

# Exploration via Random Walks in CDCL SAT Solving amid Conflict Depression

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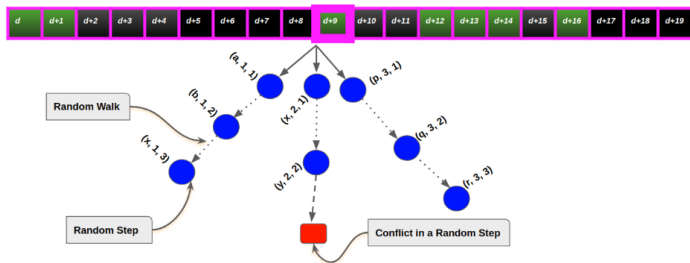
# Introduction

- Problems with combinatorial structures are solved by *heuristic search*.
- Boolean Satisfiability (SAT)
  - determine assignments of the variables to satisfy a boolean formula, if one exists. Otherwise, unsatisfiable ....
  - NP-Complete!
- Dominant SAT solvers → Conflict Driven Clause Learning (CDCL) search based.
- Variable selections (branching) in CDCL SAT are heuristics guided.
  - based on look-back principal
  - priority is based on **recent conflict involvements**.
    - A conflict arises when **a clause cannot be satisfied** wrt. the current partial assignment.
    - conflicts → learned clauses → prunes search space.
  - **intuition**: such selection will generate more conflicts.
    - VSIDS: Variable State Independent Decaying Sum.
    - LRB: Learning Rate Based.

- Identification of a pathological state of Conflict Depressions (CD).
  - No conflicts for a consecutive decisions (CD Phase).  
Eg. in the sequence (1, 0,0,0,0, 4, 2, 1, 0, 1, 0,0),
    - a number in position  $x \geq 1$  denotes **the count of conflicts** obtained in decision  $x$ .  
→ 3 CD phases of length 4, 1 and 2.
- For VSIDS, We empirically show that CD phases occurs **at a high rate**, often with **high CD phase length**.
- During a CD phase, **VSIDS selection are ineffective** to generate conflicts.

## Contribution II

- To **rectify** from CD phases, we propose to perform random exploration (*expSAT*).
  - Exploration samples the future states **amid substantial CD phases**, to discover conflicts.



- **Empirical evaluation** of expSAT with two state-of-the-art SAT solvers.
  - SAT Competition-2018 benchmark instances + SHA-1 cryptographic benchmark instances .
  - expSAT shows **gains over Satisfiable instances**.