CS 4341 D Term 2003
Introduction to Artificial Intelligence

Practice Final Examination

The Call

Having just completed your AI projects (congratulations!), you collapse in bed as the sun is beginning to rise, falling asleep instantly, if not faster. Suddenly, the red telephone beside your bed rings loudly. It is zillionaire Gil Bates, president of Mega-Hard Corporation. He has heard about your AI expertise and needs your help. An intelligent autonomous agent has gotten loose and is running amok on the Mega-Hard Network. You must track down, capture, and report on the intelligent agent.

In exchange for your cooperation, Bates offers you all the Doritos and Twinkies you can eat, a DSL line to your home, and a promise not to have his lawyers copyright your login name. Hungry, tired of `myWPI`, and not wanting to go to court, you accept his terms.

It turns out that the intelligent autonomous agent, named James, has been secretly exploiting a flaw in Mega-Hard Network security. MHN security is embodied in an expert system containing only 2 hypotheses and 10 rules. The hypotheses and rules are:

PROBLEM 1 (35 Points)

```
H1:  access = allow
H2:  access = deny

R1:  IF   server = trusted
     THEN access = allow

R2:  IF   login = correct
     THEN access = allow

R3:  IF   server = not-trusted
     THEN access = deny

R4:  If   username = gilbates
     THEN server = trusted

R5:  IF   network = internal
     AND  os = lose98
     THEN server = trusted

R6:  IF   username = ?x
     AND  password = ?y
     AND  check-password(?x ?y) = ok
     THEN login = correct

R7:  IF   os = you-nix
     THEN server = not-trusted

R8:  IF   login = incorrect
     THEN server = not-trusted

R9:  IF   NOT  login = correct
     AND  os = lose98
     THEN login = incorrect

R10: IF   ---
     THEN access = deny
```

Note that the antecedent in rule 10 is always true, so this rule is always triggered. Also, the first antecedent in rule 9 will be true whenever the value of `login` is unknown.

Checking the network log, you notice that agent James has gained access at a time when the following facts were present:

```
os = lose98
username = james
password = ShakenNotStirred
check-password(james ShakenNotStirred) = fail
network = internal
```

Apparently, these facts are sufficient to conclude that `access = allow`.

Be sure to justify your answers to the following questions.

Part A (15 Points)
Assuming that the system is based on forward chaining and that it stops when any hypothesis has been confirmed, which conflict resolution strategy is used? Explain.

1. Most specific rule (longest LHS). If two triggered rules have the same length, the highest numbered rule is fired first.
2. Most general rule (shortest LHS). If two triggered rules have the same length, the lowest numbered rule is fired first.
3. Rule order. Check lowest numbered rules first. Whenever a rule fires, check the lowest numbered rules again.
4. Circular queue of rules (R1 is checked, then R2, ..., R10, R1 etc. regardless of which rules fire).

Part B (10 Points)
Which rules are fired and in which order for Part A?

Part C (10 Points)
If the following facts were input, what would be the conclusion using the most specific rule strategy?

```
username = gilbates
os = lose98
network = external
```

Indicate which rules fire and in what order.

PROBLEM 2 (20 Points)
James is known to explore the Mega-Hard Network by visiting, that is, executing on, one machine at a time. After a random time interval, it selects another machine to visit from the set of all computers that are connected to its present machine. The machine selected is the one with the lowest internet address number that James has not yet visited.

Part A (10 Points)
What search strategy is this?

Part B (10 Points)
James stores all machines visited in a map data structure. Suggest a strategy for James to go to a specific machine in the fewest moves.

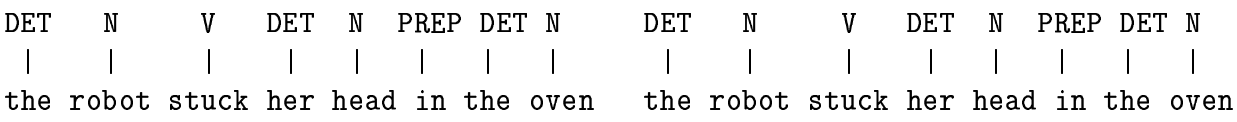
PROBLEM 3 (45 Points)
James understands the following simple grammar:

$$
\begin{aligned}
\texttt{S} &\rightarrow \texttt{NP VP} \\
\texttt{NP} &\rightarrow \texttt{DET N PP}^* \\
\texttt{VP} &\rightarrow \texttt{V NP PP}^* \\
\texttt{PP} &\rightarrow \texttt{PREP NP}
\end{aligned}
$$

Note that PP* means zero or more prepositional phrases PP.

Part A (15 Points)
Complete parse trees for the two legal parses for the sentence

```
The robot stuck her head in the oven.
```



Part B (5 Points)
Which parse is correct and why?

Part C (10 Points)
Show a frame-based representation of the meaning of the sentence pair

```
The robot stuck her head in the oven.  It was warm.
```

Be sure to include all relevant thematic roles.

Part D (10 Points)
On the other hand, changing 2 words can change the entire meaning of the sentences. Consider, for example,

```
The robot stuck her head out the door.  It was warm.
```

What is the "it" in the last sentence?
What knowledge can one use to distinguish this example from the previous one?

Part E (5 Points)
Show the "warm" frame from part C. You do not need to show the "stuck" frame.