

# Supervisor's Report on Master Thesis

Faculty of Mathematics and Physics, Charles University

**Title:** Heuristics for Length Bounded Cuts

**Student:** Bc. Pavol Madaj

**Supervisor:** doc. Mgr. Kolman Petr, Ph.D.

**Study Programme:** Computer Science - Discrete Models and Algorithms

## Summary of contributions

The thesis deals with the L-bounded cut problem in graphs. The first chapter briefly overviews the known hardness and approximation results for the problem. The second chapter describes problem instances on which the various algorithms, described later in the thesis, are compared. In the third chapter, a description of several LP relaxations of the L-bounded cut problem is given. Chapter four outlines heuristics for the L-bounded cut problem. Chapter five reports on the results of running the relaxations and heuristics from chapters three and four, on the instances from chapter two. Finally, chapter six sketches implementation details.

## Evaluation

The student did satisfy the assignment of the thesis. However, it is apparent that the thesis was completed in a hurry (in fact, in several places, it is not finished - e.g. a few times, we see question marks instead of links and references), which has a negative impact on the quality of the thesis. In the following part, I mention the main weaknesses of the thesis as submitted; I regret that Pavol did not send me any draft of the thesis before submitting it as most of the issues I list have an easy fix.

## Main Comments

1. The main drawback of the thesis, in my opinion, is an inattentive work with literature. A few examples:

- What I regret the most is that proper credit is not given to Eden Chlamtač, with whom we first considered the LP relaxation from section 3.2.
- References are missing in the description of algorithms in Sections 4.1, 4.3 and 4.4.
- The reference [2] is incorrect - a journal version of the paper should be cited instead, as some of the results listed in the thesis appear only in it.
- A couple of times, the thesis mentions the inapproximability factor 1.1377 (once, there is even a typo in it and 1.377 is stated instead) of the L-bounded cut problem. However, even in the assignment of the thesis, a recent paper with a slightly stronger bound 1.1715, is mentioned.
- Chapter 1 (Research to Date) is incomplete. An important missing result is the UGC-hardness of the L-bounded cut problem by E. Lee from 2017.
- The proof of Theorem 15 (dealing with the exponential number of constraints in the LP relaxation) via the layered network is based on the construction of Claim 1 in the paper P. Kolman, Ch. Scheideler, Improved bounds for the unsplittable flow problem, Journal of Algorithms, Volume 61, Issue 1, 2006, Pages 20-44.
- Observation 16 appears in the paper [2].
- The list of references by itself needs a polishment.

2. There are at least two theoretical results that we discussed during the previous year with Pavol that I'm missing in the thesis:

- The proof that the integrality gap of the LP relaxation with both triangle inequalities (i.e., CUTDIST and LPDIST) on the fence graphs is asymptotically smaller than the integrality gap of the natural LP relaxation.
- The proof that the integrality gap of the LP relaxation with the first triangle inequality (i.e., CUTDIST) and without the other (i.e., LPDIST) is asymptotically the same as the integrality gap of the natural LP relaxation.

### **Overall Assessment**

I would like to stress that the student performed very well over the past year (our collaboration began in fall 2022). He worked dutifully, actively and his work yielded several insights that I was not aware of earlier. It's regrettable, however, that Pavol wasn't able to allocate more time for a comprehensive thesis write-up.

I recommend the thesis for defence.

I suggest not to consider the thesis for any award.

doc. Petr Kolman, Ph.D.

Prague, August 25 2023