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Προσκαλούνται οι φοιτητές, τα μέλη Δ.Ε.Π., οι διδάσκοντες του Τμήματος και κάθε ενδιαφερόμενος, στη δημόσια υποστήριξη της Διδακτορικής Διατριβής:

«Επιτάχυνση της Μεθόδου Αποσύνθεσης Benders για την Επίλυση Προβλημάτων Μικτού Ακέραιου Γραμμικού Προγραμματισμού»

“Acceleration of Benders Decomposition Method for the solution of Mixed Integer Linear Programming Problems”

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In the current thesis, the Benders Decomposition method for the solution of Mixed-Integer Linear Problems (MILP) is studied and four novel techniques are introduced for its acceleration. Two of these techniques are problem-specific, while the other two are generalized and can be applied to any MILP.

The first technique is a generalized one and addresses the case where the application of Benders decomposition method to a MILP results into a subproblem including integer variables. In this case, it is not possible to apply the classical Benders algorithm and, for this reason, a Branch-and-Cut algorithm is proposed. The integrality constraints of the subproblem are relaxed and the Benders algorithm is applied in a branch-and-bound framework. Benders cuts generated in a node of the branch-and-bound tree are proved to be valid for all its descendants. These “Local Cuts”, can be used to warm start the master problem of each descendant node, thus leading to better initial bounds. Furthermore, a novel way is presented for generalizing the “Local Cuts” (“Generalized/Global Cuts”), offering the ability to reuse the generated cuts in the whole tree. The proposed algorithm is tested on the classical Capacitated Fixed Charge Multiple Knapsack Problem (CFCMKP) and it offers a significant reduction in CPU time compared to the corresponding algorithm without “Local Cuts”.

The second technique is a problem-specific one, that addresses the Maximal Covering Location Problem (MCLP). Specifically, a Double-type Double-standard

Model (DtDsM), with several applications in determining the location of public emergency services (ex. ambulance, fire-fighting and police vehicles), is proposed. In DtDsM two types of resources are considered: normal resources, which offer full service with small coverage distance in a predetermined time, and backup resources, which offer only a primary service with greater coverage distance. Each demand point must lie within the coverage distance of a backup resource, if it does not lie in the coverage distance of a normal resource, ensuring it receives minimal primary services. For the solution of the DtDsM for MCLP an accelerated Benders decomposition algorithm is proposed, based on the exploitation of the special structure of the problem. The suggested algorithm outperforms both the commercial solver CPLEX and the classical Benders algorithm, as regards speed and accuracy.

The third technique is a generalized one, that aims at producing more efficient feasibility and optimality Benders cuts, in order to reduce the bound fluctuation and accelerate the algorithm. The main advantage of the proposed technique is that it can be easily used in every problem of the Mathematical Programming, where Benders Decomposition is applied, without any restrictions. Four different variants of the proposed algorithm are applied on a Crude Oil Scheduling formulation and promising computational results are derived.

Finally, the fourth technique is a problem-specific one, addressing the Multi-Trip Time-Dependent Vehicle Routing Problem with Time-Windows (MTTDVRPTW), which is a challenging problem of the last-mile-delivery logistics companies. Based on a literature model, a new reformulation with reduced size is suggested. The reformulation is Benders decomposed in an effective way, resulting into a subproblem with no duality gap. By exploiting the special features of the problem, several novel valid inequalities are introduced, in order to warm start the relaxed master problem and achieve less infeasible solutions and better lower bounds. For the solution of the problem, an innovative algorithm is proposed, including suboptimal master solutions and a multi-cut generation procedure, which is based on the careful observation of the values of the Benders dual subproblem variables. Two variants of the suggested algorithm are tested on benchmark data showing improved efficiency and stronger bounds than the non-decomposed models.

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