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A Comparative Analysis on Economic Load Dispatch Problem Using Soft Computing Techniques

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ABSTRACT

This article aims at solving Economic Load Dispatch (ELD) problem using two algorithms. Here in this article, an implementation of Flower Pollination (FP) and the Bat Algorithm (BA) based optimization search algorithm is applied. More than one objective function is hoped to be achieve in this article. The Combined Economic Emission Dispatch (CEED) problem which considers environmental impacts as well as the cost is also solved using these algorithms. Practical problems in economic dispatch include both nonsmooth cost functions having equality and inequality constraints which make it difficult to find the global optimal solution using any mathematical optimization. In this article, the ELD problem is expressed as a nonlinear constrained optimization problem which includes equality and inequality constraints. The attainability of the discussed methods is shown for four different systems with emission and without emission and the results achieved with FP and Bat algorithms are matched with other optimization techniques. The experimental results show that conferred Flower Pollination Algorithm (FPA) outlasts other techniques in finding better solutions proficiently in ELD problems.

KEYWORDS

Bat Algorithm, Combined Economic Emission Dispatch, Economic Load Dispatch, Flower Pollination Algorithm

1. INTRODUCTION

Nowadays, cloud computing, big data, and the internet of things (IoT) have become inseparable parts of modern communication and information systems. They cover various aspects of society like business, industry, finance, management, and manufacturing along with various other information and communication. Hence, it is highly necessary to remain in touch with the latest advancements, applications, current issues and challenges (Gupta & Agrawal, 2019). Soft computing techniques across the globe are used for research and development, specifically in the advancement of computing technologies and overlapping areas that are essential to take care of various research challenges in this area. In order to do so, collection of high-quality articles of recently reported research advancement in applying soft computing techniques for big data and cloud computing, engaging many topics of interest, is done (Gupta et al., 2018). To minimize the overall cost, response time and load on service provider, simulation-based deployment of the algorithms along with a comparison study with other known algorithms is done which form the field, confirms the ability of the proposed algorithm to perform best (Manasrah et al., 2019).

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ELD is among the essential issues faced in operation of a power plant or operation of power system. Due to increasing population and industrialization, demand is increasing day by day. Also fuel resources of generating plants are decreasing rapidly with passing of every day. ELD's main objective is to fulfil load demand with least cost of generation which is can be achieved only if fuel cost is reduced while maintaining system constraints (Venkatesh et al., 2003). ELD is the procedure of distributing the required demand or load between the available generators or generating units in such way or manner that the operating cost of the power plant is reduced to minimum while satisfying system constraints (Gaing 2003). Till now numerous studies on ELD has been carried out because a better result would lead us to a more major cost-effective profit. Earlier methods like lagrangian multiplier method (Yang 2010) and the gradient search method (Bouzeboudja et al., 2015) that include derivative based approach have been useful to answer ELD problems but as these techniques are sensitive to the first estimate and converge into a local optimum solution which adds to the computational difficulty, as a result of which these conventional techniques are not able to solve these problems adequately. In the last few decades, many research and techniques had been made for solving ELD problems. One of the techniques among them is Fuzzy Logic Control (FLC). FLC has shown its usefulness in control applications, but its drawback is that it requires more fine tuning and simulation work before being operational. Artificial Neural Network (ANN) is another such which has few advantages and few disadvantages, but the biggest problem of ANN is its long run time, selection of layer and also the number of neurons for each layer. In recent times new approach called Evolutionary Algorithms (EA) are being used for solving ELD problems, because of their great ability to solve non-linear objective function easily. Methods based on calculus and deterministic numeric like Newton method (Nanda et al., 1994; Wong et al., 1994), lambda-iteration method (Walters & Sheble, 1993), base point and participation factors method (Aydin 2014), the interior point method (Doju et al., 1972; Abbas et al., 2017), Non-linear programming (Dasgupta et al., 2015; Dasgupta & Ghorui, 2016) algorithms, quadratic programming algorithm (Lee & Breipohl, 1993; Wood et al., 2013; Chowdhury & Rahman, 1990), Maclaurin series approximation (Granville 1994; Lin & Chen, 2002), etc., are cannot be employed as they trap at local minimum while solving nonlinear dispatch problem which are mostly complicated for optimal scheduling (Park et al., 2005). Particle Swarm Optimization (PSO) operates in the direction of improving the vector while the Genetic Algorithm (GA) has been used for modifying the decision vectors using genetic operators (Harish 2016). Due to the complexity of the system, it is difficult to compute the complex derivatives and provide the initial trial solution (which will affect the iteration size also) and hence researchers are depending on metaheuristic algorithms (MHAs) to solve the constraint optimization problems COPs (Harish 2019). Optimization technique 'TVAC-PSO with mutation strategies' is also proposed in recent times (Patwal et al., 2018). Recently, an attractive bio-inspired method—namely the Artificial Bee Colony (ABC)—has performed outstandingly to solve different complex problems with some typical computational algorithms. The modification, hybridization and improvement strategies made ABC more attractive to science and engineering researchers (Shah et al., 2018). The main task while solving any complex problem is to reduce the uncertainty level for decision makers, in order to take a sounder and more proper decision in a reasonable time. For handling such issues, various reliability parameters of the industrial system, which depicts the behaviour of the system is addressed by various researchers recently, by quantifying the uncertainties in the data in the form of fuzzy numbers (Harish, 2017). The corresponding membership functions of the system's parameters are can be computed by formulating a nonlinear optimization model and solving it (Harish 2017).

Various global optimization technique such as Simulated Annealing (SA) or GA has been effectively used to deal with ELD problem in the past decade. GA is influenced by the size of the system which is under the study and needs a long run time or period if the system under study is of large size, in addition it also gives recurrent revisiting of the same suboptimal result (Park et al., 2005). SA method was discussed by K.P. Wong but this might be unsuccessful and could get confined in one of the local optimums (Wong & Wong, 1994). PSO had also been used as a common method for the