

## CS 227: Extra Credit Homework Problems Spring 2011

**Released on: Monday, May 30th**

**Due Date: Monday, June 6th**

### **Notes:**

*This problem set is being released at the request of students who wish to improve their course grade.*

*This home work is completely optional and is not required.*

*Any credit that you receive on this homework will be added to your total score on the four home works, mid-term and the final exam. The extra credit will be applied only after the grade of the whole class has been calculated.*

### **Problem 1: Constraint Satisfaction Problems**

#### ***Part (a): Representing constraints (10 Points)***

During HW1, we collected meeting preferences from the class. A sample of those meeting preferences is shown below:

- (i) The meeting room needs to be able to hold at least  $n$  people
- (ii) The appointment may be recurring and need to be at the same time/location each week
- (iii) I want at least 1 hour between appointments
- (iv) If we are teleconferencing with our European office, meetings need to be scheduled at a time that intersects with the business hours in USA and Europe.
- (v) Bob will only attend appointments if Gary is not present

Represent these constraints in a form required for a constraint satisfaction problem. You can reuse any representation constructs that you need from the representation you developed for HW1.

**Part (b): Reasoning with constraints (10 points)**

AC-3 puts back on the queue *every* arc  $(X_k, X_i)$  whenever *any* value is deleted from the domain of  $X_i$ , even if each value of  $X_k$  is consistent with several remaining values of  $X_i$ . Suppose that, for every arc  $(X_k, X_i)$ , we keep track of the number of remaining values of  $X_i$  that are consistent with each value of  $X_k$ . Explain how to update these number efficiently and hence show that arc consistency can be enforced in total time  $O(n^2 d^2)$ , where  $n$  is the number of variables and each domain is of size at most  $d$ .

**Part (c): Working with a constraint reasoner (50 points)**

The goal of this part is to create a complete use case of meeting scheduling problem and implement it using a state of the art constraint reasoner. You will do this in the following steps.

- (i) Assume the system needs to schedule a meeting amongst three people during a week. Randomly assign meeting preferences that we considered in part(a) to these people. Each person should be assigned at least two meeting scheduling preferences.
- (ii) Assume a weekly schedule for these three individuals by assigning them some free and busy periods.
- (iii) Represent their schedule and meeting preferences as a constraint satisfaction problem.
- (iv) Use an off the shelf constraint reasoner to solve the meeting scheduling problem. We recommend using the Gecode generic constraint development environment available from <http://www.gecode.org/>.
- (v) Write a report giving a detailed description of all the steps.

## Problem 2: Representing Actions

### ***Part (a): Representing actions using situation calculus (5 points)***

Consider the following description of a process

In a dividing cell, the mitotic (M) phase alternates with interphase, a growth period. The first part of interphase (G1) is followed by the S phase, when the chromosomes duplicate; G2 is the last part of interphase. In the M phase, mitosis distributes the daughter chromosomes to daughter nuclei, and cytokinesis divides the cytoplasm, producing two daughter cells.

Write a complete formalization of this process that we started to sketch out during the lecture.

### ***Part (b): Reasoning using situation calculus (5 points)***

Consider the following question:

A particular cell has less chromosomes than some of the other cells in a mitotically active tissue. The cell in question is NOT in \_\_\_\_\_.

- (A) G2.
- (B) G1.
- (C) interphase.
- (D) the cell cycle.
- (E) S.

Write the reasoning steps that would be needed to answer this question. The reasoning needed may require a combination of general purpose reasoning with reasoning that can be done using situation calculus.

### **Problem 3: Problem Reformulation (20 points)**

Consider the following scenario:

There's a big football game tonight, and you can't miss it. You're trying to decide whether to watch it in person or on TV. Watching it in person requires having some money for a ticket. Watching it on TV is only possible if you have a TV and there isn't a local television blackout on the game. If you need money for a ticket, you can always sell your TV.

- (a) Formulate this problem as STRIPS actions, preconditions, effects, and goals
- (b) Formulate this problem as a constraint satisfaction problem
- (c) Formulate this problem as an answer set logic program
- (d) Formulate this problem as a set of HTN rules
- (e) Compare the four representations with respect to their relative advantages in representation and reasoning.