

Supervisor's Report on Master's Thesis
Filip Bialas: Combinatorial Gap Label Cover

The PCP Theorem, in one of its equivalent formulations, states that the computational problem, where the aim is to distinguish instances of constraint satisfaction problem that are satisfiable from those that are not even $(1 - \epsilon)$ -satisfiable, is NP-hard for some $\epsilon > 0$. Another landmark result in computational complexity, the Parallel Repetition Theorem, implies that the ϵ in the above claim can be pushed arbitrarily close to 1. Here r -satisfiability means that some assignment satisfies at least r fraction of the constraints.

Filip's thesis explores a recently introduced combinatorial version of the claim, where r -satisfiability is replaced by a natural combinatorial concept. The original contributions of the thesis include introducing an intermediate concept, a "probabilistic combinatorial" version, exploring its relation to the combinatorial version (Chapter 3), and a negative result which says that the most straightforward combinatorial version of the Parallel Repetition Theorem is false (Chapter 4). The latter result is highly nontrivial. The proof strategy is to first show an easier continuous version and then discretize it. This strategy and its implementation is an independent work of Filip. We plan to include the result to a journal version of SODA 2022 paper "Combinatorial Gap Theorem and Reductions between Promise CSPs" (B., Kozik). The results of the thesis clearly show Filip's potential in academia.

The presentation is very good as well. It gives sufficient and well presented background, and the results are nicely presented and argued, too. The thesis is a pleasant read; I particularly like its personal, honest, and informal (but precise) style. The thesis was written with a very little input from me.

In summary, the thesis is excellent and I recommend to accept it as a Master's thesis.



Prague, 19 August 2022

Libor Barto