T-79.4201 **Autumn 2007**
Search Problems and Algorithms
Tutorial 7, 8 November
Problems

1. (i) Give a general technique for translating a finite discrete CSP to an equivalent propositional satisfiability (SAT) problem where in a finite discrete CSP each variable has a finite domain and each constraint is a finite set of tuples.

   (ii) Use the translation to map the CSP below to a SAT problem.

   $$\langle C_1(x_1, x_2, x_3), C_2(x_1, x_3), x_1 \in \{1, 2, 3\}, x_2 \in \{1, 2, 3\}, x_3 \in \{1, 2, 3\}\rangle$$

   where $C_1 = \{(1, 2, 3), (2, 2, 3), (3, 2, 3)\}$ and
   $C_2 = \{(1, 2), (1, 3), (2, 1), (2, 3), (3, 1), (3, 2)\}$.

2. Consider the global cardinality constraint $gcc_{l,u}(X)$ where X is a vector $(x_1, \ldots, x_n)$ of variables and l, u are functions from the union of domains $D_1, \ldots, D_n$ of variables $x_1, \ldots, x_n$ to non-negative integers. A tuple $t = (a_1, ..., a_n) \in D_1 \times \cdots \times D_n$ belongs to $gcc_{l,u}(X)$ iff $l(a_i) \leq \#(a_i, t) \leq u(a_i)$ where $\#(a_i, t)$ denotes the number of times the value a_i appears in the tuple t.

   (i) Express the alldiff(X) constraint using $gcc_{l,u}(X)$.

   (ii) Consider the constraint $gcc_{l,u}(x_1, \ldots, x_8)$ where for all $i = 1, \ldots, 8$, $D_i = \{1, 2, 3\}$ and for all $a \in \{1, 2, 3\}, l(a) = 0, u(a) = 2$. Is this constraint hyper-arc consistent?

3. Compare WalkSAT and Novelty algorithms.

   (i) Give a setting for the parameter p such that Novelty is deterministic but WalkSAT is not.

   (ii) Explain why Novelty is said to be greedier than WalkSAT.

4. Write an integer program such that variables x_1, x_2 can have only values 0 or 1 and variable x_3 has the value of the Boolean function $xor(x_1, x_2)$ in all feasible solutions.