CIS 730 Artificial Intelligence
CIS 530 Principles of Artificial Intelligence
Fall 2007

Homework 3 of 10: Problem Set (PS3)
Constraints and Logic, Part I

Assigned: Wed 19 Sep 2007
Due: Fri 28 Sep 2007 (before midnight)

The purpose of this assignment is to exercise your basic understanding of intelligent agents, state space search, and game theory, and to help you apply these concepts simulate the behavior of search algorithms.

This homework assignment is worth a total of 20 points.
Each problem is worth 4 points for CIS 730 students and 7 points for CIS 530 students.
Upload a copy of your solution (scanned or typed) to your K-State drop box before the due date.

Notes: http://www.cs.duke.edu/courses/fall06/cps270/csp.pdf

1. **(530/730) English into FOPC.** Rewrite the following sentences in FOPC and convert them to clausal form (CNF). Show your work.

    a. An object in motion will tend to remain in motion, and an object at rest will tend to remain at rest, unless acted upon by an outside force.
    Hint: Consult a reference on Newton's First Law of Motion.
    b. Love gives naught but itself and takes naught but from itself. –Kahlil Gibran, *The Prophet*, "On Love"
    c. ♫ For every day there is a night / for every summer there's a fall / for every rose there's a thorn upon the vine ♫ -The Oak Ridge Boys, "Where the Sun Always Shines"
    d. Never go in against a Sicilian when death is on the line.
    Hints: Give a literal interpretation first, e.g., "it is never advisable to…". "On the line" means "at issue" or "a present risk".

2. **(530/730) Constraint Satisfaction Problems (CSP).** Read the online documentation for the CSP applet at the University of British Columbia:

    http://www.cs.ubc.ca/labs/lci/CIspace/Version3/Constraint/index.html
    http://www.cs.ubc.ca/labs/lci/CIspace/Version3/Constraint/help/general.html

    Use the specification interface to specify the Australian map coloring CSP with three colors and run a trace of *arc consistency*. Turn in the text representation of the CSP that you just created, along with the final current state of the CSP. Using a blank, white map of the Australian provinces, mark the solution (coloring) found.

3. **(730 only) Prolog warm-up: constraint propagation.** Read about constraints in Section 3.3.5 of *Structure and Interpretation of Computer Programs, second edition* by Abelson, Sussman, and Sussman:
    http://mitpress.mit.edu/sicp/full-text/book/book-Z-H-22.html#%_sec_3.3.5
    Write a simple program in pseudo-Prolog that defines Adder (addend, augend, sum) so that only two of the three need be given. You may test your program, but precise syntax is not yet essential. This problem will be continued on Machine Problem 4.

4. **(530/730) Propositional Theorem Proving.** (Based on a logic problem by Lewis Carroll.) Consider the following knowledge base:

    a. No hard search algorithms go unread by CIS 730 students.
    b. Every search procedure in the book *Combinatorial Optimization for Dummies* is global.
    c. All algorithms on MP2 use the code from AIMA.
    d. No global search is read by CIS 730 students.
    e. No search procedure that is not in *Combinatorial Optimization for Dummies* uses the code from AIMA.

    Prove: All algorithms on MP2 are easy.

    Hint: Convert every sentence above into an implicative propositional logic statement, e.g., M $\rightarrow$ A for part c, where M denotes "The algorithm is on MP2" and G denotes "The algorithm uses code from AIMA". Write out the direct statement (e.g., A $\rightarrow$ B) and contrapositive statement. Show the proof using forward or backward chaining (specify which).

5. **(730 only) Constraint Satisfaction.** Still using the CSP applet, construct and solve an instance of:

    a. 5-queens, using auto arc consistency. (Be sure to cite your sources.)
    b. A simple adder (A + B = C)
    http://mitpress.mit.edu/sicp/full-text/sicp/book/node65.html
    https://www.cs.ubc.ca/labs/lci/CIspace/Version4/hill/help/tutorial1.html
    http://isweb.redwoods.cc.ca.us/INSTRUCT/CalderwoodD/diglogic/full.htm

    (Be sure to cite your sources appropriately.)

Extra Credit (2 points). Write the Pythagorean theorem in our FOPC syntax:

http://www.cut-the-knot.org/pythagoras/index.shtml
http://mathworld.wolfram.com/PythagoreanTheorem.html

You need not prove the theorem (but it is interesting to read some of the 75 proofs).

Class participation (required). How did you come up with your "formal English" interpretations for problem 1a? Post your response to CIS730-L.