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**Assignment 4****1 Two Watched Literals**

Consider the clauses

$$\omega_1 = \boxed{x_1} \vee \boxed{x_3} \vee x_4$$

$$\omega_3 = \boxed{\neg x_1} \vee \boxed{x_2} \vee x_3$$

$$\omega_2 = x_1 \vee \boxed{\neg x_2} \vee \boxed{x_3}$$

$$\omega_4 = \boxed{x_1} \vee \boxed{\neg x_2} \vee x_4$$

where the boxes indicated the watched literals.

- Suppose that first  $x_1$  assigned true. Which literals are watched in each clause after BCP completes? Which clauses are ignored after BCP completes? Are any clauses conflicted?
- Now suppose that after first assigning  $x_1$  true,  $x_2$  is also assigned true. Which literals are watched in each clause after BCP completes? Which clauses are ignored after BCP completes? Are any clauses conflicted?

**2 VSIDS**

Given the clause set

$$\omega_1 = x_1 \vee x_3 \vee x_4$$

$$\omega_3 = \neg x_1 \vee x_2 \vee x_3$$

$$\omega_2 = x_1 \vee \neg x_2 \vee x_3$$

$$\omega_4 = x_1 \vee \neg x_2 \vee x_4$$

- What is the VSIDS score of each variable.
- Suppose that the clauses  $\omega_5 = x_2 \vee x_4$  and  $\omega_6 = x_3 \vee x_4$  are added. What is the new VSIDS score of each variable?
- Suppose that before  $\omega_5$  and  $\omega_6$  are added, the old scores are first divided by two (and rounded down to a integer), and then  $\omega_5$  and  $\omega_6$  are added. What is the new VSIDS score of each variable?

### 3 The DIMACS Format

Most fast SAT solvers require the input formula in CNF. The input CNF formula is specified in the DIMACS format. Consider the following file `sample.cnf` in DIMACS format.

```
p cnf 4 5
1 0
2 -3 0
-4 -1 0
-1 -2 3 4 0
-2 4 0
```

The first line (p cnf x y) says that the input is a CNF formula containing x variables and y clauses. Our example has 4 variables (1, 2, 3, 4) and five clauses. The negation of a variable is denoted by putting a minus sign in front of the variable number. Each clause is described in a line terminated by a zero. Note that 0 cannot be used as a variable number. So `sample.cnf` denotes the following CNF formula:  $1 \wedge (2 \vee \neg 3) \wedge (\neg 4 \vee \neg 1) \wedge (\neg 1 \vee \neg 2 \vee 3 \vee 4) \wedge (\neg 2 \vee 4)$ .

Express the clause set  $\{\omega_1, \omega_2, \omega_3, \omega_4, \omega_5, \omega_6\}$  in the DIMACS format where these clauses are defined in Problem 2. Use the variable name  $i$  in the DIMACS format for the variable named  $x_i$  in the the above clauses. (For example, use 4 for  $x_4$ .)

### 4 Using a SAT solver

Some publicly available fast SAT solvers are `MiniSat`, `zChaff`, `siege`. For this assignment we will use the `MiniSat` SAT solver which was the fastest SAT solver in the SAT-competitions of 2005 and 2006. You can run `MiniSat` SAT solver simply by the following command:

```
/afs/andrew.cmu.edu/usr24/mtschant/15414-f07/MiniSat_v1.14_linux sample.cnf sample.result
```

from you Andrew linux account (`unix.andrew.cmu.edu`). The file `sample.cnf` is a description of a CNF formula in DIMACS format. `MiniSat` reports whether the given formula is (un)satisfiable in the file `sample.result`. If the formula is satisfiable, then a satisfying assignment is also written to `sample.result`.

Run `MiniSat` on the DIMACS file you made from Problem 3. What is output is stored in results file?