Lagrangian duality applied to the vehicle routing problem with time windows

This paper considers the vehicle routing problem with time windows, where the service of each customer must start within a specified time interval. We consider the Lagrangian relaxation of the constraint set requiring that each customer must be served by exactly one vehicle yielding a constrained shortest path subproblem. We present a stabilized cutting-plane algorithm within the framework of linear programming for solving the associated Lagrangian dual problem. This algorithm creates easier constrained shortest path subproblems because less negative cycles are introduced and it leads to faster multiplier convergence due to a stabilization of the dual variables. We have embedded the stabilized cutting-plane algorithm in a branch-and-bound search and introduce strong valid inequalities at the master problem level by Lagrangian relaxation. The result is a Lagrangian branch-and-cut-and-price (LBCP) algorithm for the VRPTW. Making use of this acceleration strategy at the master problem level gives a significant speed-up compared to algorithms in the literature based on traditional column generation. We have solved two test problems introduced in 2001 by Gehring and Homberger with 400 and 1000 customers respectively, which to date are the largest problems ever solved to optimality. We have implemented the LBCP algorithm using the ABACUS open-source framework for solving mixed-integer linear-programs by branch, cut, and price.

General information
Publication status: Published
Organisations: Logistics & ITS, Department of Transport, Operations Research, Department of Informatics and Mathematical Modeling
Contributors: Kallehauge, B., Larsen, J., Madsen, O. B.
Pages: 1464-1487
Publication date: 2006
Peer-reviewed: Yes

Publication information
Journal: Computers & Operations Research
Volume: 33
Issue number: 5
ISSN (Print): 0305-0548
Ratings:
Scopus rating (2006): SJR 1.339 SNIP 2.277
Web of Science (2006): Indexed yes
Original language: English
Source: orbit
Source ID: 186410
Research output: Contribution to journal › Journal article – Annual report year: 2006 › Research › peer-review