An Empirical Understanding of Conflict-Driven Clause-Learning SAT Solvers

Vijay Ganesh

University of Waterloo, Canada
`vijay.ganesh@uwaterloo.ca`

Abstract

Conflict-driven clause-learning (CDCL) SAT solvers have deeply influenced software engineering and security research over the last two decades, thanks largely to the fact that these solvers can easily solve real-world constraints with millions of variables and clauses in them. This phenomenon has puzzled theoreticians and practitioners alike. It is widely believed that industrial instances solved efficiently by SAT solvers are highly structured. However, until recently there was little understanding of the structure of industrial instances or the way solvers go about exploiting the said structure.

In this talk, I will introduce CDCL SAT solvers, and the most important heuristics that power them. In addition, I will give an answer to the question of why SAT solvers are efficient on industrial instances. My answer is based on empirical discoveries my collaborators, students, and I have made via a rigorous and systematic experimental study of CDCL SAT solvers and industrial instances. I will conclude with a mathematical model that incorporates our empirical discoveries.