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OPTIMAL FIT THROUGH NEURAL NETWORK BASED CLUSTERING –A CASE STUDY ON THERMAL POWER PLANT

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ABSTRACT:

The objective is to predict optimal fit points of nonlinear function in the presence of linear and nonlinear parameters. To generate optimal fit high dimensional operational data are converted into low dimensional data through neural network based clustering algorithm called Self Organizing map (SOM) without deviating from its basic semantics. Data is clustered and obtained patterns are useful in deriving optimal operational set points needed for efficiency improvement. The basic architecture of SOM, neuron weight position, distances, possible hits and clustered patterns are demonstrated. The knowledge obtained from proposed analytical model generates facts where exist fewer characteristics reside in each resultant clusters that states the general behavior of attributes dominated during training process.

Keywords : Clustered Pattern, self organizing map, optimal design.

1.INTRODUCTION:

All the manufacturing sectors facing the challenging task of maintaining performance of the system which depends widely on operational data and variety of design with evaluation conditions. Solving the complicated problems which arises dynamically that affects entire process that really needs to formulate optimal objective for all the components. Several computing methodologies provide suggestible solution to enhance outcome of thermal components but challenging task is to select the best among available options. Based on the working engineering process the user needs to have knowledge about the impact of operational parameters. First, the user can select simple and flexible algorithm which reduce large volume of data into manageable units which generate optimal information. With the generated knowledge the optimal criteria can be designed.

This paper focus on the process of coal fired boiler with all the integrated sub thermal components. Different grades of coal are taken into account for this practical study. Among the infinite amount of controllable and non-controllable variables only the parameters which contain high impact are considered and computed.

The performance of optimal controller need to accurate through exact prediction of causes and if controller generates standard outcome with perfect match of actuals will enhance overall performance [1]. Artificial neural network is widely used to analyze and predict operational data by optimizing operational conditions. The guidelines to control the cause exist in the outcome of boiler is purely based on optimizing vital input parameters [2]. The different categories of coal quality are assessed with respect to energy efficiency and analysis on factors relates to environment. Insisted to have detailed analysis of important operational variables when grades of coal vary to determine level of input feed [3]. Both supervised and unsupervised learning algorithms are suited to identify useful patterns within the power data set. Cluster analysis provides significant results to enhance plant performance [4].

Comparative study of combustion data from varies operational sites reveals important investigated measures essential to decision making assessment process based on fuel related specific data[5]. The investigations and analysis of multiple factors which holds operational characteristics affecting plant efficiency and its deviations among rankine and carnot cycle were discussed. Regeneration will improve plant outcome as it uses the sensible heat of exhaust steam for the preheating of feed water [6]. The impact of static optimization of coal fired power plants in efficiency enhancement dealing with dynamic environmental changes like coal quality, unit load, operating and maintenance conditions ,equipment causes were demonstrated with operation points in presence of input disturbances were simulated [7]. Knowledge discovery in historical data is highly successful in estimating the value of one parameter from another interrelated variable. Estimated values can be used for measurements [8]. Trough prediction and determination it proves the accuracy of pattern recognition model is highly acceptable. Recognition model is simple to the human plant operator to predict, evaluate and reduce error percentage based on gained knowledge from the designed model [9]. When considered the boiler with different categories of coal , burner type, combustion methodologies ,emissions are largely vary. It is essential to design common technology that suits all grades of coal without affecting energy efficiency [10]. The model designed to evaluate operational sequential process and control energy balance by creating simulated environment. Optimal designed criteria were determined through analyzing efficiency factor and exergy analysis [11]. This has

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been well discussed in the previous paper. Christo Ananth et al. [12] discussed about a Secure system to Anonymous Blacklisting. The secure system adds a layer of accountability to any publicly known anonymizing network is proposed. Servers can blacklist misbehaving users while maintaining their privacy and this system shows that how these properties can be attained in a way that is practical, efficient, and sensitive to the needs of both users and services. This work will increase the mainstream acceptance of anonymizing networks such as Tor, which has, thus far, been completely blocked by several services because of users who abuse their anonymity. In future the Nymble system can be extended to support Subnet-based blocking. If a user can obtain multiple addresses, then nymble-based and regular IP-address blocking not supported. In such a situation subnet-based blocking is used. Other resources include email addresses, client puzzles and e-cash, can be used, which could provide more privacy. The system can also enhanced by supporting for varying time periods. Thermal and physical data represent the process characteristics are analyzed and predicted to detect future problems[13]. Almost all the business sectors are given recognition to optimization process with the intention to promote business outcome. Need to have optimal controller are simulated with practical data [14]. Vital operational parameters were chosen and analyze them regarding its real contribution to the normal and standard process [15]. Solution is effective if analysis performed on predicted data rather than raw data.

2.Self Organizing Map :

Neural network based clustering structure called self-organizing map an unsupervised learning method can be defined with appropriate dimensions that will learn to represent different regions of the input space based on the occurrence of input vector values. Neurons arrange themselves in grid like structure without human guidelines and each of them responds to different region of rectangle and neighboring neurons responds to adjacent regions. Initially weight vector is constructed randomly to train network with basic setting. After training neurons self-organize to different regions which shows how input space is classifies. Figure 1.1 to 1.6 shows how data clustered takes place in sequence.

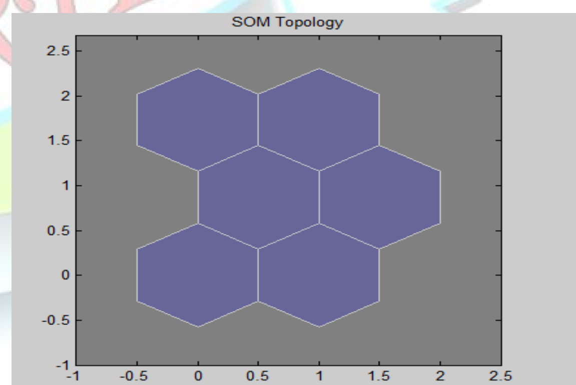

Fig : 1.1 SOM Schematic

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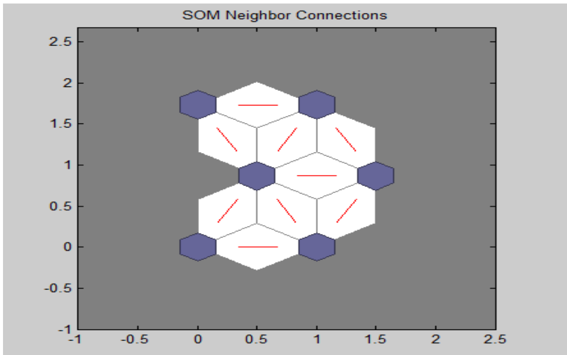

Fig :1.2 SOM- Neuron Connections

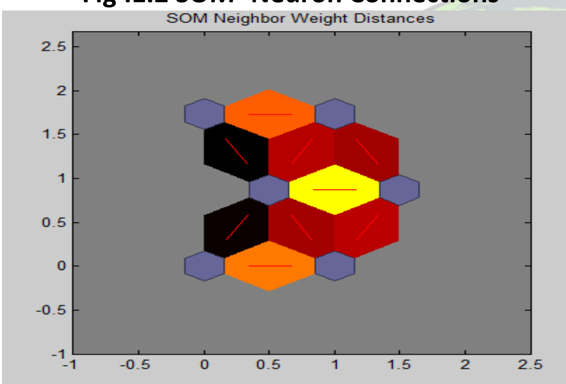

Fig :1.3 SOM – Weight Distances

Cid	X (load)		Y (heat absorption)	
	Min	Max	Min	Max
Cid_1	0.250	0.326	0.1842	0.2354
Cid_2	0.327	0.369	0.2361	0.2610
Cid_3	0.370	0.400	0.2616	0.2702
Cid_4	0.401	0.430	0.2795	0.2964
Cid_5	0.431	0.471	0.2970	0.3215
Cid_6	0.472	0.550	0.3221	0.3778

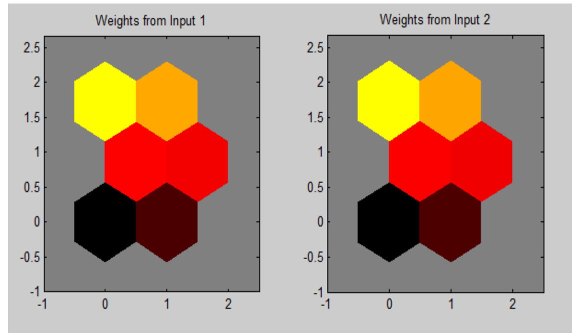

Fig :1.4 SOM – Input Weight

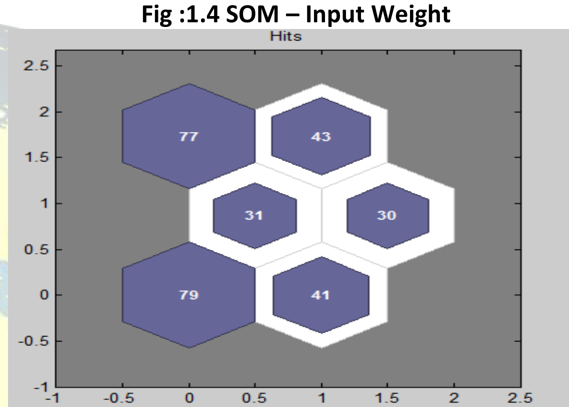

Fig :1.5 SOM – Obtained Hits

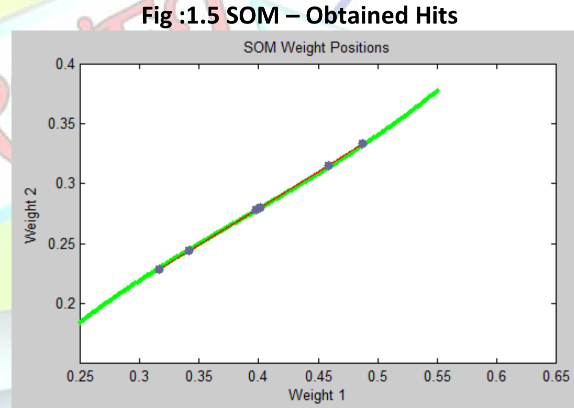

Fig :1.6 SOM – Weight Positions

The Table 1.1 summarizes the range of each SOM cluster based on the actual data considered. SOM Clustering method results in six groups of data and visualized.

Table : 1.1 SOM Clustered_Mean

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The coefficients(P1,P2) needed to the output function(y) are computed for all obtained clustered groups are listed below.

Cid	Co-efficient		Norm of Residuals
	P1	**P2**	
Cid_1	0.67213	0.017122	0.00357
Cid_2	0.59293	0.042285	0.00033
Cid_3	0.57702	0.048091	0.00016
Cid_4	0.58278	0.045768	0.00017
Cid_5	0.61118	0.033465	0.00051
Cid_6	0.71249	-0.015198	0.00449

Table : 1.2 SOM Derived_Coefficients

The output function f(x) is executed over the input parameter and denoted as follows:

$$Y = P1 * x + P2.$$

$$Y = F(X)$$

Using the computed coefficients the function f(x) will execute and estimate the value for the given input.

Table : 1.3 Evaluation Summary

Table : 1.4 Clustered Optimal Value

From SOM clustered Patterns the optimal value for each group of clustered data are represented in table 1.4.

3.Optimal Fit :

Cid	X	Y = f(X)
Cid_1	0.250	0.185
	0.274	0.201
Cid_2	0.327	0.236
	0.349	0.249
Cid_3	0.370	0.261
	0.393	0.275
Cid_4	0.401	0.279
	0.421	0.291
Cid_5	0.431	0.297
	0.464	0.317
Cid_6	0.472	0.321
	0.533	0.365

Cid	X (Grade1)	Y (Grade2)
Cid_1	2.100	2.140
Cid_2	2.483	2.529
Cid_3	2.708	2.747
Cid_4	2.891	2.925
Cid_5	3.499	3.568
Cid_6	3.110	3.145

Direct search algorithm(Nelder-Mead Simplex) is used to minimize a non linear function of several operational parameters and to fit the function with linear and non linear input parameters as given in the equation below.

$$Y = X(1) * \exp(-\lambda(1)*t) + X(2) * \exp(-\lambda(2)*t)$$

Fitness function computes the error in the fit for the above equation. Initial estimates of 'λ' may chosen randomly and minimum search algorithm starts its execution to minimize the error resulted in fitness function by adjusting 'λ' value. The output function is used to plot intermediate fits . The following figure demonstrates how optimal fitting of a nonlinear function to a set of clustered data was represented.

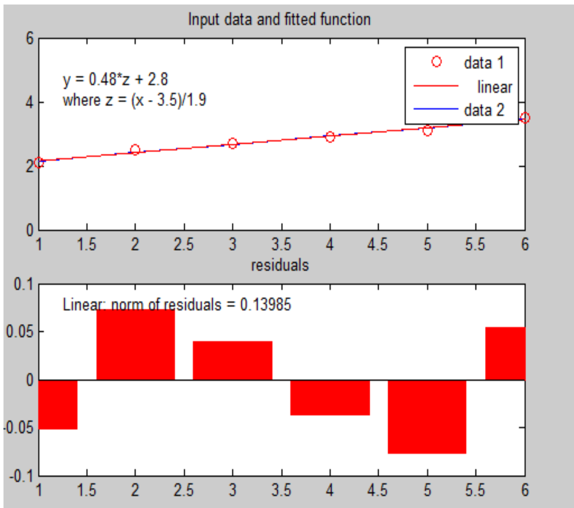

Fig :1.7 Data1 _Optimal Fit

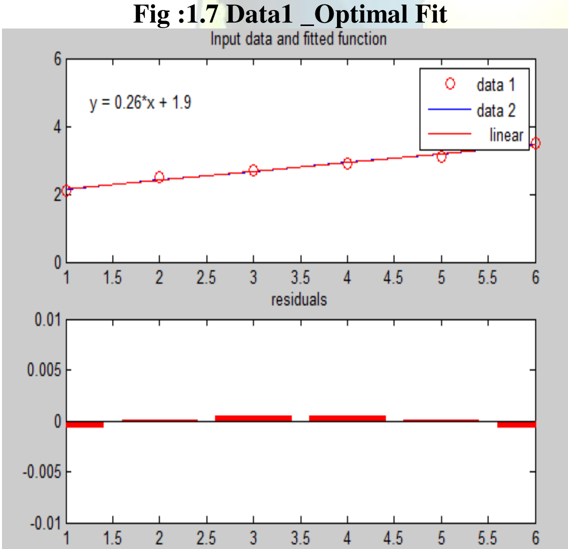

Fig :1.7 Data1 _Optimal Fit

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Conclusion:

Self-Organizing Map provides knowledge that act as input to design optimal set points. The obtained results of SOM and Direct search algorithm are visualized in appropriate figures. Optimal fit is useful in all manufacturing process and makes it effective to control and evaluate I order to optimize the plant performance.

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