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A novel multi-swarm algorithm for optimization in dynamic environments based on particle swarm optimization

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ABSTRACT

Optimization in dynamic environment is considered among prominent optimization problems. There are particular challenges for optimization in dynamic environments, so that the designed algorithms must conquer the challenges in order to perform an efficient optimization. In this paper, a novel optimization algorithm in dynamic environments was proposed based on particle swarm optimization approach, in which several mechanisms were employed to face the challenges in this domain. In this algorithm, an improved multi-swarm approach has been used for finding peaks in the problem space and tracking them after an environment change in an appropriate time. Moreover, a novel method based on change in velocity vector and particle positions was proposed to increase the diversity of swarms. For improving the efficiency of the algorithm, a local search based on adaptive exploiter particle around the best found position as well as a novel *awakening–sleeping* mechanism were utilized. The experiments were conducted on Moving Peak Benchmark which is the most well-known benchmark in this domain and results have been compared with those of the state-of-the art methods. The results show the superiority of the proposed method.

1. Introduction

Optimization is considered among the most important problems in mathematics and sciences. The importance of optimization and its numerous applications has inspired the scientists to investigate on different aspects of it. Optimization problems could be seen in real-world applications, e.g. itinerary selection. The goal in all optimization problems is to maximize or minimize one or more cost functions in a problem considering its limitations. While there are a limited number of limitations in a problem space, it can be solved easily. However, increasing limitations leads to an NP-hard problem which needs a high computational cost to be solved. Therefore, researchers are continually seeking the efficient ways for solving such NP-hard problems. Meta-heuristic methods are among these techniques.

Meta-heuristic methods present a computing method for solving optimization problems in which an iterative process for enhancing the obtained solution is utilized until a terminating state is reached. Until now, most existing meta-heuristic methods have focused on static problems. In such problems, the problem space remains unchanged during the optimization process. However, most optimization problems in real world are dynamic and non-deterministic, i.e. the problem search space changes during the optimization process. For example, scheduling tasks is a problem usually solved as a static optimization problem. However, by arriving of a new task during the scheduling procedure, or occurrence of some other problems such as failures in resources, the search environment is changed from a static problem into a dynamic one. As a result, the previous static solutions may no longer be applicable on the new environment. Such problems are called dynamic state optimization problems.

In static optimization problems, finding a global optimum is considered as the main goal. On the other hand, finding a global optimum is not the only goal in dynamic environments and tracking the optimum in the problem space is extremely important in this domain. In fact, the proposed methods for optimization in static environments fail to appropriately follow the optimum. Thus, such methods are not suitable to be used in dynamic environments and the necessity of finding different techniques involving different goal functions and different evaluation criteria for optimization in dynamic environments is obvious.

In this paper, a new optimization method based on PSO has been proposed, by presenting a set of consistency techniques with the problem space for optimization in dynamic environments. To

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