Proof Complexity and Solving LAB

VSIDS Decision Heuristic

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https://github.com/JoshuaBlinkhorn/SAT-LAB

Goals

- Implemenatation of SAT solving algorithms
  (a) 2-SAT (polynomial time)
  (b) DPLL
  (c) CDCL
    - watched literals
    - clause learning
    - decision heuristics
    - restart strategy
  (d) QBF expansion..

- Practical programming experience
  - use your favourite language (Python, C, C++, Java, ..)
  - recommended: Python

CDCL Pseudocode

```
function CDCL-solver(Φ)                          #assuming Φ is preprocessed
  decision-level ← 0
  while there are unassigned variables
    decision-level++
    decide()                                     #adds assignment to trail
    C_conflict ← propagate()                     #returns conflict clause or null

    while C_conflict is not null
      if decision-level = 0 return UNSAT
      C_learned ← analyse-conflict(C_conflict)
      if C_conflict is unit
        backtrack(0)
        assign unit literal
      else
        backtrack(asserting-level(C_learned))    #changes trail and DL
        Φ ← Φ ∧ C_learned
      C_conflict ← propagate()

    apply-restart-policy()
  return SAT
```

Decisions, Decisions, ..

- Choosing good decision variables is key to fast solving
- Well-explored research area
- VSIDS emerged as leading heuristic

Variable State Independent Decaying Sum (VSIDS)

- State-Independent – does not depend on current assignment
- Conceptually very simple – even elegant
- Tries to prioritise variables involved in recent conflicts

VSIDS Implementation

- Simple algorithm:
  - one counter per variable (use floats)
  - initialise all counters to 0
  - at conflict, add 1 to all variables involved in conflict
  - every j conflicts, multiply all counters by $0 < c_{\text{decay}} < 1$
- Variables involved in the conflict: those 'touched' in conflict analysis
- Sensible values: $j = 1000$, $c_{\text{decay}} = 0.5$
- If you have time: experiment with different values

VSIDS Task

- implement the VSIDS decision heuristic
- check correctness
- compare the solving time to your naive heuristic