Heuristic Algorithms for the Non-Bifurcated Network Design Problem

Enrico Bartolini
Department of Computer Science, University of Bologna, Bologna, Italy

Aristide Mingozzi
Department of Mathematics, University of Bologna, Bologna, Italy

June 20, 2006

Abstract

The network design problem we study in this paper is as follows. Given an undirected network, a set of origin-destination node pairs (*commodities*) and a demand for each commodity, the *non-bifurcated* network design problem is to install integer multiples of some capacity unit on the edges of the network and to route the commodities so that each commodity follows a single path. The objective is to minimize the sum of capacity installation and flow routing costs. This problem is known to be $\mathcal{NP}$-hard and the few exact methods published in the literature cannot solve problem of practical size.

We propose four new heuristic algorithms to solve this problem. First we give a necessary condition for optimality that is used by a two-phase algorithm that iteratively improves a feasible solution produced in the first phase. We then describe two truncated enumerative methods where each node of the state space at level k represents a feasible solution for the first k commodities. To limit the size of the state space, only a small subset of nodes generated at each level is expanded. The two methods significantly differ in the way they grow the state space graph and select the nodes to be expanded. Finally, we describe a tabu search procedure where the neighborhood of a solution is obtained by rerouting each commodity through a limited subset of alternative paths.

Computational results on a set of test problems taken from the literature show the effectiveness of the proposed algorithms.