FACOLTÀ DI INGEGNERIA DELL'INFORMAZIONE

Artificial Intelligence 2008–09

Test 4 – 3rd September 2009

RULES: **You have 2 hours to complete the test**
You can use no texts, written notes, computers, calculators, mobile phones
Please write your name and student ID on all sheets
Please answer Question 3 on a separate sheet to speed up the marking process

1. State Space (10 points)

Compare the Breadth First and Depth First search strategies. In particular:

- explain how the general tree-search algorithm can be adapted to implement the two strategies (you are not required to describe the whole search algorithm, only the part that implements the different strategies);
- compare the two strategies from the point of view of completeness, optimality and complexity (in both memory and time);
- describe a meaningful example of a class of problems that can be safely solved by Depth First strategies.

2. CSP (10 points)

2.1 Define the concept of a Constraint Satisfaction Problem (CSP); in particular explain the meaning of the following terms: variable, domain, value, assignment, constraint, consistent assignment, solution.

2.2 Define a map-colouring problem on a map of your choice (with at least 5 countries) as a CSP, specifying all variables, domains, and constraints. Then choose a search strategy for the solution of the problem and justify your choice. Specify and concisely define the domain-independent heuristics that you would adopt to speed up the search.

3. Logic (12 points)

3.1 Formalize the following sentences into first order logic formulae:

a) if you and I are together, then nothing can stop any of us;

b) you are stronger than me;

c) if you and I are not together, then there are things that can stop you;

d) if nothing can stop me, then you and I are together.

3.2 Transform the first order logic formulae into clauses.

3.3 Try to prove by refutation with the resolution technique that sentence d is a logical consequence of sentences a - c (you need to make the hidden assumption on 'stronger' explicit). Why does the procedure fail?

Logic solution:

3.1

a) Together(Y,I) => ¬ ∃ x (Stop(x,Y) ∨ Stop(x,I))

b) Stronger(Y,I)

c) ¬ Together(Y,I) => ∃x (Stop(x,Y))

d) ¬ ∃x Stop(x,I) => Together(Y,I)

3.2

a1) ¬ T(Y,I) ∨ ¬ Stop(x,Y)

a2) ¬ T(Y,I) ∨ ¬ Stop(x,I)

b) Stronger(Y,I)

c) Together(Y,I) ∨ Stop(K,Y) (K is a Skolem constant)

d) ∃x Stop(x,I) ∨ Together(Y,I)

3.3

By defining Stronger(Y,I) as ∀x (Stop(x,Y) => Stop(x,I)):

b) ¬ Stop(x,Y) ∨ ¬ Stop(x,I)

and by negating the thesis d,

¬d1) ¬ Stop(x,I)

¬d2) ¬ Together(Y,I)

The only possible resolution steps are: (c + ¬d2) + a1, and (c + ¬d2) + b, and then no further matching is possible, and the empty clause is not produced. This is due to the fact that being together is a sufficient, but not necessary condition for me not to be stopped by anything.