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Benchmarking discrete optimization heuristics: from building a sound experimental environment to algorithm configuration

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Propositions

accompanying the thesis

Benchmarking Discrete Optimization Heuristics:
From Building a Sound Experimental Environment to Algorithm Configuration

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1. The normalized standard bit mutation, which allows controlling the variance of the mutation strength distribution independently from its mean, can help evolutionary algorithms obtain better results via transiting from global to local search behavior. [Chapter 4]

2. The optimal crossover probability of the genetic algorithm on LeadingOnes increases with the population size, whereas for fixed population size, it decreases with increasing dimension. This finding suggests that non-asymptotic runtime analysis (i.e., bounds that hold for a fixed dimension rather than in Big-O notation) could shed new light on our understanding of evolutionary algorithms. [Chapter 4]

3. Pairing fast mutation and crossover can yield advantages in solving more difficult optimization problems when compared to standard bit mutation. [Chapter 5]

4. Algorithm configurators struggle to find the optimal configurations of the genetic algorithm when those configurations obtain boundary values for hyperparameters. [Chapter 6]

5. Algorithm configurators can obtain better configurations of the genetic algorithm regarding the expected running time by tuning for the area under the empirical cumulative distribution function. [Chapter 6]

6. While more and more algorithms are proposed for specific problems, guidelines on which algorithms favor which kinds of problems are scarce.

7. Massive, systematic, and rigorous benchmarking studies, which can serve as the base for automated configuration, meta-learning, and in-depth performance analysis, are essential for an unbiased understanding of iterative optimization heuristics.

8. The benchmarking software IOHprofiler provides a modular benchmarking pipeline, allowing for an easy transition from the implementation of algorithms to the analysis and comparison of performance data.

9. Although existing algorithm configurators have achieved success in finding better configurations than manual settings, they can be further improved by incorporating principles from advanced optimization techniques.

10. The optimal hyperparameter settings of evolutionary algorithms are usually dynamic during the optimization process. However, it remains a challenging question of how to learn these optimal settings online.

11. We learn from our achievements in science. Those learnings then result in even more achievements.