Chapter 6

An improved Dynamic Search Fireworks Algorithm Optimizes Extreme Learning Machine to Predict Virtual Machine Fault

Shoufei Han
Nanjing University of Aeronautics and Astronautics, China

Kun Zhu
Nanjing University of Aeronautics and Astronautics, China

ABSTRACT

The Dynamic Search Fireworks Algorithm (dynFWA) is an effective algorithm for solving optimization problems. However, dynFWA is easy to fall into local optimal solutions prematurely and it also provides a slow convergence rate. To address these problems, an improved dynFWA (IdynFWA) is proposed in this chapter. In IdynFWA, the population is first initialized based on opposition-based learning. The adaptive mutation is proposed for the core firework (CF) which chooses whether to use Gaussian mutation or Levy mutation for the CF according to the mutation probability. A new selection strategy, namely disruptive selection, is proposed to maintain the diversity of the algorithm. The results show that the proposed algorithm achieves better overall performance on the standard test functions. Meanwhile, IdynFWA is used to optimize the Extreme Learning Machine (ELM), and a virtual machine fault warning model is proposed based on ELM optimized by IdynFWA. The results show that this model can achieve higher accuracy and better stability to some extent.

INTRODUCTION

Fireworks Algorithm (FWA) (Tan & Zhu, 2010) is a new intelligent optimization algorithm which has been proposed in recent years. Different from other intelligent algorithms, the main idea of FWA is to simulate the fireworks explosion to search the feasible space of the function to be optimized. Up to now,

DOI: 10.4018/978-1-7998-1659-1.ch006

FWA have been applied to many real-world optimization problems (Tan, 2015) including the decomposition of non-negative matrices (Janecek & Tan, 2011), filter design (Gao & Diao, 2011), spam parameter optimization (He, Mi, & Tan, 2013), network reconstruction (Imran,, Kowsalya, & Kothari, 2014) truss mass minimization (Pholdee & Bureerat, 2014), chaotic system parameter estimation (Li, Bai, Xue, Zhu, & Zhang, 2015), resource scheduling (Liu, Feng, & Ke, 2015), etc.

However, similar to other intelligent optimization algorithms, FWA also have the disadvantages of slow convergence and low convergence accuracy. Therefore, researchers have proposed many improved algorithms to solve these problems. Based on the analysis of the explosion operator, mutation operator, selection strategy and mapping rules of fireworks algorithm, an enhanced fireworks algorithm (EFWA) is proposed (Zheng, Janecek, & Tan, 2013). The Adaptive Fireworks Algorithm (AFWA) was proposed for the fireworks algorithm to self-adjust the explosion amplitude (Zheng, Li, & Tan, 2014) which depends on the distance between the current individual with the best individual. A dynamic search fireworks algorithm (dynFWA) was proposed (Zheng & Tan, 2014) in which divided the fireworks into core firework and non-core fireworks according to the fitness value and adaptive adjustment of explosion amplitude for the core firework. Due to simplicity and efficiency, dynFWA has attracted the attention of more and more researchers. However, dynFWA has some problems such as easy to fall into local optimal solution and slow convergence.

In order to solve these problems and further improve its performance, an improved dynFWA (IdynFWA) is proposed in this chapter. In IdynFWA, firstly, the opposition-based learning is adopted to generate initial population. Then, the Gaussian mutation or Levy mutation is chosen alternately for the core firework (CF) according to mutation probability. Finally, a novel selection strategy is proposed to maintain the diversity of the population. Experimental results show that the proposed algorithm has better overall performance on the test functions.

Extreme Learning Machine (ELM) is a new single hidden layer forward feedback neural network (Huang, Zhu, & Siew, 2006), ELM has the advantages such as fast learning speed and good generalization performance, so it is used to solve various real-world problems. ELM has demonstrated superior performance over traditional methods in some areas including face recognition (Zong & Huang, 2011), text classification (Zheng, Qian, & Lu, 2013), medical diagnosis (Wang, Yu, Kang, Zhao, & Qu, 2014), image classification (Cao, Bo, & Dong, 2013), etc. However, the input weights and offsets of the ELM are randomly generated, which can cause instability of the model. In order to maintain the stability and obtain higher accuracy, IdynFWA is used to optimize ELM which is applied to predict virtual machine fault in this chapter. Experimental results show that proposed algorithm can achieve higher accuracy and better stability.

The main contribution of this paper is shown in three aspects.

1. An improved dynFWA (IdynFWA) is proposed in this chapter.
2. By comparing the performance with FWA variants and some classic intelligent optimization algorithms on CEC2013 standard functions, the proposed algorithm can improve the overall performance.
3. The IdynFWA is applied to optimize ELM to maintain the stability and obtain higher accuracy.
4. The optimized ELM is used to predict virtual machine fault.

The remainder of this chapter is organized as follows. Section II introduces framework of dynFWA and ELM. Our proposed algorithm is presented and discussed in Section III. Section IV presents experi-

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