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FOREWORD

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This special issue of Computational Management Science consists of five papers and is dedicated to **Professor Nicos Christofides** to celebrate his achievements. These papers, whose authors are former students, colleagues and friends of Nicos, cover several topics in combinatorial optimization concerning areas closely related to his research activity.

During his 40 years of academic activity Nicos has been a top level researcher, often playing a pioneering role and encompassing many combinatorial optimization areas, from theoretical results to the development of exact and heuristic algorithms for the effective solution of hard problems.

His worst-case performance guarantee heuristic algorithm for the *Travelling Salesman Problem* is a groundbreaking work and, although never published in an international journal, collected an impressive amount of citations.

His book *Graph Theory: an Algorithmic Approach*, published in 1975, has had an enormous impact not only in operational research, but also in economics and engineering.

Nicos has also been involved in successful applications of his research activity to real world problems, mainly related to distribution and financial systems.

I had the great opportunity to work with Nicos, and I was very impressed by his personality: he is one of the greatest researchers I have met, and it was really a pleasure to collaborate with him. I learned a lot from this collaboration.

The papers selected in this special issue present recent results on combinatorial optimization. They tackle important problems arising in different areas, propose

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mathematical formulations and effective exact or heuristic algorithms, and present extensive computational results to evaluate their performance.

The first paper, "*An Exact Solution Framework for a Broad Class of Vehicle Routing Problems*", by Roberto Baldacci, Enrico Bartolini, Aristide Mingozzi and Roberto Roberti, presents an exact solution framework for solving some variants of the Vehicle Routing Problem (VRP) that can be modeled as Set Partitioning problems with additional constraints. In particular, the authors derive, from the general solution framework, exact algorithms for the Capacitated VRP, the VRP with Time Windows, the Pickup and Delivery Problem with Time Windows, all types of the Heterogeneous VRP, including the Multi Depot VRP, and the Period VRP. The computational results reported in the paper show that the proposed algorithms outperform the other exact methods published so far and can solve several test instances that were previously unsolved.

The second paper, "*A Metaheuristic for the Min-Max Windy Rural Postman Problem with K Vehicles*", by Enrique Benavent, Angel Corbéran and José M. Sanchis, deals with the Multi-Vehicle Min-Max version of the Windy Rural Postman Problem. For this problem, in which the objective is to minimize the length of the longest tour to find a set of balanced tours for the vehicles, the authors present a metaheuristic, based on the combination of a multi-start procedure with an Iterated Local Search, that produces very good feasible solutions in reasonable computing times.

In the following paper, "*Reformulations and Solution Algorithms for the Maximum Leaf Spanning Tree Problem*", by Abilio Lucena, Nelson Maculan and Luidi Simonetti, the authors tackle the *NP*-hard Maximum Leaf Spanning Tree Problem, which requires, for a given graph, the determination of a spanning tree having as many leaves as possible. Two reformulations are proposed: the first one is a reinforced directed graph version of a formulation found in the literature; the second one recasts the problem as a Steiner Arborescence Problem over an associated directed graph. The corresponding Branch and Cut algorithms are computationally evaluated and compared with exact algorithms from the literature.

The fourth paper, "*A New Path-Based Cutting Plane Approach for the Discrete Time-Cost Tradeoff Problem*", by Eleni Hadjiconstantinou and Evelina Klerides, considers the problem of determining discrete time-cost tradeoffs in project networks allowing for the control of the processing time of an activity via the amount of nonrenewable resources allocated to it. For each activity, the Discrete Time-Cost Tradeoff Problem involves selecting a mode for each activity so that either: (i) the project completion time is minimized, given a budget, or (ii) the total project cost is minimized, given a deadline, or (iii) the complete and efficient project cost curve is constructed over all feasible project durations. An exact cutting plane algorithm enhanced with speed-up techniques is presented. Extensive computational results on benchmark instances show the effectiveness of the proposed algorithm.

In the last paper, "*An Approximate Solution Approach for a Scenario-Based Capital Budgeting Model*", by Anabela Costa and José M. P. Paixao, the authors consider project evaluation when the project develops stochastically over time and the decision to invest into this project can be postponed. In this case, real options techniques such as contingent claims analysis and dynamic programming can be used. Meier, Christofides and Salkin presented a scenario based model that captures risk uncer-

tainty and managerial flexibility, maximizing the time-varying of a portfolio of investment options. However the corresponding linear integer program turns out to be quite intractable even for a small number of projects and time periods. In this paper, a heuristic approach, derived from an alternative scenario based model involving a much smaller number of variables, is proposed. The approach allows the determination of reasonable quality approximate solutions with huge reductions on the computational times required for solving large size instances.

Many people contributed to make this special issue possible. First, of course, I express my gratitude to the contributors, who accepted with enthusiasm my invitation. I thank as well the referees, who timely reviewed the submissions. Finally, I wish to thank the Editors for their assistance and support.