



Performance evaluation of power system stabilizers based on Population-Based Incremental Learning (PBIL) algorithm

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ABSTRACT

This paper proposes a method of optimally tuning the parameters of power system stabilizers (PSSs) for a multi-machine power system using Population-Based Incremental Learning (PBIL). PBIL is a technique that combines aspects of GAs and competitive learning-based on Artificial Neural Network. The main features of PBIL are that it is simple, transparent, and robust with respect to problem representation. PBIL has no crossover operator, but works with a probability vector (PV). The probability vector is used to create better individuals through learning. Simulation results based on small and large disturbances show that overall, PBIL-PSS gives better performances than GA-PSS over the range of operating conditions considered.

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1. Introduction

Genetic algorithms have recently found extensive applications in solving global optimization problems [1]. GAs are search algorithms that use models based on natural biological evolution [1,2]. In the last few years, application of genetic algorithms (GAs) to design power system controllers has attracted considerable attention [3–5]. Several authors have shown that GAs provide robust and powerful adaptive search mechanism [3–5]. However, they have some limitations [5–12].

First, optimal performance of GAs depends on the optimal selection of its operators (e.g., population size, crossover and mutation rates). However, it is difficult to optimize the parameters of GAs one at a time. These parameters typically interact with one another in a nonlinear manner. In particular, optimal population size, crossover rate, and mutation rate are likely to change over the course of a single run [9–12].

Second, the problem of “genetic drift” prevents GAs from maintaining diversity in its population. Once the population has converged, the crossover operator becomes ineffective in exploring new portions of the function space [6–8].

To cope with the above limitations, many variants of GAs have been suggested often tailored to specific problems [13]. There are as many GA variants today as GA-projects. GAs users are faced with

a multitude number of choices with little theoretical guidance on how to select the appropriate one [8,12] for a particular problem.

In the last few years, several authors have used hybrid GAs to improve the performance of GAs [14–17]. In hybrid GAs, GA is combined with local search mechanism to find the optimal chromosome in a region. In [14], chaotic optimization is combined with genetic algorithm to deal with the randomness in generating initial population. In addition, annealing chaotic mutation operator is used to find the best solution in the current neighborhood area of optimal solutions. In [15], the concept and theory of quantum computing is combined with genetic algorithm to increase the diversity in the population so as to prevent premature convergence. In [16] Hebb's rule is combined with continuous genetic algorithm (CGA) to provide a simple objective function, which leads to a reduction in time needed by the CGA to identify fault section. In [17], Neuro-Fuzzy is combined with GA for tuning power system stabilizer (PSS). The parameters of the PSS are first optimized using GA then they are blended into Adaptive Neuro-Fuzzy Inference System framework. This has the effect of facilitating learning and adaptation of the chromosomes. While hybrid GA could perform better than GA, the complexity in selecting GA parameters is not reduced.

More recently, many researchers have felt the need to simplify GAs [6–8,12] by:

- (1) incorporating in GAs some kind of adaptation or learning techniques [6–8], and
- (2) making the interaction between GAs and the user as easier as possible.

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