Université des Sciences et de la Technologie Houari Boumédiène
Faculté de Mathématiques
Département de Recherche Opérationnelle

Séminaire hebdomadaire de Recherche Opérationnelle
Mercredi 14/05/2025
11h30-12h30
Salle de conférences du Bolc CAM
Faculté de Mathématiques

Orator : Khadidja CHAABANE

Title : Parallel Approach for Solving the Bi-objective Knapsack Problem

Abstract

This presentation focuses on an innovative parallel approach applied to the solution of the bi-objective knapsack problem. This problem is a representative example of com-binatorial multi-objective optimization (MOCO), aimed at identifying a set of efficient solutions offering the best possible compromises between two typically conflicting objectives. The adopted methodology relies on a rigorous mathematical modeling of the problem, where solutions are evaluated according to Pareto dominance, a key concept in multi-criteria analysis. An exact two-phase method is used: the first phase generates supported efficient solutions by exploiting the convexity of the Pareto front using a dichotomic strategy; the second phase aims to discover unsupported efficient solutions to complete the front. To overcome the increasing computational complexity, especially with large datasets, a parallel implementation was developed using a hybrid CPU-GPU architecture and the CUDA language, leveraging the massive parallelism offered by GPUs. The implemented algorithms, particularly optimized using the Branch and Bound method, achieved a dramatic reduction in computation time up to 43 times faster than sequential approaches while maintaining high accuracy. These results were validated on datasets of varying sizes (from 50 to 500 items) and outperformed other methods such as vOptSolver. The perspectives of this work include better exploitation of hardware resources, inte- gration of metaheuristics and artificial intelligence to solve more complex problems, and practical applications in logistics, industrial planning, and resource management. Overall, this approach convincingly demonstrates the power and relevance of parallel computing for efficiently solving large-scale MOCO problems.

Keywords : Combinatorial multi-objective optimization; knapsack problem; two-phase method; supported efficient solution; unsupported efficient solution; CPU-GPU architecture; CUDA.

References

[1] Chaabane, K., Bouroubi, S. and Djellouli, Y. (2024). Parallel implementation of an exact two-phase method for the biobjective knapsack problem. RAIRO-Operations Research, 58(4), 3347-3367.

[2] Kantour, Nedjmeddine, Khadidja CHAABANE, and Sadek BOUROUBI. "Entropy-based Reduction Operator for Heuristic Binary Optimization." Bulletin du Laboratoire 2 (2024): 1-23.

[3] Ulungu, Ekunda Lukata, and Jacques Teghem. "The two phases method: An efficient procedure to solve bi-objective combinatorial optimization problems." Foundations of computing and decision sciences 20.2 (1995): 149-165.