

Posudek diplomové práce

Matematicko-fyzikální fakulta Univerzity Karlovy

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Thesis title Parameterized Algorithms for 2-Edge Connected Steiner Subgraphs

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Program Computer Science **Specialization** Theoretical Computer Science

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Review text:

This thesis considers the parameterized complexity of finding 2-edge-connected Steiner Subgraph (called as Min-2-ECSS). Formally, given an undirected edge-weighted graph G (with unit weights) and a set of terminals T , the goal is to find a subgraph H of minimum weight such that every pair of terminals $u, v \in T$ has at least two edge-disjoint paths. A variant of the problem, called as Min-2-ECSM, allows picking multiple copies of an edge while having to separately pay for each copy.

The parameterized complexity of Min-2-ECSS and Min-2-ECSM (with unit edge weights) is studied with respect to the parameter number of terminals T . The following are the two main results of the thesis:

1. Min-2-ECSS admits a randomized $n^{O(|T|)}$ time algorithm, i.e., an XP algorithm parameterized by T .
2. Min-2-ECSM admits a $2^{O(|T| \log |T|)}$ time algorithm, i.e., an FPT algorithm parameterized by T .

The first result (Chapter 2) is the main technical part of the paper. The XP algorithm is designed by identifying a tree-like structure in an optimal solution for Min-2-ECSS, and then patching different parts of this structure together. This is done by using an algorithm of [BHT12] as a subroutine: it seems this is the only place where randomization is used in the algorithm. Chapter 3 provides an alternative XP algorithm for Min-2-ECSS by reduction to the vertex-disjoint version which has an easier-to-state XP algorithm [BCGI22].

The second result (Chapter 4) is obtained by a straightforward combination of results from [Jor03] and [FMvL21]. But the importance of this result is obtained by first showing that Min-2-ECSS and a problem called Bi-SCSS are polynomially equivalent which then implies a faster FPT algorithm for Bi-SCSS problem improving that from [CFM21].

Evaluation:

The thesis is written well with sufficient rigour and detail for the Masters level. The results obtained are also adequate in terms of originality and depth. A reader familiar with the topic of parameterized complexity should be able to read and understand the entire thesis.

Minor comments:

- The algorithm of [BCGI22] also seems to work for general weights, not just unit weights. This might be worth mentioning on page 4.
- Some definitions (e.g. Definition 2) are not cited from the original reference.
- In my view, the open question of whether or not Min-2-ECSS (or more generally Min- k -ECSS) is FPT parameterized by T is more central to this thesis than the Open question 2 that is currently stated.
- Appendix A: Proofs of Observation 1 and Observation 18 can be expanded (instead of a sketch). Figure A.1 can also do with some more explanation (and moving it in-place to Chapter 3).

I recommend the thesis for defense.

I suggest to not consider the thesis for the annual award.

Date: 25th January, 2023

Signature: