CS4750/7750 HW #6 (20 points)

Fall 2018

In this programming assignment, you are asked to implement the backtracking search with the MRV and degree heuristic, and forward checking to solve the Boolean satisfiability problem. A general description of the Boolean satisfiability problem is at https://en.wikipedia.org/wiki/Boolean_satisfiability_problem. The definition is as follows:

INSTANCE: Set of n variables. Set of c clauses, where each clause consists of a disjunction of some literals (i.e., variables or their negations).
PROBLEM: Find an assignment of truth values to the variables such that all clauses are satisfied.

Example: Let's say we have three Boolean variables x_1, x_2, x_3, and we have the following three clauses (each of 3 literals) to satisfy:

$(x_1 \lor x_2 \lor \neg x_3) \land (x_3 \lor \neg x_2 \lor \neg x_1) \land (x_1 \lor \neg x_2 \lor \neg x_3)$

where $\lor$ stands for OR (i.e., disjunction), $\land$ stands for AND, and $\neg$ stands for NOT (i.e. negation).

An assignment of variables that maximizes the number of clauses satisfied (=3) is $x_1=1$, $x_2=1$, $x_3=1$.

Your algorithm should be able to read in an instance in this format.
```
p cnf 3 4
1 -2 0
-1 2 -3 0
-3 2 0
1 3 0
```
The first line that begins p cnf gives the number of variables *n* and the number of clauses *c*. After that each line is a clause, consisting of a sequence of non-null numbers, which denote the corresponding variable (if the number is positive) or its negation (if it is negative). Each line is ended with a 0.

The output should be variable assignment if there is a solution or NULL if there is no solution. The variable assignment should be a {0, 1} sequence, with 0 for false and 1 for true.

The four instances to be solved are:

1. Example1.txt
2. Example2.txt
3. Example3.txt

4. Example4.txt

Plotting results: you should plot the solution of each instance as a scatter plot (https://en.wikipedia.org/wiki/Scatter_plot) with x-axis the variable ID and y-axis the true/false (0, 1) value.

Run your program on the four instances and report your results according to the submission requirement. Terminate your program if it runs for more than one hour.

In your submission, you should report the following:
1) A description of your implementation.
2) The following details of the first 10 steps in solving each of the four instances, including a) the variable selected, b) the value assigned, and c) number of variables affected by forward checking.
3) The solution of each instance (the solution plot), the number of variable-value assignments tried in the search, and the CPU execution time in milliseconds.
4) Your code with appropriate comments.

You may form groups of up to three students in each group. The group can be different from those for other PAs. One report is to be submitted by each group electronically in Canvas. You may use any programming language in your implementation.

Your submission should consist of two files:
1) A report file.
2) Your code zip file.