

Black-Box Complexity—A Complexity Theory for Evolutionary Computation

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Topic: As in classic algorithmics, also in evolutionary computation the runtime analysis approach is most useful when it is complemented by a meaningful complexity theory. In the last few years, black-box complexity—a notion introduced by Droste, Jansen, and Wegener in their seminal 2006 *Theory of Computing Systems* paper—has gained more and more attention. Several deep and surprising results were well received by both the EC community and the classic algorithms community.

The black-box complexity of a problem, in simple words, is the minimum number of fitness evaluations needed to solve it when using black-box optimization algorithms like, e.g., evolutionary algorithms. Comparing the black-box complexity with the runtime of an evolutionary algorithm allows us to judge how good the algorithm is. If they are equal, no better evolutionary algorithm can exist for this problem. For many problems, however, we observe a significant gap between the black-box complexity and the runtime of the best known randomized search heuristic. For such problems, we need to analyze where this gap comes from. This already has led to the design of novel and superior evolutionary algorithms.

This tutorial gives a gentle introduction to the young area of black-box complexity aimed at an audience with no previous experience in this topic. The audience will

- observe how such a complexity theory shapes our understanding of how difficult a problem is to be solved by EC approaches;
- gain an overview of the most important black-box results of the last five years;
- learn the most useful methods to derive black-box complexity results, which are taken from combinatorial game theory, information/learning theory, randomized algorithmics, and theory of EC;
- see how to use findings in black-box complexity to design superior evolutionary algorithms.