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Short Communication

Modern Optimization Problems and its Solutions Using a Variety of Meta-Heuristic Optimization Algorithms: Application, Description, Critical Points, and Potential Future Works

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Recently, many optimizations algorithm has been proposed in the literature to solve various optimization problems either easy or even hard. In this paper, we discuss the ability of the current optimization algorithms to solve any optimization problem from the read-world. When we look into the current methods, we found many optimizers proved their ability to solve the problems.

These optimizers have been proposed based on specific behavior, and some considerations, such as Genetic Algorithm (GA), is proposed in [1], which is based on the genetic search by hyperplane sampling. Arithmetic Optimization Algorithm (AOA) [2], which is proposed by Abualigah., *et al*. in 2021. AOA is based on a mathematical presentation using the arithmetic operators. Aquila Optimizer (AO) [3] is also proposed by Abualigah., *et al*. in 2021. This optimizer mimics the Aquila's behaviors in nature during the process of catching the prey. Particle Swarm Optimization (PSO) is proposed in 1995 [4]. It is based on the concept for the optimization of nonlinear functions. Gray Wolf Optimizer (GWO) is proposed in 2014 by Marjalili., *et al*. in [4]. GWO mimics the leadership hierarchy and hunting mechanism of grey wolves in nature.

The main idea in these techniques or optimizers is that they deal with a set of solutions to find the best solution by performing a specific number of endeavors (Evolution iterations). Each solution typically contains several positions, which is based on the dimension of the problem. Each problem deal with the specific number of position related to the dimension size. For example, if we solve a clustering problem and deal with six different clusters, the dimension of the solutions is six positions. Another example, if we deal with the task scheduling problem with 150 virtual machines, the dimension of the solutions is 150 positions. Each position presents the corresponding value to make a decision.

Consequently, the question is how to formulate a mathematical model to update the position values. We figure out that many mathematical notations have been proposed in the literature. Each mathematical has distinguished characterizations to update the candidate solutions. The history of the optimization methods starts from the Genetic Algorithm and ends with today; we can not specify the last method because the generation of the optimizer is growing exponentially. Typically, two main search mechanisms in each optimizer; exploration search and exploitation search. These are the primary search mechanisms, and in each method, the search processes are categorized either to exploration or exploitation.

One search paper in [5] mentioned no efficient method to solve all the problems as "no free lunch theorems for optimization". This study encourages the authors to modify and propose new optimization methods to solve the optimization problems. Thus, every day we discover new problems that have been presented as optimization problems, which required significant efforts and contributions to find new best solutions to address these problems. Some common optimization problems from the real-world are text clustering [6], feature selection [7], tasks scheduling [8], parameter es-

timation [9], intrusion detection systems [10], image segmentation [10], industrial engineering real-world problems [11], and others [12]. These problems can be investigated further to find better solutions [13,14].

Generally, most real-world problems can be formulated as optimization problems, which can be easily investigated to find the best solution. The mathematical presentation allows the optimizers to deal with these problems according to specific design. According to the literature, this domain is successful according to the number of publications, citations, solved problems, applications, modifications, etc. It is possible to conduct new research in this area by modifying and propose new methods. Moreover, test the current problem solutions and seeks to find better solutions for that problems.

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