Abstract

Genetic Algorithms (GAs) are a class of evolutionary algorithms inspired by the processes of natural evolution. A growing body of literature demonstrates that GAs seem particularly suitable to solve complex problems by maintaining a population of solutions to provide high quality Pareto-Optimal Frontier (POF). However, their main drawback is high computational cost due the high volume of computing operations as an inherent feature of GAs. Moreover, the existing approaches are not always sufficient for new instances of Multi-Objective Optimization Problems (MOOPs). Also, performance of GAs to solve unseen problems may vary due to stochastic nature of GAs and complexity of the problem.

To address the problem of high computational cost in GAs, we propose and introspective framework called Introspective Framework for Configuration of GAs (IFCGA) for inspection of stochastic optimization process during and after execution of GA and reflection on the observational findings which may have impact on computational cost of such execution. The theoretical and practical constituents of the framework are constructed through a bottom-up approach including a data-driven methodology, a tool suit and a list of refinements to improve the performance of the GAs.

The inspection phase consists of 1) a Monitorable GA (MGA) as a modified version of GA to monitor the evolution of POF through a number of identified parameters, 2) a list of proposed Progress Indicators (PIs) to measure the performance and convergence progress of the GA, and 3) a tool suit called Design Support Tool (DST) to support the inspection process by visualization, manipulation and data analysis for a given POF. The inspection output is an analytical report incorporated by the DST's user, either a domain expert or an algorithm developer for reflection purposes. The inclusion of the reflection phase ensures mapping the introspected knowledge to a desired/optimal configuration for the GA or to refine the existing MOOP model in terms of problem complexity.

IFCGA is implemented by extending Controleum which is designed as a generic framework for multi-objective optimization purposes to support the development of MGA, PIs and to monitor the introspective data. DST is designed and implemented as a stand-alone executable software. A tutorial for application of DST on real-life scenarios is also provided.

The framework is validated by conducting experiments on instances of both general and domain specific problems, namely: 0/1 Knapsack and Building Automation System (BAS). The experiments indicate that the proposed approaches are capable of inspecting a GA to derive insights about the existing relationship and correlation between the introspective parameters and computational cost to reach convergence. Consequently, the introspected knowledge can be mapped to desired/optimal design to improve the overall performance of GAs.