Report
on David Jurenka's bachelor thesis
entitled "Upper Bounds for (k, s)-SAT"

Stefan Dantchev

August 30, 2011

A (k, s)-SAT instance is a propositional formula in CNF, such that all clauses are of size k and each variable occurs at most s times (positively or negatively). It turns out that, for every k, there is a threshold $f(k)$, such that for every $s \leq f(k)$, all (k, s)-SAT instances are trivially satisfiable, while for $s \geq f(k)+1$, the (k, s)-SAT problem is NP complete. Unfortunately, the exact values of the function $f(k)$ are known for small values of k only.

The first contribution of the thesis is a computer program that finds upper bounds for $f(k)$ by searching for an unsatisfiable (k, s)-SAT of certain structure. The algorithm is based upon known theoretical results. The actual implementation seems to be quite sophisticated, and there is a very good discussion on the design of the program and the results produced. Overall, this is a solid experimental result that builds upon and requires deep understanding of some theoretical results.

The second contribution is a new lower bound on the size of an (k, s)-SAT enforcer, a satisfiable (k, s)-SAT instance, which forces the value of a designated variable to be true. The proof, although not long and difficult, is a very neat probabilistic argument. It led to finding an optimal $(3, 4)$ enforcer, which in turn led to an improved inapproximability result for MAX-$(3, 4)$-SAT.

To summarise, the thesis is a very nice mixture of theory and experimentation, and is very well written. In my opinion, it is equivalent to a good research publication. The author has clearly demonstrated his ability not only to understand and produce theoretical results but also to do advanced computer programming. Based on all this, I would strongly recommend that the thesis be awarded the highest grade.