Tutorial on SAT Solvers

Combinatorial Problem Solving (CPS)

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SAT Solvers

- SAT solvers take as input a CNF formula $F$ and return:
  - sat(+ model): if $F$ is satisfiable
  - unsat: if $F$ is unsatisfiable

- We will be using kissat (developed by Armin Biere)
- Usage: kissat [ <option> ... ] <input>
- See options with kissat -h
Input Format: DIMACCS (I)

- First some optional comment lines: c<comment>
- Then a line: p<cnf><num_vars><num_clauses>
- Then clauses:
  - Each variable is represented with an integer $\geq 1$
  - Negated literals are negative integers
  - Literals in a clause separated by blank spaces
  - 0 marks the end of a clause
Input Format: DIMACS (II)

\[ (x_1 \lor x_2) \land \neg x_3 \]

This is an example of SAT formula

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

\[ (x_1 \lor x_2) \land (x_1 \lor \neg x_2) \land (\neg x_1 \lor x_2) \land (\neg x_1 \lor \neg x_2) \]

This is an example of UNSAT formula

```
p cnf 2 4
 1 2 0
 1 -2 0
-1 2 0
-1 -2 0
```
Output Format

- There may be comment lines started with c that should be ignored (as in the input format)
- 1st line of the remaining lines is one of:
  - s SATISFIABLE
  - s UNSATISFIABLE
- If satisfiable, then comes a list of true literals. Each following line is of the form v <list of lits>

Example: output for formula \((x_1 \lor x_2) \land \neg x_3\)

```
s SATISFIABLE
v 1 2 -3 0
```

Interpretation \(I\) with \(I(x_1) = I(x_2) = 1, I(x_3) = 0\) is model