

A comprehensive comparison of evolutionary optimization limited by number of evaluations against time constraints

Abstract

In this study, the importance of optimization problems constrained by time is highlighted. Practically allevolutionary optimization studies have focused exclusively on the use of number of fitness evaluations as the constraining factor when comparing different evolutionary algorithms (EAs). This investigation represents the first study which empirically compares EAs based on time-based constraints against number of fitness evaluations. EAs which yield an optimum or near-optimum solutions is crucial for real-time optimization problems. Which EAs are able to provide near optimum solutions in time limited real-time optimization problems has never been answered before. To find out the answer for this question, four well-known and most commonly-used algorithms are tested. Particle swarm optimization (PSO), Differential Evolution (DE), Genetic Algorithms (GA), and Covariance Matrix Adaptation Evolution Strategy (CMA-ES) are tested in three different setups of experiments. A comprehensive and latest global optimization benchmark test suite is used in the form of the CEC 2015 Global Optimization Competition's 15 scalable test problems. The first experiment is to test the performance of these algorithms in expensive benchmark optimization problems that limit the number of fitness evaluations to $50N$ where N represents the number of optimization dimensions. The second experiment allows these algorithms to run up to the full $10000N$ evaluations. The last experiment will compare the performance of these algorithms limited by time to 300 milliseconds. The results obtained shows that DE can perform well in the $50N$ and $10000N$ evaluation. Critically, we have shown for the first time that in time-limited situations, DE is also the frontrunner by obtaining clearly better results compared to the other three well-known and widely used EAs.