Solving non-convex economic dispatch problem via backtracking search algorithm

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1. Introduction

The problem of ED (economic dispatch) is a basic consideration to optimizing power system operation. ED determines the power shared among the generating units of power system to meet electrical demand while minimizing cost and satisfying system constraints.

In a convex ED problem, the cost function of a generating unit is considered as a quadratic function. Practical and non-convex ED problems, however, contain non-convex cost functions that are due to the valve-point effect of the generating units. Classical methods have been adopted to solve conventional ED problems (i.e., containing convex cost functions) but instead produce non-optimal solutions because of the non-convexity/non-linearity of practical ED problems [1]. Dynamic programming, for example, has been proposed in addressing non-convex ED problems because it does not restrict the form of the cost function; the increased dimension of the problem, however, may demand higher computational efforts [2]. Classical methods include interior point [3], quadratic programming [4], linear programming [5], Lagrangian relaxation algorithm [6], dynamic programming [7], and lambda iteration [8].

Unlike classical methods, metaheuristic methods are better options because they can handle more constraints and are able to explore the search domain effectively in finding the optimum; they include ICA (imperialist competitive algorithm) [9], CS (cuckoo search) [1], DE (differential evolution) [10], ABC (artificial bee colony) [11], PSO (particle swarm optimization) [12], TLBO (Teaching-Learning-based optimization) [13], SOA (seeker optimization algorithm) [14], MCGS (modified group search optimizer) [15], GA (genetic algorithm) [16], and HBMO (honey bee mating algorithm) [17]. DE is especially very effective because it does not need derivative information from the cost function; instead it sub-optimally or prematurely converges [17]. Other drawbacks associated with metaheuristics are high sensitivity to the control parameters, long computational time, and slow convergence to approximately optimum solution [18].

Recent hybrid methods overcome those drawbacks, able to handle the high complexities of practical ED problems. One method might be adopted for its high convergence, another for its provision of a suitable initial guess for the problem. The hybrid methods are combinations of either two or more metaheuristic methods or metaheuristic with classical techniques. Combinations of PSO with DE [17], GA with API [19], GA-LI [20], CPSO-SQP [21], and FCASO-SQP [22] perform better as hybrids than individually.

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