CS471- Homework 2

Due date: Feb 5th at 11:59pm EST

Introduction

The objective of this assignment is to get familiar with constraint satisfaction and logical agents.

Submission

Your homework must be typed and must contain your name and Purdue ID. To submit your assignment, log into `data.cs.purdue.edu` (physically go to the lab or use ssh remotely) and follow these steps:

1. To ssh use the command: `ssh username@data.cs.purdue.edu`
2. Make a directory named `username-hw2` (all letters in lower case)
3. Copy your PDF and code inside it. To do it remotely use the comand from your computer:
   `scp ./path/to/your-file.pdf username@data.cs.purdue.edu:./remote/path/from-home-dir/`
4. Go to the directory containing `username-hw2` (e.g., if the files are in /homes/aporco/aporco-hw2, go to /homes/aporco), and execute the following command:

   ```
   turnin -c cs471 -p hw2 username-hw2
   ```

   (e.g. Aldo would use: `turnin -c cs471 -p hw2 aporco-hw2` to submit his work)
5. To overwrite an old submission, simply execute this command again.
6. To verify the contents of your submission, execute the following command:

   ```
   turnin -v -c cs471 -p hw2
   ```

Required files

You will need to submit 1 file:

- The PDF containing your typed answers.

Problem Set

Problem 1: Solve the cryptarithmetic problem in Figure 6.2 by hand, using the strategy of backtracking with forward checking and the MRV and least-constraining-value heuristics.

Problem 2: Show how a single ternary constraint such as A + B = C can be turned into three binary constraints by using an auxiliary variable. You may assume finite domains. (Hint: Consider a new variable that takes on values that are pairs of other values, and consider constraints such as X is the first element of the pair Y). Show how constraints with more than three variables can be treated similarly.

Problem 3: Which of the following are correct?

a. $False \models True$
b. $True \models False$
c. $(A \wedge B) \models (A \iff B)$
d. $A \iff B \models A \vee B$
e. $A \iff B \models \neg A \vee B$
f. $(A \wedge B) \implies C \models (A \implies C) \vee (B \implies C)$
g. $(C \vee (\neg A \wedge \neg B)) = ((A \implies C) \wedge (B \implies C))$
h. $(A \vee B) \wedge (C \vee \neg D \vee E) \models (A \vee B)$
i. $(A \vee B) \wedge (\neg C \vee \neg D \vee E) \models (A \vee B) \wedge (\neg D \vee E)$
j. $(A \vee B) \wedge \neg(A \implies B)$ is satisfiable
k. $(A \iff B) \wedge (\neg A \vee B)$ is satisfiable.
l. $(A \iff B) \iff C$ has the same number of models as $(A \iff B)$ for any fixed set of proposition symbols that includes A, B, C

Problem 4: According to some, a person who likes cats (C), likes dogs (D) if he/she likes all animals (A), but otherwise does not. Which of the following are correct representations of this assertion?

i. $(C \wedge D) \iff A$
ii. $C \implies (D \iff A)$
iii. $C \implies ((A \implies D) \vee \neg D)$

Problem 5: This question considers representing satisfiability (SAT) problems as CSPs.

a. Draw the constraint graph corresponding to the SAT problem $(\neg X_1 \vee X_2) \wedge (\neg X2 \vee X3) \wedge ... \wedge (\neg X_{n-1} \vee X_n)$ for $n = 5$.

b. How many solutions are there for this general SAT problem as a function of n?

c. Suppose we apply BACKTRACKING-SEARCH (page 215) to find all solutions to a SAT CSP of the type given in (a). (To find all solutions to a CSP, we simply modify the basic algorithm so it continues searching after each solution is found.) Assume that variables are ordered $X_1, ..., X_n$ and false is ordered before true. How much time will the algorithm take to terminate? (Write an O() expression as a function of n.)