Evolutionary Algorithms for Solving Real-World Problems An Introduction

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Abstract

Evolutionary Algorithms are a class of nonlinear, direct global optimization algorithms gleaned from the model of organic evolution, using principles of mutation, recombination, selection, and a population of candidate solutions to a given problem. Traditionally, members of this class of algorithms include e.g. genetic algorithms, evolutionary programming, and evolution strategies, but the borders between these different classes of instances disappeared over the past decade and lots of hybrid algorithms have been proposed.

This presentation focuses on the algorithmic aspects of evolutionary algorithms, in particular the differentiation between genetic algorithms and evolution strategies, and on practical applications of these algorithms which prove their suitability and superiority for hard industrial optimization problems. As evolution strategies are generally more difficult concerning their algorithmic components, some emphasis will be put on this class of algorithms.

In particular, evolution strategies have proven to be useful in case of challenging, practical optimisation problems involving high-dimensional multimodal search spaces under noisy / dynamic conditions of the objective function. They can deliver solutions fast (i.e., with few simulator calls or function evaluations) and are well suited for multi-disciplinary and multi-objective optimisation. Moreover, they benefit from the property to self-adapt their search strategy to the needs of the objective function, such that the user is not required to tune their parameters or deal with any other aspects of the optimisation method.

Driven by properties of practical problems, evolution strategies are constantly improved and further developed in our research activities. In the presentation, we give an overview of the state of the art in evolution strategies and present some examples of practical problems that have been solved using evolution strategies.

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Figure: The evolutionary loop (left), a population on an artificial problem topology (middle), an application to an industrial problem of metal stamping process optimisation (right).