ABSTRACT

In the past few years, the power system planning and scheduling systems have been improving day by day, and for that purpose, the need for accurate forecasts is increasing. Time-series forecasts are required for demand, electricity price, and wind and solar forecasting. The forecasts can be provided through statistical, machine learning, or hybrid methods. The Machine learning (especially the neural network) models have achieved outstanding performance in the areas like image classification, natural language processing, and time-series forecasting. Nonetheless, the architecture of neural networks significantly impacts their overall performance. Concerning the design of the most cutting-edge NNs, they are generally hand-crafted by experts in that domain, which requires heavy trial and error efforts.

On the other hand, it becomes a challenging task for users who are not experts in the NN domain to choose the best architecture for their application. Also, there is another issue that the basic NNs only sometimes suit the particular application. Therefore, several strategies have been explored for automating the designing of the NNs, like evolutionary algorithms (EAs), bayesian optimization and reinforcement learning (RL), and concatenating with some other statistical methods. Among these methods, the evolutionary algorithms have gained the maximum interest due to their less complexity and easy integration for automating the design of the NNs. Deep Neuroevolution is one such efficient class of models referring to the automated procedure and training of NNs using EAs. This thesis first describes the comprehensive analysis, survey, and evaluation of the current state-of-the-art studies on employing statistical and machine learning algorithms along with evolutionary algorithms. Then, the major issue of designing optimal probabilistic models through neural networks is being addressed along with the designing of neuroevolution models on two different case studies: one on wind forecasting and the other one on load forecasting. The experimental results show that the deep neuro-evolution models designed in this research work perform better than the other state-of-the-art algorithms.

In this thesis, deep learning-based novel algorithms are proposed in each chapter. As in Chapter 3, neural grasshopper optimized DeepAr is proposed in which the evolutionary algorithm is used for the optimization of the hyperparameters of the DeepAr and this model is tested on the GEFCom-14 and AEMO datasets and the prediction interval coverage probability (PICP) and Pinball loss (PL) for the two datasets are 0.902, 0.320 and 0.933, 1.4885, respectively. In Chapter 4, a hybrid model based on combining a deep neural network and state-space model is proposed, which utilizes the basic features of both models. This model has been tested on univariate as well as multivariate loads, and this model can be employed in areas where less data is available to the places where extensive data is available. Whereas chapter 5 proposes a novel neuroevolution algorithm based on CNN for handling the uncertainty associated with load forecasting. Also, the mean scaled interval score metric is used to evaluate the forecasts.