Posudek diplomové práce

Matematicko-fyzikální fakulta Univerzity Karlovy

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Název práce   Algorithms for Low Highway Dimension Graphs

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Pracoviště   KAM, Charles University

Text posudku:

The thesis shows several algorithmic results for variants of the k-Supplier with Outliers problem on graphs of low doubling dimension and of low highway dimension, in the regime of parameterized approximations. This setting is well-motivated due the applications of the k-Supplier problem in transportation networks, which can be modelled using either the doubling or highway dimension. The presented results are:

1. a 3/2-approximation for k-Center with Outliers parameterized by k, the number of outliers, and the highway dimension,

2. an approximation scheme for k-Supplier with Outliers parameterized by k, the number of outliers, and the highway dimension,

3. an approximation scheme for Capacitated k-Supplier with Outliers parameterized by k, the number of outliers, and the doubling dimension,

4. a reduction showing W[1]-hardness of approximating Capacitated k-Supplier with Outliers within any factor better than 2 parameterized by k and the treewidth, and

5. a reduction showing NP-hardness of approximating Non-Uniform k-Supplier within any constant factor, on graphs of constant highway and doubling dimension.

These results nicely complement each other: while algorithm 2 effectively subsumes algorithm 1, the latter is faster than the former. Algorithm 3 generalizes the solved problem even further, but the parameterization is by the doubling instead of the highway dimension. This downgrade in the parameter is explained by result 4, since a parameterized approximation scheme parameterized by k and the treewidth would be needed to exploit the algorithmic tools leading to an approximation scheme for low highway dimension graphs. Finally, the inapproximability result of 5 shows

that we cannot hope to generalize the problem to the non-uniform case and still expect a parameterized approximation schemes. These results are obtained by putting together several algorithmic techniques that have been previously used to obtain similar results for special cases (most notably the k-Center problem).

The thesis is well written with a clear structure that explains the connections between the results well. The author shows a thorough understanding of the subject matter. He demonstrates his abilities to apply and combine various algorithmic techniques to new settings, while providing a broad view of the possibilities and impossibilities of parameterized approximation algorithms for variants of the k-Supplier problem with applications in transportation networks. In light of this, I recommend passing this thesis at the defence.

Práci doporučuji k obhajobě.

Práci navrhuji na zvláštní ocenění.

In my opinion this thesis is very strong, as the author demonstrates his ability to apply and combine techniques from several previously published papers to prove his algorithms and hardness results. It is also planned to publish the obtained results at a competitive conference in the near future.

V Praze dne 7. června 2021

Podpis: