European Online Journal of Natural and Social Sciences 2014;
Vol.3, No.3 Special Issue on Environmental, Agricultural, and Energy Science
ISSN 1805-3602
www.european-science.com

Application Of Multi-Layered Perceptron Neural Network (MLPNN) with Consideration of Losses and Emission Dispatch

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Abstract

Nowadays, optimum generation and consumption of energy are considered as two important problems. Economic Dispatch that is the most optimum is one of important problems in power system. This paper presents a multi-layered perceptron neural network (MLPNN) method to solve the combined Losses and emission dispatch problem. Therefore, knowing Problem-Solving in Economic Dispatch is a necessity. First, the Economic Dispatch is explained and then neural network is reviewed. Next, different kinds of neural networks are mentioned by using in Economic Dispatch.

Keywords: Economic Dispatch, Neural Network, Perceptron, Losses, Emission Dispatch

Introduction

The goal of Solving ED is optimum using of generation to cover limitations such as generation of each power plant, losses, fuels, cost, employee, etc. There is no complete solution for ED with pragmatism yet. Each method have constrained in solving ED. Methods that using for ED division three sections: classical, intelligent, and compound. First section is Exhaustive Enumeration, Priority List, Dynamic Programming, Lagrangian Relaxation. These methods don't have accuracy in convergence and quality in nonlinear system. Current intelligent method for solving ED is tabu search, Simulated Annealing, Genetic Algorithm, ABC Algorithm. These methods have better accuracy and quality in nonlinear systems. But in larger systems and time calculation have problem will appear. By using compound methods such as Neural networks with Simulated Annealing and, we try to decrease the problems (faster and application in large system) of classical and intelligent method. In (Wood A. J., Wollenberg B. F., 1984), authors have investigated environmental economic dispatch via neural networks with using Hopfield network. Sample system has 15 units. In (Draidi.A., Labed.,2012), authors have investigated economic dispatch with multiple fuel types by enhanced augmented Lagrange Hopfield network. In (Slochanal ,S.M.R., Sudhakaran ,M., 2004) , authors have investigated application of multi-layered perceptron neural network to combine economic and emission dispatch with consideration losses and emission NOx. Comparison simple genetic algorithm and Refined genetic algorithm and perceptron neural network, Unit commitment etc.

Economic Dispatch Problem

The goal of Economic Dispatch is to supply amount of needed load with possible minimum cost. Economic Dispatch present as formulization minimization cost of final fuel in thermal power plant is:

$$F = Min\sum_{i=1}^{n}(a_1 + b_1P_1 + c_1P_1^2\ )$$

That is:

$$\sum_{i=1}^{n}(P_1 + P_D + P_L) = 0$$

$$P_L = \sum_{i=1}^{n}(B_1 P_1^2)$$

$$P_{\min,i} \le P_i \le P_{\max,i}$$

a_i , b_i, c_i show cost of generator i and n is the nimber of generator in net. Shows power of generator production, P_D is the measure requested power and P_L shows loss line (Wood A. J. , Wollenberg B. F).

Review in Neural Network

In 1949 Mak Kalokh and Pit introduced simple model of artificial neural network which was a simple linear model. In 1969 neural network dropped. Because if doesn't have ability solve for nonlinear systems. In 1982 Hopfield introduced multi layer networks and feedback learning algorithm and they were solutions for nonlinear problem (Draidi.A., Labed.,2012). Neural network is improving in analysis dimension, numeric dimension, etc. Neural network application in engineering problem such as signal process, Unit Commitment, etc. In this paper we will present working which is done for application of neural network in Economic Dispatch. neural network is method of human for electronic simulation of brain. Therefore, in order to understand how neural networks work, first all must know how gray cells works. Our brain is made of almost 100 billion very small units called neuron. Each of them adjoins to thousands of other neuron and tie in with them by electrochemical signals. A signal which is reach to one neuron is received by conjunctions which are branched at the end of core of neural cell. Neuron always receives signals from these entrances in itself in some way. If final results is more them of limen amount, neuron is hot and make voltage and forward signal to the cells which is called axon. Neural network is made of many artificial neurons. One artificial neuron in simple way model biologic neuron by electronic. Number of neuron which is used depends on duty performance. Figure. 2 shows different ways for conjunctions of artificial neurons to make a neural network. We will describe the more common way which is called feed forward network.

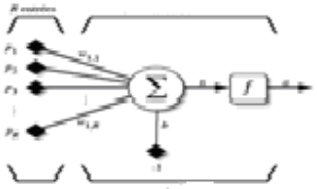

Figure1. Simple Model of Neural Network

Each entrance to neuron has its weight. Numerical weight float with binary point and these are things is adjusted while teaching neural network. There are positive and negative weights in neural network. Therefore, they can have stimulation effect on each entrance while each entrance arrive to the core, is multiplied its weight and them collect core of all entrances. Finally give output. If output be more than limen, neuron has on output signal. If stimulation be lower than one neuron output is zero. This case is showed with step function. Some formulas can be beneficial. A neuron can have from one to n number entrance. Entrances is showed with and weight with. Total of weight multiplied entrances is showed with which is called stimulation before.

$$a = x_1 w_1 + x_2 w_2 + ... + x_n w_n$$

$$a = \sum_{i=1}^{n} x_i w_i$$

If stimulation be more than limen output a is 1. Vice versa output a is zero. Some of these neuron conjunct with different ways. One of ways to organize neuron name feed forward network. Its name related to neurons of every layer grazes from output of next layer until reaching last layer of neural network. Figure 3 shows multi-layer neural network.

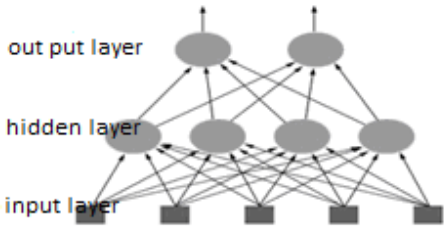

Figure 2.Multi layer neural network

Every entrance sent out to the neurons is hidden in layers. Then output neuron of this layer connected to all neuron. Every number of hidden layers with feed forward network is possible. But usually for problems we can solve, one layer is enough. More amount of neuron which is used in figure is arbitrary. One layer can have many neurons which all of them depends on this problem. Now we describe Economic Dispatch then solution of neural network is studied to make clear concept of neural network (Slochanal , & Sudhakaran , 2004) .

Description of Emission Constraints in Economic Dispatch

Economic dispatch which was explained before minimizes final cost but ignores environmental production of NOX and SO2 trepan maximum amount both of them. It is necessary due to environmental condition consider this constraints in Economic dispatch. Therefore, we will present constraints formulization.

$$MinC = W_0 F + W_1 E_S + W_2 E_N$$

E_S Reagent for pollution amount SO_2 and E_n reagent for pollution amount NO_X

$$E_S = \sum_{i=1}^{n} (d_i + e_i p_i + f_i p_i^2)$$

$$E_n = \sum_{i=1}^{n} (g_i + h_i p_i + k_i p_i^2)$$

Now if we consider emission factors in zero we will reach to economic dispatch. If consider cost factors zero, just optimize NO_X and SO_2 constraints. We can consider both of them at the same time(Yalcinoz, & Hasan, 2003). Some index paper about Perceptron neural network: in 1999 paper presented with subject of A neural-based redispatch approach to dynamic generation allocation by R.H. Liang and other partners (Liang, 1999). In 2007 paper presented with subject of A Novel Neural Network for Economic Load Dispatch with Environmental constraints by T. Sree Renga and other partners (Sree Renga, Raja, Marimuth, & Sing, 2007). In 2008 paper was presented with subject of A Novel EP Approach for Power Economic Dispatch with Valve-Point Effects and Multiple Fuel Options by P.S.Manoharan and other partners (Manoharan,& Kannan, 2008) .

Simulation Results

In this paper, we will consider three plants. First unit is coal-fired stoves. The second unit is the oil heater. The third unit is a diesel-fired unit heater. Neural network simulation performed in Matlab. network toolbox. All components of the data presented to network(except the total load for input) were normalized with following equations.

$$x' = \frac{x - \bar{x}}{Std_x} \ , \ x_{norm} = \frac{1}{1+\exp(-x')}$$

Where x is the value of the component that must normalize, $\bar{x}$ and Std_x are, respectively, the mean and standard deviation of the same component. x_{norm} is the component value after normalization. Network output is p_1, p_2, p_3. Losses are p_{loss}. Emission Function is. Test system is shown in Table 1.

Table 1. Test System

	a_i	b_i	c_i
Cost function unit one	0.00156	7.92	561
Cost function unit two	0.00194	7.85	310
Cost function unit three	0.00482	7.97	78
Emission NO_X unit one	13.85932	0.32767	0.00419
Emission NO_X unit two	13.85932	0.32767	0.00419
Emission NO_X unit three	40.2669	0.54551	0.00683
Losses line	0.00003	0.00009	0.00012

Network designing, the input layer has one neuron. Output layer has three neurons, hidden layer has four neurons. Transfer function hidden layer is purelin and tansig. Network Training is gradient method. Training parameters include:

net.trainParam.show = 50
net.trainParam.lr = 0.05
net.trainParam.epochs =2000
net.trainParam.goal = 1e-2
The simulation results can be observed in Table 2 below:

Table 2. Results of the Numerical Simulations (MW)

Cost fun units	**MlNN**	**GA**
Cost fun first unit	564.3487	5610972.
Cost fun second unit	313.2746	310.3219
Cost fun third unit	78.1699	78.0478
Emission NO_X first unit	14.0016	13.0972
Emission NO_X second unit	13.9999	13.5269
Emission NO_X third unit	40.2810	40.6378

Mean Squared Error are shown in fig. 3. results of a gradient and simulating the feasibility are shown in fig. 4.

According to results, MLPNN method has good accuracy, reliability and Implementation but doesn't have good iteration and high calculation time to get to the results.

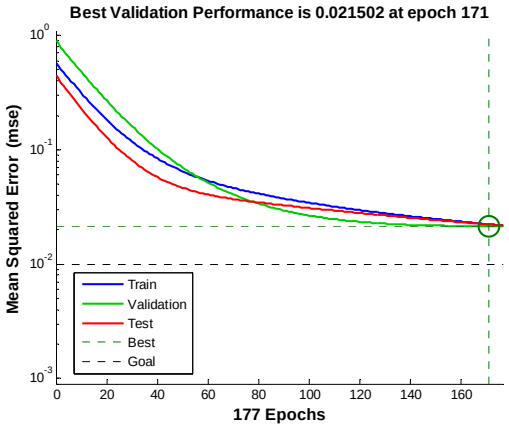

Figure 3. Results from the Sum of Squared Errors

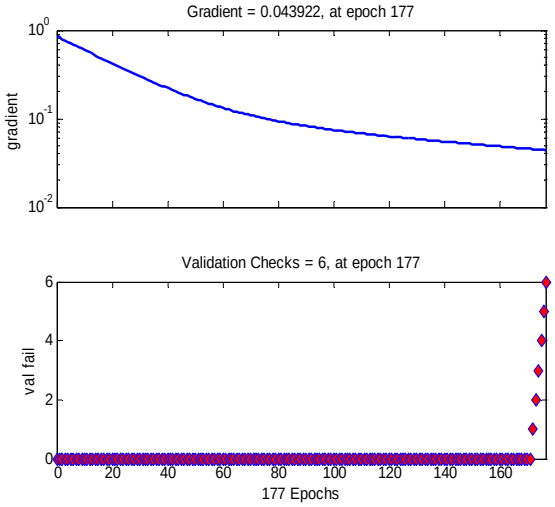

Figure4. Results of a Gradient, Simulating the Feasibility

Conclusion

In this paper, solution to the economic dispatch problem as a constrained optimization problem has been obtained using MLPNN. The MLP method has advantage of being a quick method compared to the iterative optimization methods such as GA. once a MLPNN is trained; it provides solutions in a cycle. According to table, responses of net are acceptable and in some cases, better from other approaches such GA method.

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