Parameterized complexity of directed traveling salesman problem

Ondřej Suchý
(joint work with Václav Blažej, Andreas Emil Feldmann, Foivos Fioravantes, and Paweł Rzążewski)

The Directed Traveling Salesman Problem (DTSP) is a variant of the classical Traveling Salesman Problem in which the edges in the graph are directed and a vertex and edge can be visited multiple times. The goal is to find a directed closed walk of minimum length (or total weight) that visits every vertex of the given graph at least once. In a yet more general version, Directed Waypoint Routing Problem (DWRP), some vertices are marked as terminals and we are only required to visit all terminals. Furthermore, each edge has its capacity bounding the number of times this edge can be used by a solution.

While both problems (and many other variants of TSP) were extensively investigated, mostly from the approximation point of view, there are surprisingly few results concerning the parameterized complexity. Our starting point is the result of Marx et al. [APPROX/RANDOM 2016] who proved that DTSP is W[1]-hard parameterized by distance to pathwidth 3. In this paper we aim to initiate the systematic complexity study of variants of Directed Traveling Salesman Problem with respect to various, mostly structural, parameters.

We show that DWRP is FPT parameterized by the solution size, the *feedback edge number* and the *vertex integrity* of the underlying undirected graph. Furthermore, the problem is XP parameterized by treewidth.

On the complexity side, we show that the problem is W[1]-hard parameterized by the distance to constant treedepth.