Domain-agnostic synergetic combinations of global optimization metaheuristics

Project objectives

The development of optimization algorithms that we have seen in recent years tends toward specialization. In particular, in the domain of continuous optimization, there exist several well-known benchmarks that remain constant or change relatively little over the years. This has resulted in a clear tendency to develop increasingly efficient algorithms devoted to increasing the performance on the above and other established benchmarks. State-of-the-art solutions primarily require laborious setting of multiple initial parameters, which in real-world scenarios can be difficult, if at all possible.

In this view, we would advocate the need to shifting the focus of the global optimization research community from the highly specialized approaches towards more universal problem-agnostic approaches. demonstrating high performance across various classes of optimization problems.

Research plan

The focus of the project is on development of generally applicable problem-agnostic optimization approaches that would be ready to use with no specific tuning, parameter adaptation or application of specific auxiliary mechanisms, such as restarts. On a general note, the research will concentrate on the following five topics (T1-T5).

(T1): The use of a neural network for on-line adaptation of the optimization process parameters.

(T2): Sampling-based selection of a particular optimization algorithm to be used in a current state of the optimization process.

(T3): Efficient information exchange between two (or more) instances of the same algorithm, though with different parameterizations, or between two (or more) optimization algorithms with different underlying operational principles.

(T4): Elimination or high reduction of the restart mechanisms by means of online monitoring of the progress of the optimization process with the aim to prevent the process from being stuck in a local minimum.

(T5): Theoretical analysis of the local and asymptotic properties of the developed algorithms based on the construction of a formal model of these methods based on the Markov chain framework.

Expected outcomes

The outcomes of the project will, first of all, include a set of generic optimization methods applicable in a problem-agnostic scenario. The source code of the methods will be made freely available for research purposes and the algorithms will be provided to the research community in a ready-to-use form.

Furthermore, a set of deliberately selected test problems will be composed into a comprehensive benchmark with the aim of their use by other researchers for evaluation and assessment of their algorithms. This benchmark will be made freely available for the research community and will be curated by the project members in the future, after completion of the project.

Last but not least, the conducted research will allow for building a qualified research team composed of senior researchers, PhD students and master students. Two doctoral theses and four master theses related to the project scope are planned to be submitted within two-year period after the project completion (i.e., within a period of 5 years since the project onset).