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Integer Programming Benders Decomposition and Its Applications

Yingyi Chu

Centre for Planning and Resource Control
Imperial College London, England

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Benders decomposition is a fundamental technique for solving large-scale optimization problems. However, it has long been restricted to continuous problems. In this talk we present a theory of integer programming Benders decomposition. The foundation is laid on a *complete representation* of the Benders master problem in the presence of integer subproblems. Based on the representation theory, a class of *linear* Benders cuts is derived, by which the finite convergence of the Benders algorithm is guaranteed. Computationally, generating a linear Benders cut only involves solving a simple linear program (cut generation program). Finally, a practical integer programming Benders decomposition algorithm is presented. The proposed algorithm is applied to the parallel machine scheduling problem arising in many manufacturing and supply chain management applications. The problem is modeled as an integer (or mixed integer) program, and it naturally decomposes into an assignment master problem and a number of scheduling subproblems. Computational results have shown that the proposed algorithm could substantially reduce the solving time, compared with commercial mixed integer programming (MIP) solvers. A second application is a bandwidth planning problem from network traffic engineering. A *temporal decomposition* approach is employed to exploit the problem structure, which fits into the framework of integer programming Benders decomposition. Again the results have shown the benefits of using the proposed algorithm, in terms of solving time and solution quality.

Yingyi Chu is currently a Ph.D. candidate in Optimization at Imperial College London, England, expecting to complete his degree in this year. He received a Masters degree from National University of Singapore, and a Bachelors degree from Tsinghua University, China. His research interests include discrete optimization, decomposition theory, scheduling, network optimization, hybrid algorithms and constraint programming.

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