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Analysis of the Hardness of SAT Formulations for Ramsey-type Problems

Constraint satisfaction methods can be used to model interesting and difficult combinatorial problems. This allows us to offload the combinatorial search to, for example, a Boolean satisfiability (SAT) solver. The purpose of doing this would be to leverage the continued advancements in the area of SAT solvers. Yet, some relatively small formulas resulting from encoding combinatorial problems are extremely challenging even for award-winning solvers. Studying the structural properties of these formulas can be used to better understand what makes SAT instances hard. Previous cases of such studies include the resolution of pigeonhole formulas and the space of pebbling formulas. We propose a similar analysis of Boolean formulas encoding edge coloring problems from finite Ramsey theory and related Folkman numbers, both requiring testing the arrowing predicate. Such formulas provide good benchmarks for both satisfiable and unsatisfiable instances, as well as for symmetry breaking and model enumeration techniques.