CODING ASSIGNMENT-1

ME 674 SOFT COMPUTING

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REPORT

1. Introduction:

Problem definition: Prediction of output power with artificial neural network using extended datasets for Stirling engines

Background:

Artificial neural network (ANN), can accurately recognize and learn the underlying relations between inputs and outputs regardless of their dimensionality and nonlinearity and without explicit physical considerations. In addition, ANN has been considered as an effective alternative to traditional statistical techniques for function approximation and data fitting since it does not need hypothetical premise concerning the mathematical models. Owing to these advantageous features, ANN has been applied in studies of Stirling engines.

In this paper, ANN model has been applied to predict the output power of a Stirling engine. Also it has been demonstrated that ANN is capable of mapping the implicit relationship between the considered inputs and outputs and predicting the performance of the system with good accuracy.

Three thermodynamic and dynamic parameters, i.e. Charging Pressure (P_c), Heating Temperature (T_h) and Engine Speed (N), are selected as the input parameters, while operating output Power is selected as the output parameter.

ANN NETWORK (METHODOLOGY):

While calculating the following parameters:

No. of patterns = 112

No. of input parameters used=3

No. of output parameters used=1

No. of Hidden Layer = 1

Architecture of the model used:

Activation function in hidden layer: Log-Sigmoid function

Activation function used in output layer: Log-Sigmoid function

Input parameters:

	Parameter	Unit
1	Heating temperature	°F
2	Charging Pressure	Bar
3	Engine Speed	RPM

Output parameters:

	Parameter	Unit
1	Power Output	BHP

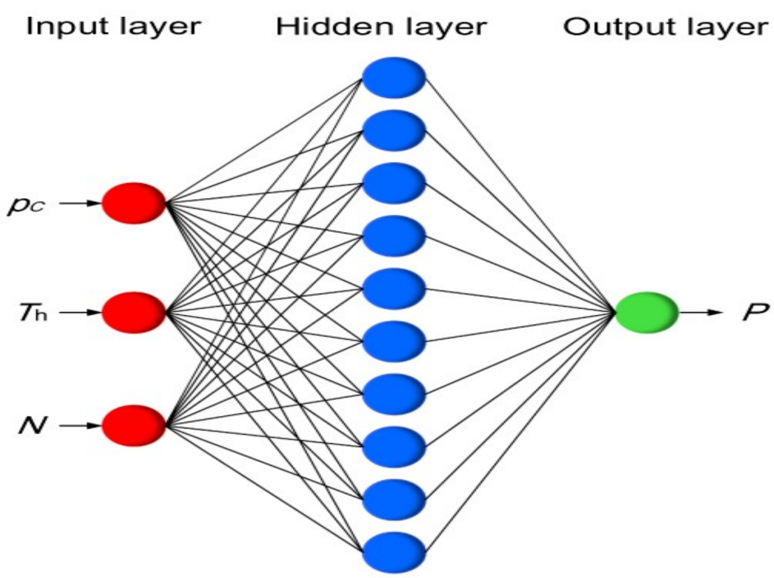

Figure 1 ANN with Power Output

2. <u>Selecting optimum value of learning rate:</u>

After checking MSE(mean squared error) values of training set for different values of eta(learning rate-ranging from 0.1 to 0.9) for 5000 Iterations, we found that higher value of eta gives fast optimum result with less value of MSE.

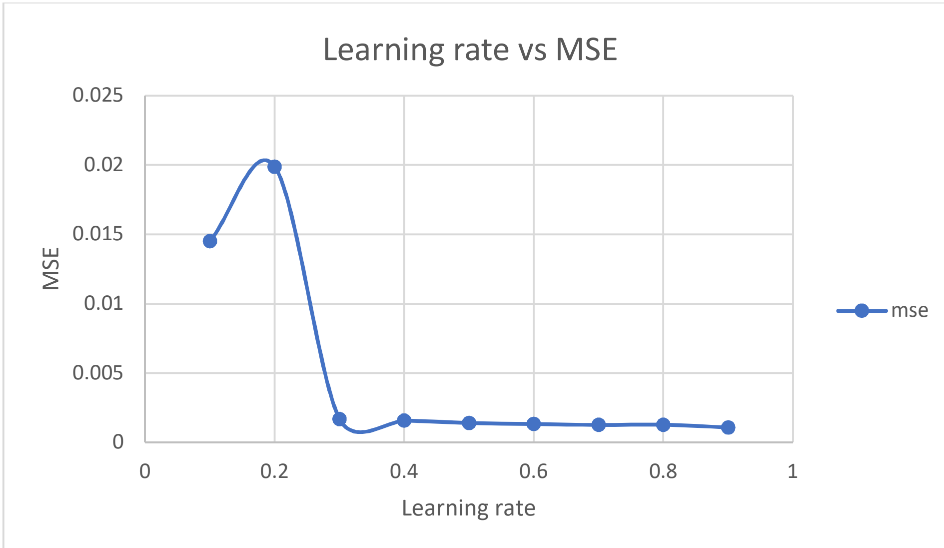

Figure 2 Learning rate with MSE

Therefore, optimum learning rate,

Eta = 0.85

3. <u>Selection of optimum number of hidden Neurons:</u>

After checking MSE (mean squared error) values of training set for different values of M (no of hidden layers-ranging from 1 to 10) for 500 Iterations, the following graph is obtained:

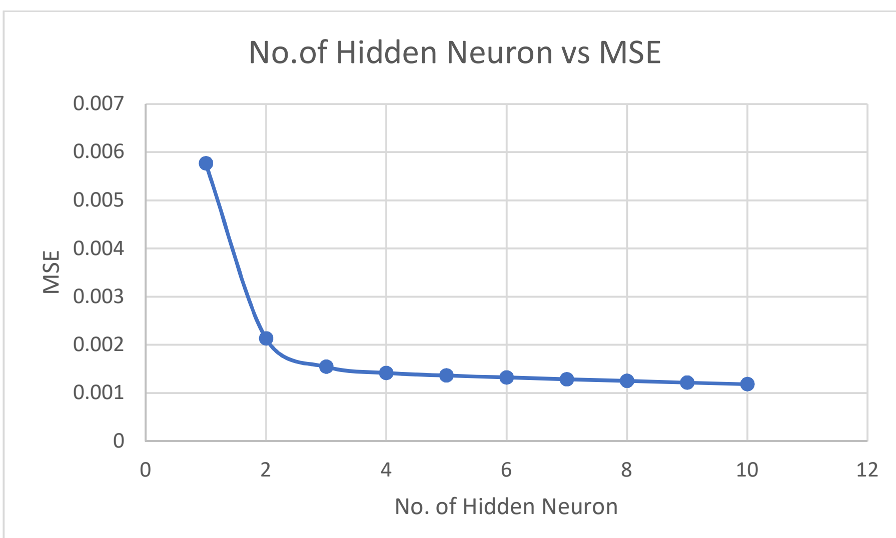

Figure 3 No. of Hidden Neuron with MSE

Therefore, optimum number of hidden layers,

M = 10

4. <u>Iteration with MSE:</u>

The MSE value continuously decreases with the number of iteration, but the rate at which it is decreasing slows down. The following graph is obtained for no. of iteration:

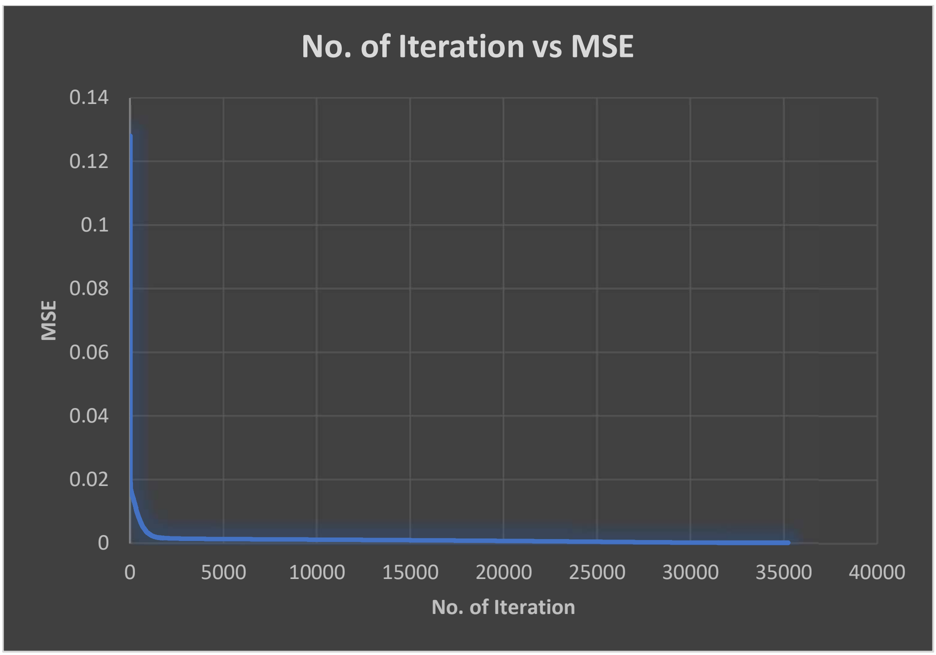

Figure 4 No. of Iteration with MSE

5. <u>Results</u>

Test set MSE = 1.5×10^{-4}

No of iterations used = 32256

The MSE value continuously decreases with the number of iteration, but the rate at which it is decreasing slows down.

Final optimum values,

M = 10

Eta = 0.85

6. Conclusions

1. For lesser MSE value no. of iterations is very high.
2. Final **V** and final **W** are predicted.
3. For greater accuracy we have to consider higher no. of training patterns with higher no. of iterations.
4. As we approximated to one hidden layer with 4 hidden neurons, the program was taking more time. So we optimize no. of hidden neurons.
5. Overall, it can be said that using ANN we can very nicely formulate such real life problems and experiments.

References:

1. https://www.sciencedirect.com/science/article/pii/S0306261920306358