Massachusetts Institute of Technology

6.038 Artificial Intelligence in Practice

Problem Set 6A: Tuesday, March 10, 1998
DUE: Thursday, March 12, 1998

NB: For this assignment, we encourage (but do not require) you to work together in pairs and hand in a single solution per pair. Please select different partners than any from previous problem sets. You may retain the same partners for Part B of this assignment.

1 Background

In this problem set, we explore how to add semantics to a grammar. In this assignment we'll look at some simple cases.

2 Files

We will be using the same parser as in PS 5. The parser can be loaded into MIT Scheme by loading `/mit/6.038/ps5/load.scm`. If you are using Scheme-to-C, use the `load.sc` file. If you are running Scheme-to-C, we have also provided `/mit/6.038/bin/ps5-sci` which has the key files compiled in. You will need to load the grammar file yourself.

The file `/mit/6.038/ps6/gram-sem.scm` has the little sample grammar, you are to work with.

3 Adding Semantics

The following very simple grammar, can be used to parse the sentence "Every picture tells a story".

```
(:grule (NP ?agr) (VP ?agr) -> (S))
(:grule (Det ?agr) (N ?agr) -> (NP ?agr))
(:grule (V/tr ?agr) (NP ?agr) -> (VP ?agr))
(:wrule every (Det sg3))
(:wrule picture (N sg3))
(:wrule paints (V/tr sg3))
(:wrule a (Det sg3))
(:wrule story (N sg3))
```

As part of the operation of the parser, a parse tree is built. So that the assertion that is added to the database is along the lines of:

```
(S (NP (Det every) (N picture))
   (VP (V/tr paints)
       (NP (Det a) (N story))))
```

We would like to extend this grammar so that in addition to computing the parse tree, it computes a logical sentence that represents the "meaning" of this sentence. In particular, we want the grammar the build up the following logical formula (the variable names are arbitrary):

```
(all ?v1 (-> (picture ?v1)
             (exists ?v2 (and (story ?v2) (paint ?v1 ?v2)))))
```

That is, “for every (?v1) if ?v1 is a picture then there exists (?v2) such that ?v2 is a story and ?v1 paints ?v2.”

You mission is to modify the grammar rules so that they build these semantics during the parsing process. You'll do that by adding one or more entries to each of the NP, Det, V/tr and S assertions. These extra entries will be used to assemble the semantics.

As a big hint, these are the final rules for all the lexical entries:

```
(:wrule every (Det sg3 ?x ?p ?q (all ?x (-> ?p ?q))))
(:wrule picture (N sg3 ?x (picture ?x)))
(:wrule paints (V/tr sg3 ?x ?obj (paint ?x ?obj)))
(:wrule a (Det sg3 ?x ?p ?q (exists ?x (and ?p ?q))))
(:wrule story (N sg3 ?x (story ?x)))
```

All you have to do is modify the three grammar rules. Hand in the modified rule together with a brief explanation.