A Social Spider Algorithm for Global Optimization

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Abstract

The growing complexity of real-world problems has motivated computer scientists to search for efficient problem-solving methods. Metaheuristics based on evolutionary computation and swarm intelligence are outstanding examples of nature-inspired solution techniques. Inspired by the social spiders, we propose a novel Social Spider Algorithm to solve global optimization problems. This algorithm is mainly based on the foraging strategy of social spiders, utilizing the vibrations on the spider web to determine the positions of preys. Different from the previously proposed swarm intelligence algorithms, we introduce a new social animal foraging strategy model to solve optimization problems. In addition, we perform preliminary parameter sensitivity analysis for our proposed algorithm, developing guidelines for choosing the parameter values. The Social Spider Algorithm is evaluated by a series of widely-used benchmark functions, and our proposed algorithm has superior performance compared with other state-of-the-art metaheuristics.

Keywords: Social spider algorithm, global optimization, swarm intelligence, evolutionary computation, meta-heuristic.

1. Introduction

With the fast growing size and complexity of modern optimization problems, evolutionary computing is becoming increasingly attractive as an efficient tool for optimization. Depending on the nature of phenomenon simulated, evolutionary computing algorithms can be classified into two important groups: evolutionary algorithms (EAs) and swarm intelligence based algorithms. EAs, which mainly draw inspiration from nature, have been shown to be very successful for optimization among all the methods devised by the evolutionary computation community. Currently several types of EAs have been widely employed to solve real world combinatorial or global optimization problems, including Genetic Algorithm (GA), Genetic programming (GP), Evolutionary Strategy (ES) and Differential Evolution (DE). These algorithms demonstrate satisfactory performance compared with conventional optimization techniques, especially when applied to solve non-convex optimization problems [1][2].

In the past two decades, swarm intelligence, a new kind of evolutionary computing technique, has attracted much research interest [3]. The term swarm is employed in a general manner to refer to any collection of interactive agents. Swarm intelligence is mainly concerned with the methodology to model the behavior of social animals and insects for problem solving. Researchers devised optimization algorithms by mimicking the behavior of ants, bees, bacteria, fireflies and other organisms. The impetus of creating such algorithms was provided by the growing needs to solve optimization problems that were very difficult or even considered intractable.

Among the commonly seen animals, spiders have been a major research subject in bionic engineering for many years. However, most research related to spiders focused on the imitation of its walking pattern to design robots, e.g. [4]. A possible reason for this is that a majority of the spiders observed are solitary [5], which means that they spend most of their lives without interacting with others of their species. However, among the 35 000 spider species observed and described by scientists, some species are social. These spiders, e.g. *Mallos gregalis* and *Oecobius civitas*, live in groups and interact with others in the same group. Based on these social spiders, this paper formulates a new global optimization method to solve optimization problems.

Spiders are air-breathing arthropods. They have eight legs and chelicerae with fangs. Spiders have been found worldwide and are one of the most diverged species among all groups of organisms. They use a wide range of strategies for foraging, and most of them detect prey by sensing vibrations. Spiders have long been known to be very sensitive to vibratory stimulation, as vibrations on their webs notify them of the capture of prey. If the vibrations are in a defined range of frequency, spiders attack the vibration source. The social spiders can also distinguish vibrations generated by the prey with ones generated by other spiders [6]. The social spiders passively receive the vibrations generated by other spiders on the same web to have a clear view of the web. This is one of the unique characteristics which distinguishes the social spiders from other organisms as the latter usually exchange information actively, which reduces the information loss to some degree but increases

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