

Abstract

The Lovász Local Lemma (LLL) is a cornerstone principle in the probabilistic method of combinatorics, and a seminal algorithm of Moser & Tardos (2010) provided an efficient randomized algorithm to implement it. This algorithm could be parallelized to give an algorithm that uses polynomially many processors and runs in $O(\log^3 n)$ time, stemming from $O(\log n)$ adaptive computations of a maximal independent set (MIS). Chung et. al. (2014) developed faster local and parallel algorithms, potentially running in time $O(\log^2 n)$, but these algorithms work under significantly more stringent conditions than the LLL. We give a new parallel algorithm, that works under essentially the same conditions as the original algorithm of Moser & Tardos, but uses only a single MIS computation, thus running in $O(\log^2 n)$ time. This conceptually new algorithm also gives a clean combinatorial description of a satisfying assignment which might be of independent interest. Our techniques extend to the deterministic LLL algorithm given by Chandrasekaran et al. (2013) leading to an NC-algorithm running in time $O(\log^2 n)$ as well. We also provide improved bounds on the run-times of the sequential and parallel resampling-based algorithms originally developed by Moser & Tardos. These bounds extend to any problem instance in which the tighter Shearer LLL criterion is satisfied. We also improve on the analysis of Kolipaka & Szegedy (2011) to give tighter concentration results. Interestingly, we are able to give bounds which are independent of the (somewhat mysterious) weighting function used in formulations of the asymmetric LLL.