p> <p>b</p> <p>n₁</p> <p>n₂</p>
<p>Predicates:</p> <p><i>x is rich</i></p> <p><i>x is missing brain</i></p> <p><i>x is richer than y</i></p> <p><i>x lives further upstate than y</i></p> <p><i>x lives between y and z</i></p> <p><i>x is a parent of y</i></p> <p><i>x is a child</i></p> <p><i>x is happy</i></p> <p><i>x and y live together</i></p>	<p>Large(x)</p> <p>Tet(x)</p> <p>Larger(x,y)</p> <p>BackOf(x,y)</p> <p>Between(x,y,z)</p> <p>Likes(x,y)</p> <p>Small(x)</p> <p>Happy(x)</p> <p>SameRow(x,y)</p>

Higher-Order Logic

- Hey, not so fast R&N!
- Define identity
- E.g., “There is a noteworthy property Selmer and Conrad share.”
- SNePSLOG (possible 1 credit ind st investigation)
- The λ operator
- $\lambda x, y \text{ Gender}(x) \neq \text{Gender}(y) \wedge \text{Address}(x) = \text{Address}(y)$
- Basically same in Lisp. . . JR9000

Some Lisp...

- JR9000's gentle questions
- Ralph's not-so-gentle game
- True randomness? An automatic A?
- Collatz' function...*h*

Collatz' Function

$$c(n) = \begin{cases} n & \text{if } n = 0 \vee n = 1 \\ n \div 2 & \text{if } n \text{ is even} \\ 3n + 1 & \text{otherwise} \end{cases}$$

- Conjecture: Starting from any positive integer n , repeated iteration of this function eventually produces the value 1.
- Lisp. . .

Mental Objects

- The problem w/ straight FOL in connection w/ beliefs
- The detective story example
- A driving example (extemporaneous)
- Russell & Norvig's Treatment of Mental Objects – any good?
- CYC and Problem 8.15

```
function KB-AGENT(percept) returns an action  
static: KB, a knowledge base  
         t, a counter, initially 0, indicating time  
  
  TELL(KB, MAKE-PERCEPT-SENTENCE(percept, t))  
  action ← ASK(KB, MAKE-ACTION-QUERY(t))  
  TELL(KB, MAKE-ACTION-SENTENCE(action, t))  
  t ← t + 1  
return action
```

Figure 1: Generic Logic-Based Agent.

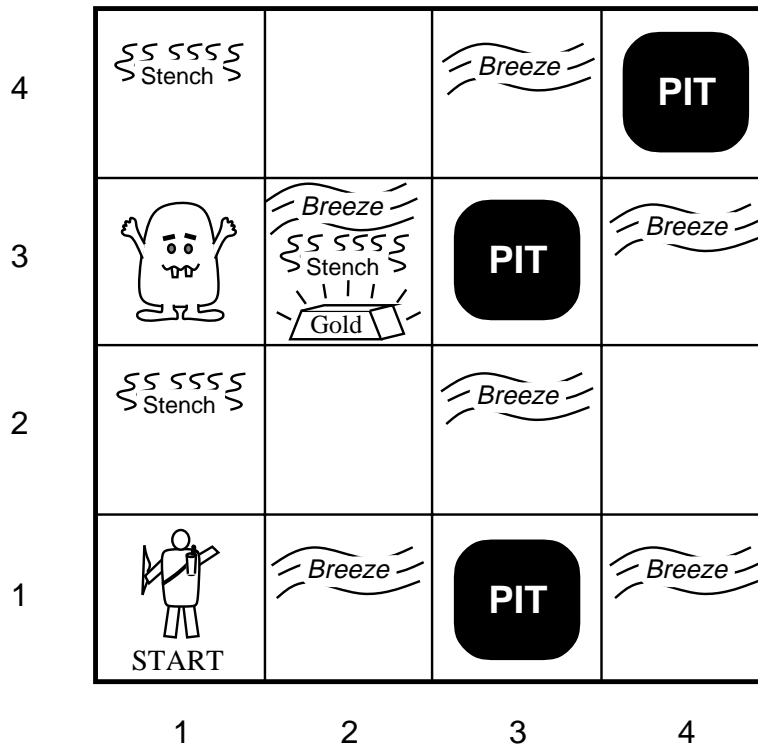


Figure 2: Typical Wumpus World.

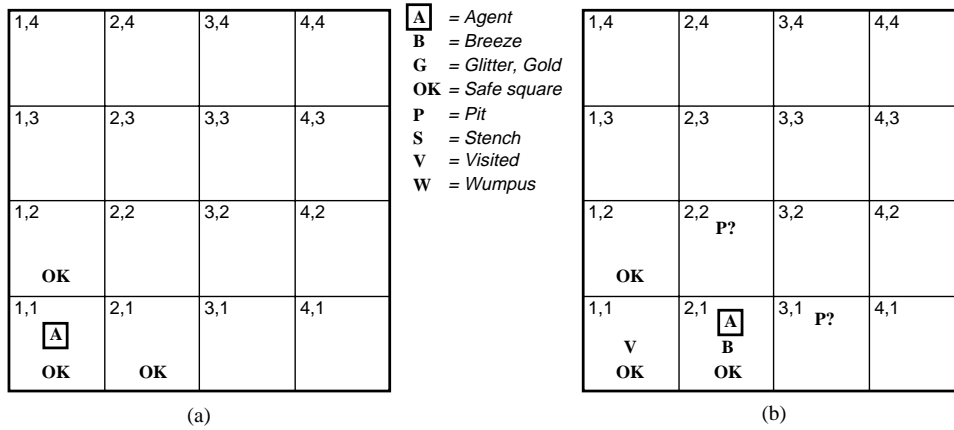


Figure 3: First Step By Agent in WW.

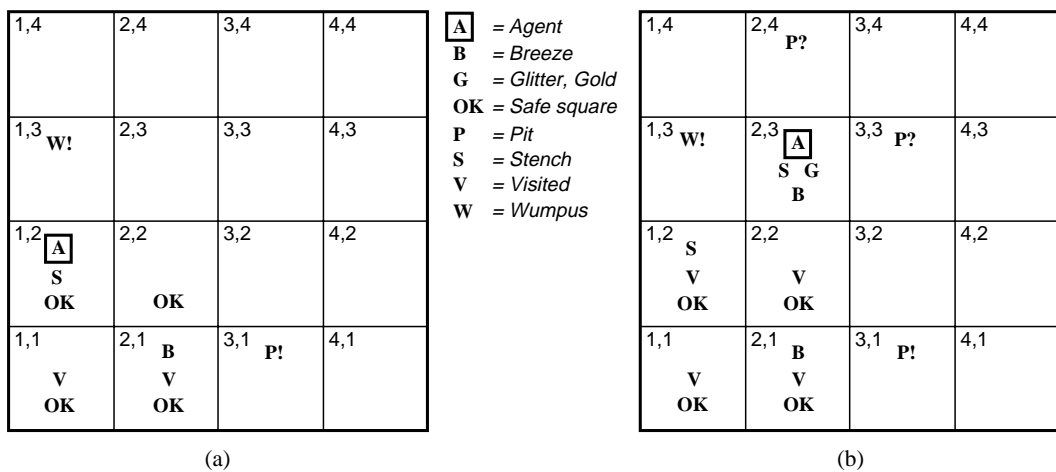


Figure 4: Later Stages of Agent in WW.