

# Improved Branch-Cut-and-Price for Capacitated Vehicle Routing

D. Pecin (1), A. Pessoa (2), M. Poggi (1), and E. Uchoa (2)

(1) Departamento de Informática, Pontifícia Universidade Católica do Rio de Janeiro, Brazil

(2) Departamento de Engenharia de Produção, Universidade Federal Fluminense, Brazil

Presenting author: **Marcus Poggi**

## Abstract

The best performing exact algorithms for the Capacitated Vehicle Routing Problem developed in the last 10 years are based in the combination of cut and column generation. Some authors only used cuts expressed over the variables of the original formulation, in order to keep the pricing subproblem relatively easy. Other authors could reduce the duality gaps by also using a restricted number of cuts over the Master LP variables, stopping when the pricing becomes prohibitively hard. A particularly effective family of such cuts are the Subset Row Cuts. This work introduces a technique for greatly reducing this impact on the pricing of these cuts, thus allowing much more cuts to be added. The newly proposed Branch-Cut-and-Price algorithm also incorporates and combines for the first time (often in an improved way) several elements found in previous works, like route enumeration and strong branching. All the instances used for benchmarking exact algorithms, with up to 199 customers, were solved to optimality. Moreover, some larger instances with up to 360 customers, only considered before by heuristic methods, were solved too. Below we graphically present two new optimal solutions.

**Keywords:** Column Generation, Cut Separation, Algorithmic Engineering

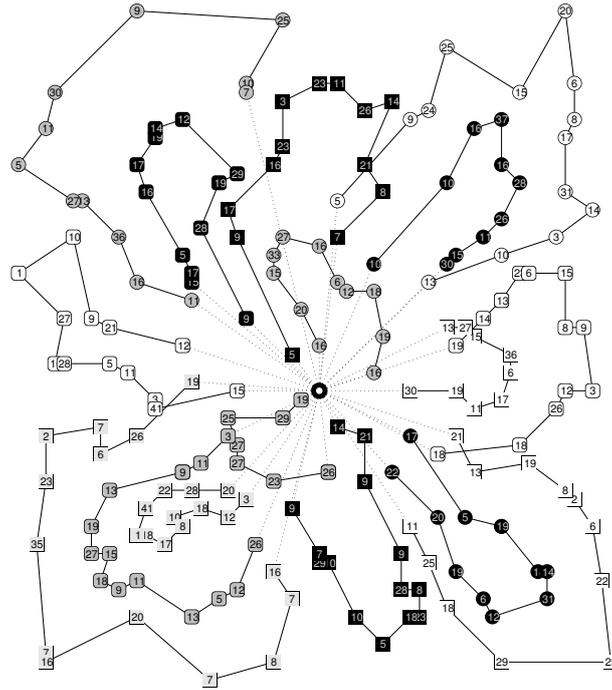


Fig. 1. Optimal solution of M-n200-k16, value 1274

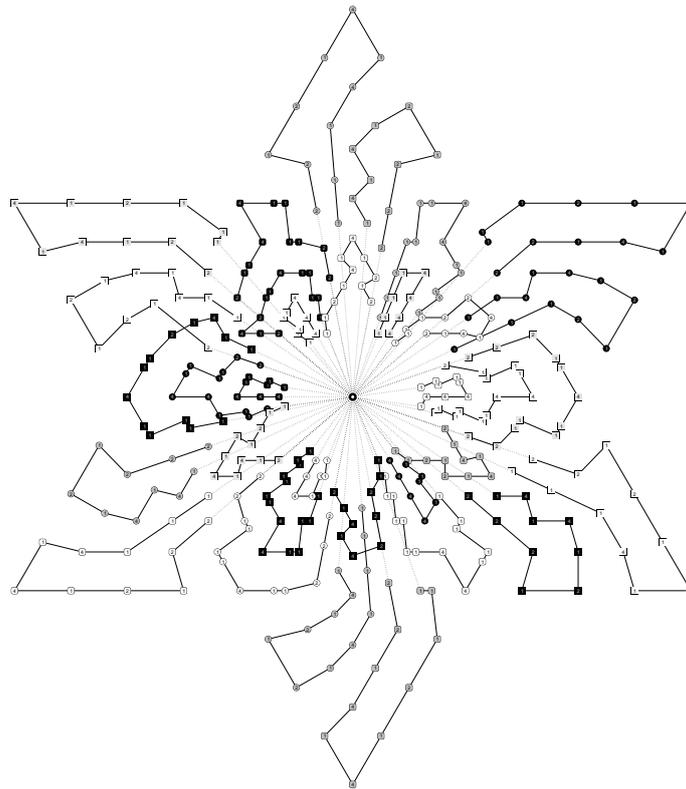


Fig. 2. Optimal solution of G19, value 1365.60