Computational Intelligence

A Logical Approach

Problems for Chapter 2

Here are some problems to help you understand the material in Computational Intelligence: *A Logical Approach*. They are designed to help students understand the material and practice for exams.

This file is available in html, or in pdf format, either without solutions or with solutions. (The pdf can be read using the free acrobat reader or with recent versions of Ghostscript).

1 Models and Logical Consequences (ground)

Given the knowledge base:

$a \leftarrow b \wedge c.$

$a \leftarrow g.$

$b \leftarrow d.$

$b \leftarrow f.$

$c \leftarrow e.$

$d \leftarrow h.$

$e.$

$f \leftarrow e.$

where $\{a, b, c, d, e, f, g, h\}$ is the set of all atoms.

(a) Give a model of the knowledge base.

(b) Give an interpretation that is not a model of the knowledge base.

(c) Give two atoms that are logical consequences of the knowledge base.

(d) Give two atoms that are not logical consequences of the knowledge base.

2   Interpretations and Models (with variables)

Suppose we had a domain with two individuals, *x* and *y*. Suppose we had two predicate symbols *p* and *q* and three constants *a*, *b*, and *c*. Suppose we had the knowledge base *KB* defined by

$p(X) \leftarrow q(X)$.

$q(a)$.

(a) Give one interpretation that is a model of *KB*.

(b) Give one interpretation that is not a model of *KB*.

(c) How many interpretations are there? Give a brief justification for your answer.

(d) How many of these interpretations are models of *KB*? Give a brief justification for your answer.

3   Proofs and Logical Consequences (ground)

Given the knowledge base *KB* containing the clauses:

$a \leftarrow b \wedge d$.

$b \leftarrow e \wedge f$.

$c \leftarrow h \wedge e$.

$d \leftarrow e$.

$d \leftarrow b \wedge g$.

$e \leftarrow h$.

$g \leftarrow c \wedge d$.

h.

(a) Show how the bottom-up proof procedure works for this example. Show at each stage the value of *C*. Give all logical consequences of *KB*.

(b) *a* isn't a logical consequence of *KB*. Explain what this means. Show why *a* isn't a logical consequence of *KB*.

(c) *g* is a logical consequence of *KB*. Explain what this means. Give a top-down derivation for the query ?*g*.

4   Unification

For each of the following pairs of atoms, either give a most general unifier, or explain why one doesn't exist.

(a) $p(X, Y, a, b, W)$
   $p(E, c, F, G, F)$

(b) $p(X, Y, Y)$
   $p(E, E, F)$

(c) $p(Y, a, b, Y)$
   $p(c, F, G, F)$

(d) $ap(F0, c(b, c(B0, L0)), c(a, c(b, c(b, c(a, emp)))))$
   $ap(c(H1, T1), L1, c(H1, R1))$

5 Proofs (with variables)

Consider the following knowledge base:

```
ap(emp,L,L).
ap(c(H,T),L,c(H,R)) <-
    ap(T,L,R).
adj(A,B,L) <-
    ap(F,c(A,c(B,E)),L).
```

(a) Give a top down derivation (including all substitutions) for one answer to the query:

   ```
   ? adj(b,Y,c(a,c(b,c(b,c(a,emp))))).
   ```

(b) Are there any other answers? If so, explain where a different choice could be made in the derivation in the previous answer, and continue the derivation showing another example. If there are no other answers explain why not.

[You are meant to do this exercise as would a computer, without knowing what the symbols mean. If you want to give a meaning to this program, you could read *ap* as *append*, *c* as *cons*, *emp* as *empty*, and *adj* as *adjacent*.]