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Solving Hard Instances from Knapsack and Bounded Knapsack Problems: A New State-of-the-Art Solver

Abstract: The Knapsack Problem and the Bounded Knapsack Problem are classical optimization problems of fundamental importance in combinatorial optimization, integer programming, and operations research. Although both problems admit simple pseudo-polynomial-time dynamic programming algorithms, highly optimized exact solvers can often exploit their structure to achieve much faster practical performance. A prominent example is COMBO, a knapsack solver proposed more than 20 years ago that remains remarkably efficient on large-scale instances, frequently exhibiting runtimes close to O(n log n) in practice, even when both the number of items and the knapsack capacity are large. Nevertheless, several benchmark instances continue to pose significant challenges for state-of-the-art exact algorithms.

This talk presents the paper Solving Hard Instances from Knapsack and Bounded Knapsack Problems: A New State-of-the-Art Solver, by Renan F. F. da Silva, Thiago A. de Queiroz, and Rafael C. S. Schouery. The paper introduces RECORD, an enhanced exact solver designed to preserve the practical efficiency of COMBO while substantially improving performance on hard instances. The proposed approach combines algorithmic refinements with careful computational engineering, enabling RECORD to outperform both COMBO and BOUKNAP on challenging benchmark sets, often by several orders of magnitude. Overall, the talk highlights how problem-specific insights and well-designed algorithmic improvements can lead to meaningful advances in the exact solution of classical optimization problems.

Biography: Renan Fernando Franco da Silva is a master's student in Computer Science at the Institute of Computing of the University of Campinas (UNICAMP), Brazil. His master's research focuses on developing a combinatorial branch-and-bound algorithm for the one-dimensional cutting stock problem. From February to August 2025, he conducted an academic research exchange at the University of Modena and Reggio Emilia, Italy, under the supervision of Prof. Manuel Iori. During his undergraduate studies, he developed a branch-and-price-and-cut framework for cutting, packing, and related problems. This framework established the state of the art for five classical problems, including the one-dimensional cutting stock problem, and was published in the INFORMS Journal on Computing.

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Mardi / Tuesday

16 juin / June 16th, 2026

10 h

Université Laval

Responsable / Organizer:
Jean-François Côté