

Neural Network in Economic Dispatch: A Review

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ABSTRACT

Nowadays Economic Dispatch is one of the pretical problem in power systems. One of the suitable ways for solving the problem of Economic Dispatch is the use of neural network. First Economic Dispatch and Neural Network explained. More over, Kind of most common Neural Network and Advantages and Disadvantages of them is studied. Considering environment constraints that use in Economic Dispatch. Compared numeric results in index paper presented. **KEYWORDS:** Economic Dispatch, Neural Network, Hopfield, Perceptron, environment constraint.

1. INTRODUCTION

For long time ago optimization problems divert mind of researchers and scientists in order to find optimized ways for solving these problems and have a clear enviroment, lowest cost, etc. in electrical engineering problems such as Economic Dispatch and Unit commitment is important problem in power systems. Suitable optimization in Economic Dispatch problem, minimize cost, considering environment constraints such as losses, generation constraints, etc. there are Different ways to reach these goals.in general these methods are in three groups of classical, intelligent and combinational methods. First section is Exhaustive Enumeration, Priority List, Dynamic Programming, Lagrangian Relaxation. These methods have not enough accuracy in convergence and quality in nonlinear system. Current intelligent method for solving ED is Genetic Algorithm, ABC Algorithm, Neural Network. 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 Genetic Algorithm, we try to decrease the problems faster and application in large system of classical and intelligent methods. In this paper, First Economic Dispatch and Neural Network explained. More over, Kind of most common Neural Network and Advantages and Disadvantages of them is studied. Considering environment constraints that use in Economic Dispatch. Compared numeric results in index paper presented.

2. 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:

$$F = \text{Min} \sum_{i=1}^n (a_i + b_i P_i + c_i P_i^2) \quad (1)$$

That is:

$$\sum_{i=1}^n (P_i + P_D + P_L) = 0 \quad (2)$$

$$P_L = \sum_{i=1}^n (B_i P_i^2) \quad (3)$$

$$P_{\min,i} \leq P_i \leq P_{\max,i} \quad (4)$$

a_i , b_i , c_i show cost of generator i and n is the number of generator in net. P_i Shows power of generator production, P_D is the measure requested power and P_L shows loss line[1].

3. 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. Beacause 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[2].

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. So in order to understand how a neural network 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 adjoin to thousands of other neuron and tie in with them by electrochemical signals. Signals which is reach to one neuron is recieved by conjunctions which are branched at the end of core of neural cell. Nouron always recieve signals from these entrances in itself in some way. If final results is more them of limen amount, nouron is hot and make voltage and forward signal to the cells which is called axon. neural network is made of many artificial nourons. One artificial neuron in simple way model biologic nouron by electronic. Number of nouron which is used depend on duty performance. Figur. 2 shows different ways for conjunctions of artificial nourons to make a neural network. We will describe the more common way which called feedforward network.

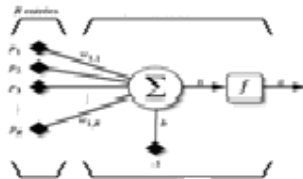


Figure .1.simple model of neural network

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. So 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 formulns can be beneficial. A neuron can have from one to n number entrance. Entrances is showed with $x_1, x_2, x_3, \dots, x_n$ and weight with $w_1, w_2, w_3, \dots, w_n$. total of weight multiplie entrances is showed with $x_1 w_1, x_2 w_2, x_3 w_3, \dots, x_n w_n$, which is called stimulation before.

$$a = x_1 w_1 + x_2 w_2 + \dots + x_n w_n \tag{5}$$

$$a = \sum_{i=1}^n x_i w_i \tag{6}$$

If stimulation be more than limen output a is 1. vise versa output a is zero. Some of these neuron conjunct with different ways. One of ways to organize neuron name feedforward network. Its name related to nourons of every layer graze from output of next layer untill reaching last layer of neural network. Figure 3 shows multi layer neural network.

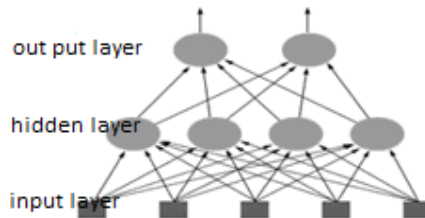


Figure .2.multi layer neural network

Every entrance sent out to the neurons which is hidden in layers. Then output neuron of this layer connected to all neuron. Every number of hidden layers with feedforward network is possible. But usually for problems we can solve, one layer is enough. More over number of neuron which is used in figure are 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[3].

3.1. Kind of high usage neural network in Economic Dispatch

3.1.1. Hopfield Neural Network

Hopfield neural network use for recognizing of model. Hopfield neural network all of the neuron similarly and non of them have distinguished as an output or input. First neuron nourish by entrauces. Then inside repetition of network is the reason of convergence to the one of the models. One of the disadvantage of Hopfield neural network is convergence to the answer which is not in models. Hopfield neural network is used for elimination of harmonic and noise also

recognizing rotten images. With deviation of desirable model to the absorbence spots of aim incident, areas of these spots be controlled. Fog 4 shows related chart to this network. Hopfield Algorithm has these steps:

First step: primitive amount of network with input

$$p = \{-1,1\}^{s \times 1} \quad a(0) = p \tag{7}$$

second step: calculate ingredinate of memory matrix

$$w_{ij} = \sum_{q=1}^Q p q^{q,i} \tag{8}$$

third step: repetition of this formula untill attainment of convergence

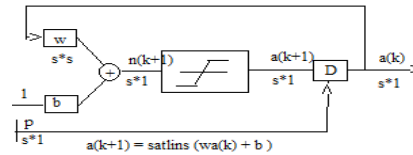


Figure .3. Hopfield neural network

Some index paper about Hopfield neural network: in 1998 paper presented with subject of application on neural network to dynamic dispatch using multi processors by Y. Fukuyama and other partner[5]. in 2000 paper presented with subject of Adaptive Hopfield neural networks for economic load dispatch by Lee.K.Y and other partner[6]. in 2007 paper presented with subject of Augmened Lagrange Hopfield Network for Economic Dispatch by Jirawadee polprasert and other partner. This paper compound ALHN and ANN and test system is 13 untill 120 generator. This method is faster than Lambada, GA [7]. in 2008 paper presented with subject of A Hopfield Solution to Economic Problem with Transmission Losses by F.Bemhamida and other partner. considering line losses in this paper. Test system is 15 generator. System is studied aspect thermal and with this method rate of solution is high[8]. in 2008 paper presented with subject of Application of Hopfield Neural Networks to Economic Environmental Dispatch(EED) by M.Benyahia and other partner. considering line losses in this paper. Test system is 6 generator.[9]. in 2009 paper presented with subject of Economic Dispatch with Emission and Transmission Constraints by augmented Lagrange Hopfield Network by Vo Ngoc Dieu and other partner. considering line losses and declivity rate in this paper. Test system is 1200 generator. Result show time of calculation and cost performance is lower [10]. in 2012 paper presented with subject of Economic dispatch with multiple fuel types by enhanced augmented Lagrange Hopfield network by Dieu Ngoc Vo and other partner.[11]. in 2007 paper presented with subject of A dynamic programming based fast computation Hopfield neural network for unit commitment and economic dispatch by S. Senthil Kumar and other partner.[12]. in 2007 paper presented with subject of On-line emission and economic load dispatch using adaptive Hopfield neural network by S. Balakrishnan and other partner.[13].

3.1.2. Perceptron Neural Network

for easy describe, we introduce one layer perceptron. pnceptron nural ntwork is one of the first neural network which is used for learning. Meaning of learning is correction weight matrix and biyas vector by repeat. Rule of learning in pnceptron nural ntwork is as below. Fig. 4 shows the related chart[14].

$$w^{new} = w^{old} + \frac{1}{2} ep^T \tag{9}$$

$$B^{new} = B^{old} + \frac{1}{2} e \tag{10}$$

Perceptron algorithm include these steps:

Frst step: constitution of input matrix

$$p = [p^1 p^2 p^3 \dots p^l] \tag{11}$$

Second step: constitution of output matrix

$$T = [T^1 T^2 T^3 \dots T^l] \tag{12}$$

Third step: constitution of network output matrix

$$V = [W B] \tag{13}$$

$$Q = [q^1 q^2 q^3 \dots q^l] \tag{14}$$

$$a = SSign(V \times Q)E \tag{15}$$

Forth step: constitution of network error

$$E = T - A \tag{16}$$

Fifth step: alignment of network parameter

$$V^{new} = V^{old} + \frac{1}{2}ep^T \tag{17}$$

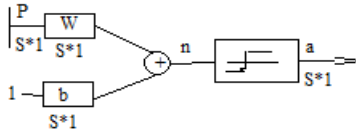


Figure .4. Perceptron neural network

Some index paper about Perceptron neural network: in 2012 paper presented with subject of Application of Multi-Layered Perceptron Neural network(MLPNN) to Combined Economic and Emission Dispatch by J.Hamidi and other partner. considering line losses and emission NO_x and SO₂ in this paper. Test system is thermal. result is compried with lambda and simple genetic and genetic[13].

4. Describe some constraints in economic dispatch

4.1. Emission constraints in economic dispatch

Economic dispatch which was explained minimizes final cost but ignores enviromental production of NO_x and SO₂ trepan maximom amount both of them. It is necessary due to enviromental condition consider this constraints in Economic dispatch. So we will present constraints formulization.

$$MinC = W_0F + W_1E_S + W_2E_N \tag{18}$$

E_S reagent for pollution amount SO₂ and E_n reagent for pollution amount NO_x

$$E_S = \sum_{i=1}^n (d_i + e_i p_i + f_i p_i^2) \tag{19}$$

$$E_n = \sum_{i=1}^n (g_i + h_i p_i + k_i p_i^2) \tag{20}$$

Now if we consider emission factors in zero we will reach to economic dispatch. If consider cost factors zero, just optimize NO_x and SO₂ constraints. We can consider both of them at the same time[16]. 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[17]. 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[18]. in 2008 paper 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 [19].

4.2. Describe constraint of power transmtion line in economic dispatch

Classical economic dispatch can be with capacity constraint of power transmtion line fig. 5 shows two areas of K and J generator.

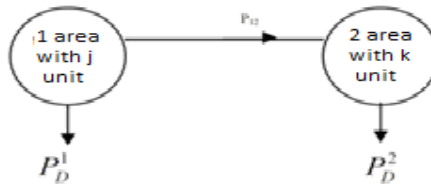


Figure 5.tie line network

Each area has espeical production amount of itself.

$$\sum_{i=1}^j P_i^1 = P_D^1 + P_{12} \tag{21}$$

$$\sum_{i=1}^k P_i^2 = P_D^2 + P_{12} \tag{22}$$

Constraint is as below:

$$-P_{12}^{\max} \leq P_{12} \leq P_{12}^{\max} \tag{23}$$

P_D^1 and P_D^2 are recommended load amount in area 1 and 2. P_{12} and P_{12}^{\max} amount of power transmission and maximum transferable power between area 1 and 2 [20]. in 2002 paper presented with subject of Fuel constrained economic emission load dispatch using hopfield neural networks by M. Basu and other partners [21]. in 2001 paper presented with subject of Hopfield neural network approaches to economic dispatch problems by T Yalcinoz and other partners. Test system is 3 until 240[22]. in 2004 paper presented with subject of An efficient Hopfield network to solve economic dispatch problems with transmission system representation by Ivan.N. da.Silva and other partners. In this method transmission system said by linear equations of economic dispatch and Constraint. Inside paramaters are received by valid-subspace method. This paramaters ensure reaching to convergence point[23].

5. Comparison result kind of methods with ANN for solve economic dispatch

Study different test system in index paper help to researchers and scientists to choice the best method for solve economic dispatch. In this section comparison some of numeric result with different test system. Table. 1 shows comparison of total cost and calculation time for system with high units.

Table 1.numeric result ALHN, QP

Num.unit	Method	Total. Cost(\$)	calculation time(s)
80	QP	287.852.85	0.45
	ALHN	287.852.90	0.18
160	QP	575.705.70	2.97
	ALHN	575.705.80	0.33
240	QP	863.558.54	10.05
	ALHN	863.558.70	0.64
320	QP	Impossible	Impossible
	ALHN	1.151.411.60	3.40
400	QP	Impossible	Impossible
	ALHN	1.439.264.50	5.33
800	QP	Impossible	Impossible
	ALHN	2.878.529.03	18.65
1.200	QP	Impossible	Impossible
	ALHN	4.317.793.53	66.49

Table. 2 shows total cost and calculation time for systems which have 240 units.

Table 2.numeric result ALNN, QP, IHNN

Num.unit	Load (Mw)	Method	Total. Cost(\$/h)	calculation time(s)
80	20	IHNN	272.8	9.6
		QP	272.8	0.39
		ALNN	272.8	0.07
120	31.5	IHNN	432.6	35.2
		QP	431.8	1.23
		ALNN	431.8	0.22
160	41	IHNN	560.7	67.6
		QP	559.6	2.78
		ALNN	559.6	0.27
240	57	IHNN	774.98	289.5
		QP	770.55	10.14
		ALNN	770.55	0.32

Table. 3 shows comparison of total cost and calculation time for systems which 20 units.

Table 3.numeric result N-R•EHNN•SQP•ALHN

method	Losses(Mw)	Total. Cost(\$/h)	Calculation time(s)
N-R	93.76115	62.761.5	0.4
EHNN	97.952	62.610.0	0.11
SQP	91.952	62.456.6	2.13
ALHN	92.012	62.456.7	0.096

Conclusions

According to a paper presented in different ways to economic dispatch is considered. neural network is a suitable method for solving this problem. Two kind of suitable neural network is Hopfield and Perceptron. This method like other suitable methods has constrains such as calculation time, etc. Some way presented as solution which improve accuracy and calculation time. neural network have easy performance, good accuracy is suitable. solving economic dispatch is better than before if combination with other algorithm such as genetic and etc.

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