International Journal of Innovative
Computing, Information and Control
Volume **7**, Number **4**, April **2011**

ICIC International ©2011 ISSN 1349-4198
pp. **1819–1829**

APPLICATION OF A HEURISTIC ALGORITHM TO MIXED-INTEGER BI-LEVEL PROGRAMMING PROBLEMS

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Received December 2009; revised April 2010

Abstract. *In this paper, we consider a mixed-integer bi-level linear programming (or a leader's) problem with one parameter in the right-hand side of the constraints in the lower level (or a follower's) problem. Motivated by the application to a natural gas cash-out problem, we consider a particular case that consists in minimizing the cash-out penalty costs for a natural gas shipping company. The functions are linear at both levels, and the proposed algorithm is based upon an approximation of the optimal value function using the branch-and-bound method. Therefore, at every node of this branch-and-bound structure, we apply a new branch-and-bound technique to process the integrality condition.*
Keywords: Gas cash-out problem, Integer programming, Parametric programming, Branch-and-bound approach

1. **Introduction.** Hierarchical decision making is strongly motivated by real-world applications. For example, in engineering design, the main objective of the design engineer may be constrained by the properties inherent in the process (such as minimum energy), which, in turn, may be parametric in decision variables, chosen by the engineer. These problems can be formulated within a bilevel programming problem (BLP) framework, where an upper level (or, outer) optimization problem is constrained by another, lower level (or, inner) optimization problem.

Hierarchical problems also arise in the (non-simultaneous) Stackelberg games [1], in which various decision makers try to maximize their utility functions with delay. Because of that, they are often not able to realize their decisions independently and at the same time, but are forced to act according to certain hierarchy. We will consider the simplest case of such a situation, where there are only two acting decision makers. The leader is