International Journal of Engineering Research & Management Technology
ISSN: 2348-4039
September-2015 Volume 2, Issue-5
Email: editor@ijermt.org www.ijermt.org

PREDICTING THE FOREST FIRE USING MULTI-LAYER FEED FORWARD NEURAL NETWORK USING BACKPROPAGATION

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ABSTRACT: Fires in forest area is a major area of concern today because it is a major environmental issue as well as creating economic and ecological damage and also endangering humans and livestock. Detection of prone area is a key to controlling this phenomenon. For this one of the tool is to use of automatic prediction systems based on local sensors such as data provided by metrological department. In this paper we are exploring the possibility of implementing the use of feed-forward neural network (multi-layer perceptrons) using multiple back propagation algorithm in predicting the affected area of the area under observation. Our model uses 10 input variables and gives us the 2 variables as output. Our method predicts the affected area with the RMSE Error of 0.0860 and with overall average accuracy of 88.12%.

KEYWORDS: Machine Learning; Neural Network; Forecasting; ANN; Feed Forward Neural Network

I. INTRODUCTION

Forecasting the forest fires (also called wildfires) now becomes the crucial issue now a days which affects the forestation, and do ecological and environmental damage which in turn affects the humans and livestock directly and indirectly. Humans suffer the most from this phenomenon. National economies are strongly linked and heavily influenced by the wildfires. The key setback for predicting the area is its uncertainty. This particular feature is undesirable for the fire fighting responsiveness by the fire fighters however, it is unavoidable. This uncertainty will remain and cannot be ruled out however, an attempt can be made to minimize its gravity. Forest Fires Forecasting is one of the solutions in this process. Each year around millions of hectares (ha) of forest land are destroyed all around the world. Portugal is highly affected by the forest fires [13].The 2003 and 2005 fire seasons were especially dramatic, affecting 4.6% and 3.1% of the territory with 21 and 18 human deaths and vast livestock. Early detection is the key element for successful firefighting and firefighting preparedness.

I. Data

Our study is considering the fire data from Montesinho Natural Park situated in Trans-os-Montes northeast region of Portugal (Figure 1)

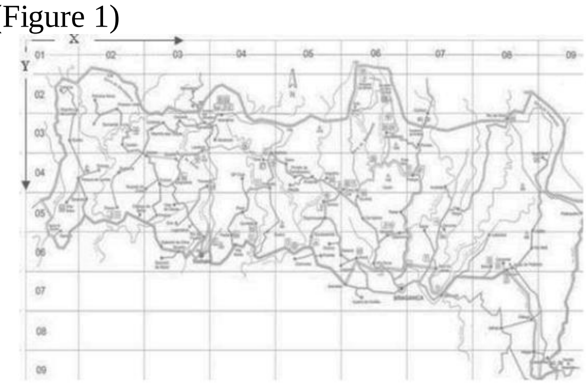

Fig.1 The map of Montesinho Natural Park

This park contains a high flora and fauna diversity having Mediterranean Climate, the average annual temperature is within the range 8º C to 12º C. The data used in our model was collected from

January 2000 to December 2003 .The data contains 517 entries. It has 12 variables all of which has been recorded for three years. This data is available at http://www.dsi.uminho.pt/~pcortez/forestfires/.

The Forest Fire Weather Index is the Canadian System for rating fire danger and it includes five components. [14] (i) **FFMC**- Fine Fuel Moisture Code (ii) **DMC**-Duff Moisture Code (iii) **DC** – Drought Code (iv) **ISI**- Initial Spread Index (v) **FWI** –Fire Behavior Index Along with these five components we have data of Temperature , Wind, RH, Burned Area and Rain. In total we have 12 variables the remaining two are the x and y component of the place as shown in the Figure 1 .We divided the whole map into 9×9 squares as depicted in the figure 1.

II. DESCRIPTION of Dataset attributes

S. No.	Variable	Description
1	X	x-axis coordinate (from 1 to 9)
2	Y	y-axis coordinate (from 1 to 9)
3	month	Month of the Year(January to December)
4	FFMC	FFMC Code
5	DMC	DMC Code
6	DC	DC Code
7	ISI	ISI Code
8	temp	Outside temperature (in C)
9	RH	Outside relative humidity (in %)
10	wind	Outside wind speed(in km/h)
11	rain	Outside rain(in mm/m^2)
12	area	Total Burned area(in ha)

III. METHODOLOGY

In this study we have made an attempt to use an artificial neural network with backpropogation for forecasting .Out of 12 variables we 10 are taken as inputs and 2 are as output.The input data has been pre-processed and rescaled between -1 and 1 using MBP’s internal feature.

IV. ANN

Artificial Neural Network (ANN): A neural network is massively parallel distributed processor made up of simple processing units (neurons) that has a natural propensity for storing experimental knowledge and making it available for use. It resembles the brain in two respects: Knowledge is acquired by the network from its environment through a learning process. Inter-neuron connection strengths, known as synaptic weights, are used to store the acquired knowledge. -Simon Haykin, (2009)

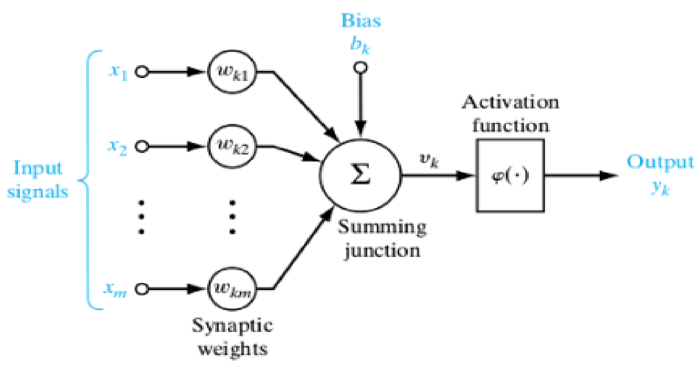

Fig. 2 A basic neural network architecture

V. TOPOLOGY OF NEURAL NETWORK

A 3-layer Feed Forward Artificial Neural Network (10-5-2) has been used and multiple back-propagation algorithms are used to train the network. A feed forward network with one hidden layer and enough neurons in the hidden layers can fit any finite input-output mapping problem. A total of ten inputs, only one hidden layer with 5 neurons and two outputs have been used. The network converged within a decent time of three minutes.

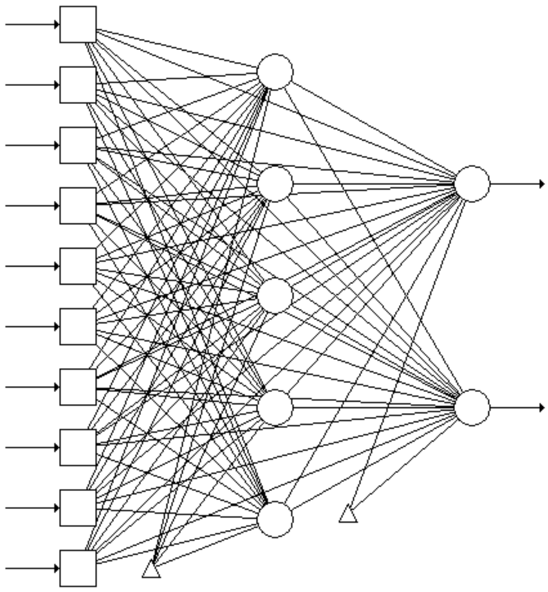

Fig.3 Topology for Feed-forward Neural Network used (10-5-2) in the study

VI. Network Training

The Supervised learning method was used to train the network. Supervised learning essentially involves function approximation. It encodes a behaviouristic pattern into the network by attempting to approximate the function that underlies the data set. The authors have used gradient descent with momentum and adaptive learning back-propagation as their training algorithm for both learning and space network. For the hidden layer, Sigmoid has been used as an activation function while linear function is used for the output layer.

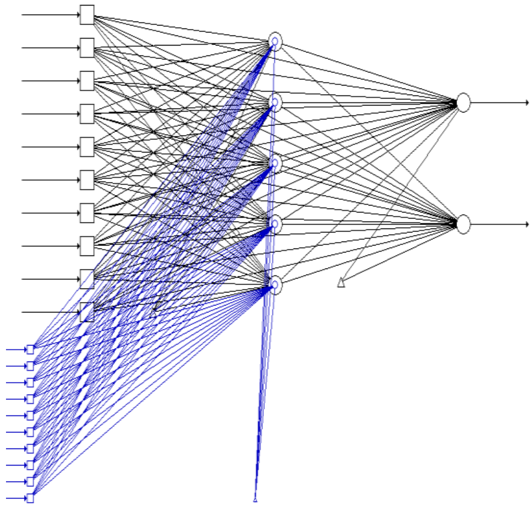

Fig. 4 Neural Network while learning phase

VII. DATA ANALYSIS

For analysing the efficiency of the system the data was partitioned into two parts viz Training data and testing data. After building the network it was trained using the FFNN with multiple back propagation algorithm. Adaptive step sizes, using individual step size for each weight was used. After training the network, the test data were used to evaluate the efficiency. The evaluation was carried out comparing the test data. The RMSE values obtained for the proposed network model are:
The total training was for only 10,000 epochs and the following screenshots provide the detailed data about the training and testing patterns:

	Main Network	**Space Network**
Training	0.0848131917	0.0697475410
Testing	0.1767423315	0.0928913178

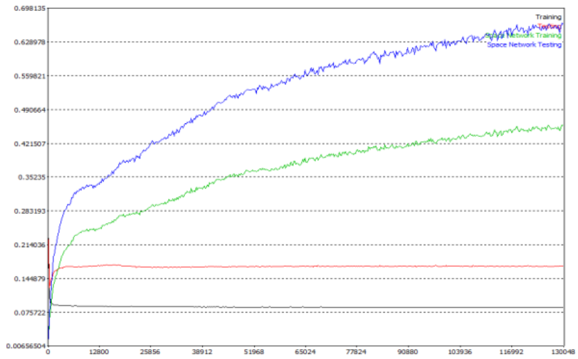

Fig. 5 Graphical view of the RMSE values

The results of network output were close to the desired values. The black lines represent the network output and the red lines represent desired output.

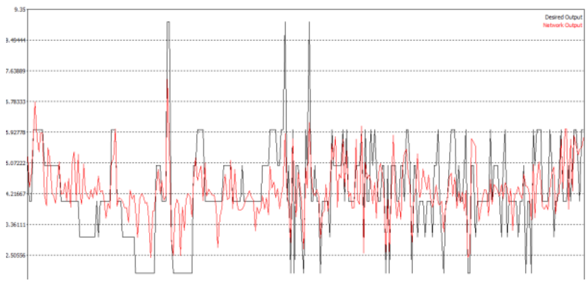

Fig. 6 Graphical view of the output and desired values.

VIII. INPUT SENSITIVITY

Main Network

		from the input layer									
to the 1th hidden layer	bias	1th neuron	2th neuron	3th neuron	4th neuron	5th neuron	6th neuron	7th neuron	8th neuron	9th neuron	10th neuron
1th neuron	4.01147	17.5173	-13.2932	-16.7659	-1.36889	5.5105	25.0916	19.0822	-8.28085	-2.42906	-6.21166
2th neuron	-8.31294	21.0607	-8.28532	9.19047	-0.481583	2.2423	-19.1276	-16.3253	-28.68	11.3813	-13.3266
3th neuron	0.664638	7.08282	-13.2196	-10.284	-17.2614	5.30401	-7.73506	4.90241	-30.4244	-0.433	0.71275
4th neuron	-1.85046	37.1916	22.5728	-56.6066	30.9187	29.684	-7.68642	-1.09607	7.6623	3.45944	14.252
5th neuron	4.67823	2.44753	-11.1344	9.90586	29.9375	-9.51325	-4.72301	1.03603	8.81254	-3.58081	-13.189

		from the 1th hidden layer					from the input layer									
to the output layer	bias	1th neuron	2th neuron	3th neuron	4th neuron	5th neuron	1th neuron	2th neuron	3th neuron	4th neuron	5th neuron	6th neuron	7th neuron	8th neuron	9th neuron	10th neuron
1th neuron	2.136	14.6097	29.5888	-60.7168	-15.9562	29.9347	0.515351	1.34138	-0.323174	-0.779112	2.67812	0.886338	1.02042	-0.115135	0.437187	0.718128
2th neuron	-0.302387	5.84086	9.87733	-17.9821	-6.00025	9.86148	0.145962	0.57758	0.198336	-0.467513	0.64136	0.224272	0.405902	0.00873756	-0.162646	0.397894

IX. CONCLUSION

The study shows that the Forest Fires Forecasting can be predicted with reasonable accuracy with the help of proposed feed-forward neural network model which otherwise have unreliability with traditional methods. It also reveals that the FFNN with multiple back propagation can be used to model any other time series forecasting.

Further development to this study using more inputs like Geographical Conditions ,Soil Type, Type of Vegetation etc. might lead to even better results.

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