The complexity of computing a maximum robust flow *

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Robust network flows are a concept for dealing with uncertainty and failures in the network infrastructure. One of the most basic models is the Maximum Robust Flow problem: Given a network and an integer k, the task is to find a path flow of maximum robust value, i.e., the guaranteed value of surviving flow after destruction of any k arcs in the network. This problem can be seen as a two-player zero-sum game on a graph, where a flow player wants to maximize the flow value, while the interdictor wants to minimize it.

The complexity of computing a maximum robust flow appeared to have been settled almost a decade ago: Aneja et al. showed that the problem can be solved efficiently when $k = 1$, while Du and Chandrasekaran provided an NP-hardness reduction for $k = 2$. We point to a flaw in the latter proof, leaving the complexity for constant k open once again. For the case that k is not bounded by a constant, we present a new hardness proof, establishing that the problem is strongly NP-hard even when only two different capacity values occur and the number of paths is polynomial in the input. We will also discuss a $1/k$-approximation algorithm by Bertsimas et al. whose analysis is based on constructing a mixed strategy of the interdictor to upper bound the optimal solution value.

*joint work with Yann Disser, Tom McCormick, and Gianpaolo Oriolo.