Oberseminar

Monday, September 9, 2024, 10:00 c. t.

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Polylogarithmic Approximation Algorithms for Directed Steiner Problems in Planar Digraphs

Steiner Tree and Steiner Forest are two fundamental problems in network design. The input to Steiner Forest is an edge-cost graph $G = (V, E)$ and a collection of k vertex source/sink pairs $s(i)$, $t(i)$. The goal is to find a minimum cost subgraph H of G such that H contains an $s(i)$-$t(i)$ path for each pair. Steiner Tree is the "single-source" version of Steiner Forest, in which there is one source s that we aim to connect to all given sink vertices. When the input graph is undirected, these problems both admit constant factor approximation algorithms. On the other hand, the corresponding problems on directed graphs have strong lower bounds on their approximability. Directed Steiner Tree (DST) admits an $O(\log^2 k /\log \log k)$-approximation in quasi-polynomial time; this approximation ratio is tight under plausible complexity assumptions, and obtaining a polylogarithmic approximation in polynomial time remains a major open problem. Directed Steiner Forest (DSF) is hard to approximate to a factor $\Omega(2^{\log^{(1-\varepsilon)}n})$ for any $\varepsilon > 0$, and the best known approximation ratio is polynomial in the number of terminals.

In this talk, I will discuss recent results demonstrating the tractability of these problems in planar digraphs. Friggstad and Mousavi [ICALP '23] obtained a simple and elegant polynomial-time $O(\log k)$-approximation for DST in planar digraphs using Thorup's shortest path separator theorem. Building on this work, we prove that the natural cut-based LP relaxation for DST has an integrality gap of $O(\log^2 k)$ in planar digraphs [Chekuri et al., ESA '24]. Using several additional structural insights on planar graph reachability, we extend this work to the Directed Steiner Forest setting, where we obtain a polylogarithmic approximation algorithm in planar digraphs.

The Oberseminar takes place in the Seminarraum, 1st floor. Participants are invited to have coffee or tea in the lounge before.

S. Held, S. Hougardy, B. Korte, V. Traub, L. Vargas Koch, L. Végh, J. Vygen