

Elegance of Simplicity: Designing Metaheuristics for Real-World Applications

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Abstract. Metaheuristics serve as the primary building blocks for modern industrial solvers and complex optimization engines. While their flexibility allows for rapid integration into both academic frameworks and practical software, the pursuit of performance often leads to their over-engineered designs. Beyond that, we emphasize the idea of simplicity and simplification in algorithm design as the keys to generality and robustness. Drawing on a wide range of successful applications, we show how distilling algorithms to their core principles leads to better outcomes. We present case studies across several optimization challenges: implementing slack induction by string removals in vehicle routing, utilizing iterative forward search in course timetabling, and applying local search in grid scheduling and warehouse planning. Furthermore, we discuss how cross-domain hyper-heuristics benefit from this philosophy. With a focus on robust performance across diverse and complex domains, designing simple(r) algorithms can advance the current state of the art.