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RESEARCH PAPER

A new bats echolocation-based algorithm for single objective optimisation

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Abstract Bats sonar algorithm (BSA) as a swarm intelligence approach utilises the concept of echolocation of bats to find prey. However, the algorithm is unable to achieve good precision and fast convergence rate to the optimum solution. With this in mind, an adaptive bats sonar algorithm is introduced with new paradigms of real bats echolocation behaviour. The performance of the algorithm is validated through rigorous tests with several single objective optimisation benchmark test functions. The obtained results show that the proposed scheme outperforms the BSA in terms of accuracy and convergence speed and can be efficiently employed to solve engineering problems.

Keywords Optimisation · Bats echolocation · Reciprocal altruism · Bats sonar algorithm · Adaptive bats sonar algorithm

1 Introduction

In general, optimisation is the process of obtaining either the best minimum or best maximum result under specific circumstances [16, 29]. Most of the engineering problems in, for example, engineering design, manufacturing processes and control are solved by employing optimisation approaches [16]. Over the past four decades, researchers have developed various types of algorithms for solving a range of engineering optimisation problems [12]. Among these is the evolutionary and metaheuristic algorithm [25] which is based on combination of rules and randomness, simulating natural phenomena such as animal behaviours or processes of biological evolution [1, 12]. Swarm intelligence has been categorised under evolutionary algorithms. Swarm intelligence techniques are developed based upon modelling the collective behaviour of social group of living species, for instance; colony of ants, bacteria, bees, bats, birds and fish [1, 8]. In general, swarms have self-organisation and decentralised control features and all the swarm follows the same system where a population of swarm cooperates and interacts with each other in the group and the environment under certain rules during foraging or socialising purpose [8, 25].

Nowadays, swarm intelligence raised a lot of attention from the research community. There are many swarm intelligence algorithms that have developed recently to solve single objective optimisation problems. Yang [26] presented a firefly algorithm (FA) that was encouraged from the unique pattern of flashing light by a swarm of fireflies. The FA idealised from three rules; all fireflies are unisex, attractiveness is proportional to their brightness and objective function landscape determines the brightness. Yang [26] compared the performance of FA with GA and PSO on ten single objective optimisation benchmark test functions. The results indicated FA outperformed both of the algorithms regarding the efficiency and success rate. In the same year, [28] developed a cuckoo search (CS) algorithm that was based on the obligate brood parasitic behaviour of some cuckoo species. This algorithm is also integrated with the Lévy flight behaviour of some birds and fruit flies. The CS algorithm operates based on three rules inspired by cuckoo breeding behaviour. The rules are: each cuckoo lay one egg in a random nest at a time, the best nest with the highest quality of eggs will bring forward to next

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