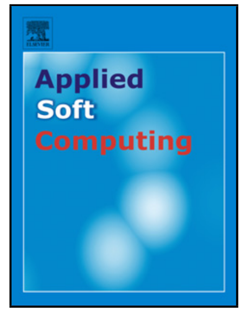

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Learning Enhanced Differential Evolution for Tracking Optimal Decisions in Dynamic Power Systems

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Abstract

Optimal power flow (OPF) refers to the problem of optimizing the operating decisions such as electric power generation in power systems, which are always subjected to dynamic factors like bus loads. Conventionally, OPF in dynamic environments has been solved by static-oriented optimization methods based on the prediction of the dynamic factors. However, as the dynamics of modern power systems become more and more complex and difficult to predict, research interest of intelligent methods that track the optimal decisions of OPF has been grown recently. Devoted to this objective, a Learning Enhanced Differential Evolution (LEDE) is proposed in this paper. LEDE incorporates the idea of nearest-neighbor rule from the field of machine learning, with which decisions of the previous environments are retrieved continually to replace the newly generated individuals of Differential Evolution. A so-called elitism stochastic ranking strategy is also proposed, used in LEDE to handle constraints of OPF. Experiments are conducted on the dynamic IEEE 30-bus system and IEEE 118-bus system, and the results show the efficiency of LEDE in comparison with other algorithms.

Keywords: Dynamic Optimal Power Flow, Differential Evolution, Learning, Evolutionary Dynamic Optimization

1. Introduction

Optimal power flow (OPF) is the problem of determining the operating decisions such as electric power generation and transmission in power systems, so that some system performance indices could be optimized [1, 2, 3]. In the decision making systems of power systems, OPF is usually formulated mathematically as a constrained optimization problem [1]. At present, optimization techniques of OPF can be divided into two categories [2, 3, 4]: mathematical programming based methods and heuristic optimization algorithms [4], such as differential evolution (DE) [5] and particle swarm optimizer (PSO) [6].

In the real world, due to the dynamic changes of the bus loads, network connections, etc., the optimal decisions of OPF could change with time. Conventionally, OPF in dynamic environments (dynamic OPF) has been solved by static-oriented optimization methods based on prediction of load patterns and operation conditions etc. However in recent years, with more new energy and electrical equipment being involved, the dynamics of the modern power systems are becoming more frequent, complex and difficult to predict [7, 8]. Therefore, some researchers argue that

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