List of publications

Title: Influence Maximization in Hypergraphs using Multi-Objective Evolutionary Algorithms [paper] [code]
Year: 2024
Venue: 18th International Conference on Parallel Problem Solving From Nature (website)
Authors: Stefano Genetti, Eros Ribaga, Elia Cunegatti, Quintino Francesco Lotito, Giovanni Iacca
Abstract: The Influence Maximization (IM) problem is a well-known NP-hard combinatorial problem over graphs whose goal is to find the seed set of nodes in a network that spreads influence at most. Among the various methods for solving the IM problem, evolutionary algorithms (EAs) have been shown to be particularly effective. While the literature on the topic is particularly ample, only a few attempts have been made at solving the IM problem over higher-order networks, namely extensions of standard graphs that can capture interactions that involve more than two nodes. Hypergraphs are a valuable tool for modeling complex interaction networks in various domains; however, they require rethinking of several graph-based problems, including IM. In this work, we propose a multi-objective EA for the IM problem over hypergraphs, aiming at minimizing the seed set size while maximizing influence. Smart initialization and hypergraph-aware mutation operators are utilized to facilitate algorithm convergence. While the existing methods rely on greedy or heuristic methods, to our best knowledge this is the first attempt at applying EAs to this problem. Our results over nine real-world datasets and three propagation models, compared with five baseline algorithms, reveal that our method achieves in most cases state-of-the-art results in terms of hypervolume and solution diversity.

Title: Evolutionary Reinforcement Learning for Interpretable Decision-Making in Supply Chain Management
Year: 2025
Venue: Evostar, The Leading European Event on Bio-Inspired AI
Authors: Stefano Genetti, Alberto Longobardi, Giovanni Iacca
Abstract: In the context of Industry 4.0, Supply Chain Management (SCM) faces challenges in adopting advanced optimization techniques due to the “black-box” nature of most AI-based solutions, which causes reluctance among company stakeholders. To overcome this issue, in this work, we employ an Interpretable Artificial Intelligence (IAI) approach that combines evolutionary computation with Reinforcement Learning (RL) to generate interpretable decision-making policies in the form of decision trees. This IAI solution is embedded within a simulation-based optimization framework specifically designed to handle the inherent uncertainties and stochastic behaviors of modern supply chains. To our knowledge, this marks the first attempt to combine IAI with simulation-based optimization for decision-making in SCM. The methodology is tested on two supply chain optimization problems, one fictional and one from the real world, and its performance is compared against widely used optimization and RL algorithms. The results reveal that the interpretable approach delivers competitive, and sometimes better, performance, challenging the prevailing notion that there must be a trade-off between interpretability and optimization efficiency. Additionally, the developed framework demonstrates strong potential for industrial applications, offering seamless integration with various Python-based algorithms.

Status: accepted but currently not publicly available.

Title: An Intelligent Digital Twin based on Machine Learning for Interpretable Decision-making in Manufacturing
Year: 2025
Venue: International Journal of Production Economics (website)
Authors: Stefano Genetti, Giorgio Scarton, Marco Formentini, Giovanni Iacca
Abstract: In the context of Industry 4.0, several technologies converge to orchestrate improvements in business performance. Among these, Artificial Intelligence (AI) and Digital Twins (DTs) stand out as some of the most promising. These two technologies are connected through the concept of intelligent DTs (iDTs), which enhance standard DTs with intelligent capabilities while keeping humans at the core of the process. One of the main obstacles to the broad adoption of iDTs in operations and supply chains is the reliance on opaque AI models, which often limit trust and acceptability among operations experts and managers. To address this, it is critical to design iDTs that not only leverage the advanced capabilities of AI but also provide interpretable and actionable insights to stakeholders. In this paper, we present an action research in Adige Spa to develop an iDT framework for production scheduling. Our framework integrates interpretable machine learning techniques, employing evolutionary learning to produce decision trees that are transparent by design. Additionally, we incorporate Large Language Models (LLMs) to explain decision tree policies in natural language, enhancing user understanding. The framework also facilitates human interaction, allowing users to express preferences and guide the tree learning process. Results in a hybrid flow shop setting demonstrate that the proposed iDT framework delivers interpretable and effective decision-support policies while empowering users to influence and refine its outcomes, hence bridging the gap between AI-driven insights and real-world applicability.

Status: rebuttal phase.

Title: A Hybrid Constrained Programming with Genetic Algorithm for the Job Shop Scheduling Problem
Year: 2025
Venue: 10th Workshop on Industrial Applications of Metaheuristics (website)
Authors: Alessandro Lorenzi, Stefano Genetti, Chiara Camilla Rambaldi Migliore, Giovanni Iacca
Abstract: The Job Shop Scheduling Problem (JSSP) is a widely studied NP-hard optimization problem with significant academic and industrial relevance, particularly in the context of Industry 4.0, where efficient scheduling algorithms are crucial for improving decision-making in increasingly automated production systems. Despite extensive theoretical advancements, a gap remains between academic research and real-world implementation, as most studies either focus on theoretical aspects or emphasize numerical advantages while neglecting practical deployment challenges including those related to computational constraints. To fill this gap, we propose a hybrid optimization approach, HCPGA, which integrates a state-of-the-art Constraint Programming (CP) solver, CP-SAT, with a custom Genetic Algorithm (GA). The CP solver generates feasible solutions, which are then used to initialize the GA's population. The GA further optimizes the schedule,

minimizing the makespan. Our experimental evaluation on 74 JSSP benchmark instances of varying sizes demonstrates that, while standalone CP-SAT and HCPGA achieve comparable makespan results, the latter significantly reduces the time and memory required to find a good solution. This makes our approach highly valuable for industrial applications. To our knowledge, this is the first attempt to combine an evolutionary approach with an exact solver for solving the JSSP, specifically addressing the need for computational efficiency.

Status: currently under review.