A New Harmony Search Algorithm with Evolving Spiking Neural Network for Classification Problems

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***Abstract*—In this study, a new hybrid harmony search algorithm with evolving spiking neural network (NHS-ESNN) for classification issues has been demonstrated. Harmony search has been used to enhance the standard ESNN model. This new algorithm plays an effective role in improving the flexibility of the ESNN algorithm in creating superior solutions to conquer the disadvantages of ESNN in determining the best number of pre-synaptic neurons which is necessary in constructing the ESNN structure. Various standard data sets from UCI machine learning are utilised for examining the new model performance. It has been detected that the NHS-ESNN give competitive results in classification accuracy and other performance measures compared to the standard ESNN. More argumentation is provided to verify the effectiveness of the new model in classification issues.**

***Index Terms*—Harmony Search; Classification; Spiking Neural Network; Evolving Spiking Neural Networks.**

I. INTRODUCTION

Patterns classification becomes very important for various data mining processes. Especially, when it is used for a decision support system [1]. Various fields in existence require classification such as medicine, handwritten character recognition, speech recognition, industry and science, medical diagnoses. Artificial neural networks (ANNs) can be considered as one of the robust classifiers because their ability to deal with noise [2]. ANNs are amongst the most well-known brain computational models and ANN solves problems that are based on standard algorithmic techniques. Spiking neural networks (SNNs), the third generation of ANNs, play a vital role in the processing of biological information [3]. Spiking models give an in-depth explanation of the behavior of biological neuron. More details are utilized with the computations average firing rate with actual neurons. In addition, the difference in firing times could be applied as an alternative of rate coding [4].

As one of the best SNN models, the evolving spiking neural network (ESNN) is utilized extensively in current studies as in [5], [6]. The ESNN has a number of profits [7] as being a competent neural model, simple and trained using a fast one-pass learning algorithm. The treatment of model evolving can be altered at whatever time new data becomes available with no constraint to train again the former existing instances. However, the ESNN has some shortcomings, i.e. finding out the optimal number of pre-synaptic neurons for a specified data set is the mainly essential one [8], [9]. Identifying the pre-synaptic neurons number is vital for the structure of ESNN like the hidden nodes or MLP. More number of pre-synaptic neurons enlarges the time computation whereas fewer of them affect the accuracy of learning. Watts [10] prefers to select the parameters of evolving connectionist systems (ECOS) training automatically. Consequently, choosing an optimization method to carry out this parameter adaptation is significant. Among the various optimization techniques, harmony search (HS) algorithm is utilized in this paper for several reasons summed up as: HS method robustness, less HS results computation and the unnecessary derivative information for HS [11]. Some researchers analyzed the performance of HS compared to the other methods. According to Soltani et al. [12], HS is better than particle swarm optimization (PSO) in convergence rate and time consuming. Moreover, it would be interesting to apply the hybridization of HS with other algorithms. Hence, this paper presents a new method to obtain an accurate and simple ESNN. The new algorithm seeks for the optimal values to achieve better accuracy and better structure of ESNN to enhance performance for classification issues. The rest sections of this study are formed as follows: Section II elaborates the methods utilized in this paper, while Section III elucidates the found results and discussion; as a final point, Section IV presents the conclusion and future works.

II. METHODS

This section offers the fundamental basis of evolving spiking neural network (ESNN) and explains the related algorithms that have been used for improvement.

Firstly, ESNN introduction has been presented. The second part concentrates on harmony search (HS) algorithm which is utilized for enhancing the classification performance. Finally, the third part focuses on the proposed method.

A. Evolving Spiking Neural Network (ESNN)

Wysoski enhanced a new model recognized as Evolving Spiking Neural Network (ESNN) [13]. In general, ESNN utilized the evolving connectionist systems (ECOS) principles where neurons are created cumulatively [14, 15]. ESNN used the one-pass propagation of the data to learn data gradually