Oliver Kramer

Self-Adaptive Heuristics for Evolutionary Computation

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Abstract

Evolutionary algorithms are biologically inspired meta-heuristics. They perform randomized search with the help of genetic operators. The success of evolutionary search is often a result of proper parameter settings and knowledge, the practitioner integrates into the heuristics. An extended taxonomy for parameter setting techniques is proposed. Self-adaptation is an implicit parameter adaptation technique enabling the evolutionary search to control the strategy parameters automatically by evolution.

Evolution strategies exhibit plenty of mutation operators from isotropic Gaussian mutation to the derandomized covariance matrix adaptation. The biased mutation operator proposed in this book is a self-adaptive operator biasing mutations into beneficial directions. Our experimental analysis reveals that biased mutation is appropriate for search at the boundary of constrained search spaces. Another successful example for self-adaptive mutation is self-adaptive inversion mutation proposed in this work. Its strategy parameters determine the number of successive inversion mutations, i.e. swaps of edges in graphs. Experimental analysis and statistical tests show that the operator is able to speed up the optimization, in particular at the beginning of the search. A convergence analysis shows that self-adaptive inversion mutation converges to the optimum with probability one after a finite number of iterations.

Crossover is the second main operator of evolutionary search. The book proposes self-adaptive enhancements for structural crossover properties like crossover points. The experimental analysis reveals that the link between strategy parameters and fitness is weak for the proposed properties. At the end, the work concentrates on self-adaptation of step sizes in constrained search domains. It may result in premature fitness stagnation. We prove premature convergence for a (1+1)-EA under simplified conditions. Adaptive constraint handling heuristic are introduced that offer useful means to overcome premature stagnation.

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