Author's Accepted Manuscript

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www.elsevier.com/locate/caor

PII: S0305-0548(16)30201-5
DOI: http://dx.doi.org/10.1016/j.cor.2016.08.006
Reference: CAOR4061

To appear in: *Computers and Operation Research*

Received date: 14 August 2015
Revised date: 8 August 2016
Accepted date: 10 August 2016

Cite this article as: Yuning Chen and Jin-Kao Hao, An iterated "hyperplane exploration" approach for the Quadratic Knapsack Problem, *Computers and Operation Research,* http://dx.doi.org/10.1016/j.cor.2016.08.006

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An iterated "hyperplane exploration" approach for the Quadratic Knapsack Problem

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Submitted 14 Aug. 2015 / Revised 21 March 2016 / ***Minor revised 8 Aug 2016***

Abstract

The quadratic knapsack problem (QKP) is a well-known combinatorial optimization problem with numerous applications. Given its NP-hard nature, finding optimal solutions or even high quality suboptimal solutions to QKP in the general case is a highly challenging task. In this paper, we propose an iterated "hyperplane exploration" approach (IHEA) to solve QKP approximately. Instead of considering the whole solution space, the proposed approach adopts the idea of searching over a set of hyperplanes defined by a cardinality constraint to delimit the search to promising areas of the solution space. To explore these hyperplanes efficiently, IHEA employs a variable fixing strategy to reduce each hyperplane-constrained sub-problem and then applies a dedicated tabu search procedure to locate high quality solutions within the reduced solution space. Extensive experimental studies over three sets of 220 QKP instances indicate that IHEA competes very favorably with the state-of-the-art algorithms both in terms of solution quality and computing efficiency. We provide additional information to gain insight into the key components of the proposed approach.

Keywords: Quadratic Knapsack problem; Hyperplane exploration; Tabu search; Variable fixing; Heuristics.

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