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Mortality Prediction Using Non –Linear Auto Regression Dynamic Neural Network

Ms.S.Priyanka, Ms.E.Shaila Kumari, Dr.G.Gandhimathi, Mrs.V.Gowri, Mr.J.Raja
Department of Electronics and Communication Engineering, Trichy Engineering College, Trichy, Tamil Nadu, India

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ABSTRACT

Mortality is an essential health effect of ambient air pollution and has been studied extensively, it is still possible to study the day-to-day mortality at the historically low levels of air pollution now occurring in most developed countries. This paper studies and explores the methodologies for modeling, simulation, and controls in ANN-based on time series application of pollution mortality. To show and prove the effectiveness, simulated and operational data sets are employed to demonstrate the ability of neural networks in capturing complex nonlinear dynamics where NARX model is set up to explore and relate both steady-state and transient features on pollution mortality. The structures were configured, generated, and ran in MATLAB to create and train the platform. The validation, testing, and results validate that the techniques can be accurately applied, which implies both models effectively capture dynamics of the system up to a certain degree of acceptance. Performances of the proposed method have been analyzed statistically using Mean Square Error estimator and R-Squared value.

Keywords— NARX, Regression, Time series prediction, Neural Networks, Machine Learning, Levenberg-Marquardt

I. INTRODUCTION

Serious air pollutions struck Athens, which came apparent in the early 1988. The relationship between daily mortality and shortterm variations in the ambient levels of ozone , black smoke , sulphur dioxide , carbon monoxide (CO), nitrogen dioxide), and particulate matter considered in the. Daily total and cause-specific mortality count air quality, temperature, relative humidity, and influenza data. The air pollution was demonstrated using, which exhibited more substantial relativerisk in younger age groups.This paper will evaluate the performance between two Algorithms that are used to predict pollution mortality. Air pollution factors measurements are in the same dataset storing all historical air pollution factors, and data will be treated as training sets for the program in the one model.The primary purpose of the prediction is to reduce doubt associated with decision making in investment, predicting future possibilities. This problem can be analysed by the Neural network time series is used to select data, create and train a network. feed forward back propagation network is designed the network is trained by Levenberg-Marquardt (LM) algorithm. finally the Performance is validated with suitable metrics of mean squared error (MSE) and regression (R-2).

II. LITERATURE REVIEW

Several works have been done in using ANN to forecast future occurrences. .[1] This paper work evaluates and predicts the Spatio-temporal behavior of air quality in Metropolitan Lima, Peru, using artifcial neural networks. The conventional feed forward back propagation known as Multilayer Perceptron (MLP) and the Recurrent Artifcial Neural network known as Long Short-Term Memory networks (LSTM) were implemented for the hourly prediction of PM10 based on the past values of this pollutant and three meteorological variables obtained from five monitoring stations. The models were validated using two schemes: The Hold-Out and the Blocked-Nested Cross-Validation (BNCV). The simulation results show that periods of moderate PM10 concentration are predicted with high precision .[2]This survey tells that is to use the Internet of Things (IoT) technology to monitor the acquired data, process the data, and predict the next data using a neural network. The existing prediction models have limitations. They don't accurately capture the law between the concentration of haze and the factors affecting reality. It is difficult to accurately predict the nonlinear smog data. One algorithm proposed in this paper is a two-layer model prediction algorithm based on Long Short Term Memory Neural Network and Gated Recurrent Unit (LSTM&GRU). We set a doublelayer Recurrent Neural Network to predict the PM2.5 value. This model is an improvement and enhancement of the existing prediction method Long Short Term Memory (LSTM). [3]This survey says that accurately predicting the PM2.5 concentrations in order to prevent the citizens from the dangerous impact of air pollution .The variation of PM2.5 depends on a variety of factors, such as meteorology and the concentration of other pollutants in urban areas. In this paper, they implemented a deep learning solution to predict the hourly forecast of PM2.5 concentration in Beijing, China, based on CNN-LSTM, with a spatial-temporal feature by combining historical data of pollutants, meteorological data, and PM2.5 concentration in the adjacent stations. Experimental results indicate that "hybrid CNN-LSTM multivariate" method enables more accurate predictions . [4]Next survey is prediction of air quality based on deep learning technology is studied in depth. Based on long short-term memory (LSTM), a comprehensive prediction model with multi-output and multi-index of supervised learning (MMSL) was proposed. The particle concentration data (mainly PM2.5) of the present monitoring station, as well as that of the nearest neighbor stations, the meteorological data, and the gaseous pollutant data in the air (mainly CO, NO2, O3, SO2) of the same period were integrated. All data were converted into the supervised learning format and normalized. The LSTM was used for training to obtain the predicted values of air quality pollution indicators (PM2.5, CO, NO2, O3, SO2) and the performance was done by RMSE and (R-2) values. [5]This survey tells that the World Health Organisation (2019) has stated that 83 % areas of United Kingdom was found exceeding the air pollution level in 2019. This paper evaluates the forecasting of No2 pollutant in air by comparing deep learning and time series models and the results it was clear that neural network with stacked LSTM has outperformed every well.

III. OVERVIEW OF PAPER

The flow chart shown in fig.1 is showing different phases of the predictive approach for NARX which involves various steps required to be attained for this approach. Dataset needed for the predictive system, which will be transformed into time series format in the form of matrix in time step (cell column, matrix column, matrix row). There is three kinds of target time steps employed in this model .

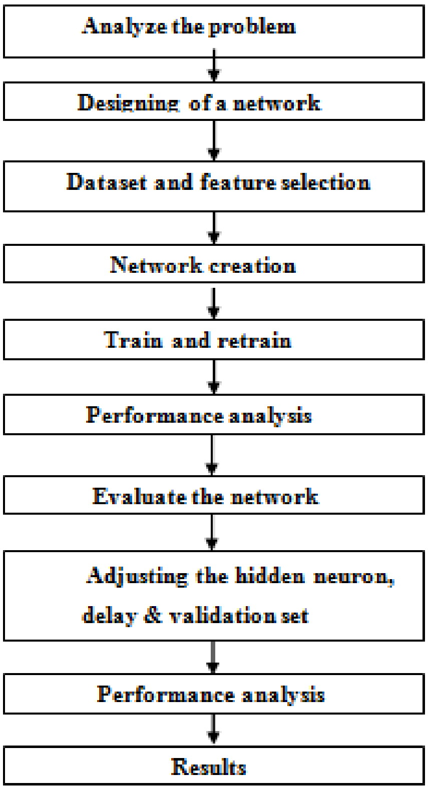


Fig 1 : Predictive Flowchart for NARX

A. Nonlinear Autoregressive with External (Exogenous) Input (NARX)

Nonlinear Autoregressive Network with Exogenous Inputs (NARX) is a recurrent dynamic network with feedback connections that enclose several layers of the network . The snapshot of NARX network is shown in fig. 2 with tapped delay lines and two-layer feed-forward network, a sigmoid transfer function in the hidden layer, and a linear transfer function in the output layer.

IV. METHODOLOGY

Levenberg-Marquardt (LM) optimization is a virtual standard in nonlinear optimization. It is a pseudo-second-order method which means that it works with only function calculations and gradient information, but it estimates the Hessian matrix using the sum of outer products of the gradients .

$$X_{k+1} = X_k - [J^TJ + \mu I]^{-1} J^T e \quad (1)$$

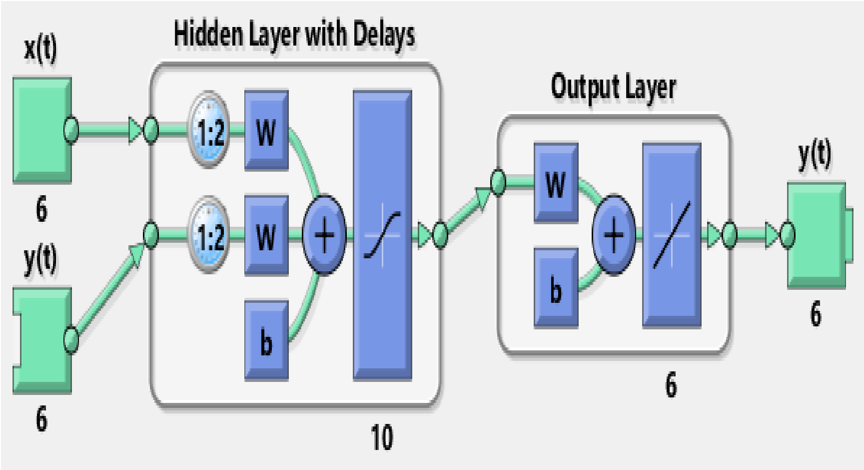


Fig 2: NARX network overview

All target vectors and input vectors are randomly separated into three set values of validation, training, and testing with assigned values of, and respectively. The number of neurons and delays was tuned up to further vary the performance of the network at 5, 10,15, 20, 25, and 2, 3 4,5 correspondingly. The network stopped when the target MSE was achieved or after the maximum number of epochs was reached.

A. Experimental Data

The dataset used to evaluate the performance between NARX and NIO is pollution. set, the dataset was used to train the neural network to predict mortality due to pollution. It is a 1×219 cell array of 8×1 vectors representing eight measurements over 219 time steps. The measurements are Temperature, Relative humidity, Carbon monoxide, Sulfur Dioxide, and Nitrogen dioxide, Hydrocarbons, Ozone, and Particulates. Pollution Targets is a 1x219 cell array of 3x1 vectors representing 219 time step of three kinds of mortality to be predicted. The to-be predicted mortality includes Total mortality, Respiratory mortality and cardiovascular mortality.

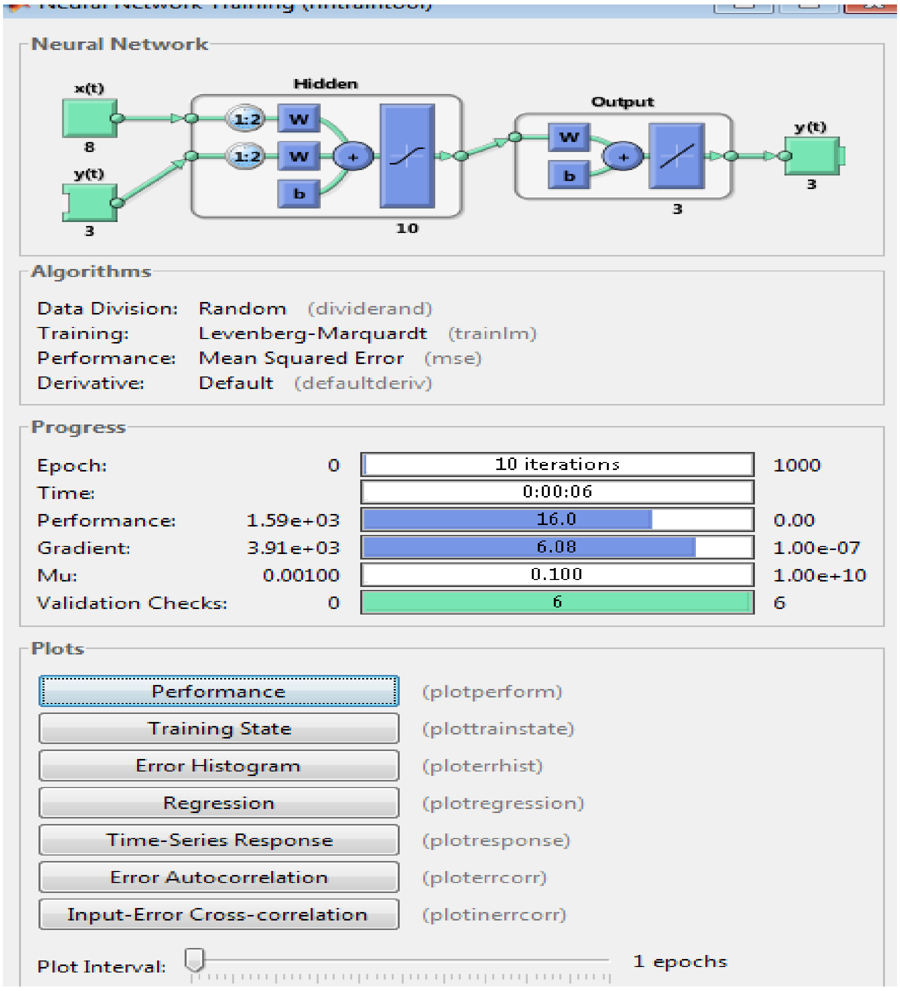
V. RESULT AND DISCUSSION

This section describes the complete series of tests implemented, simulation output, and experimental set-up.

A. Simulated NARX Results

The simulated results for NARX using some variable parameters are illustrated in Table and Figures .

- ✓ Table 1: Result of NARX with parameters of different hidden neurons (Train and Retrain)
- ✓ This tabulation shows that changing the Hidden neuron (10) has good efficiency of Regression and Epoch.
- ✓ Changing the neurons of the simulation in the NARX are shown in figure 3 to figure 6 .



HN	E	T	V	Test	All R
10	10	0.99758	0.99614	0.99554	0.99705

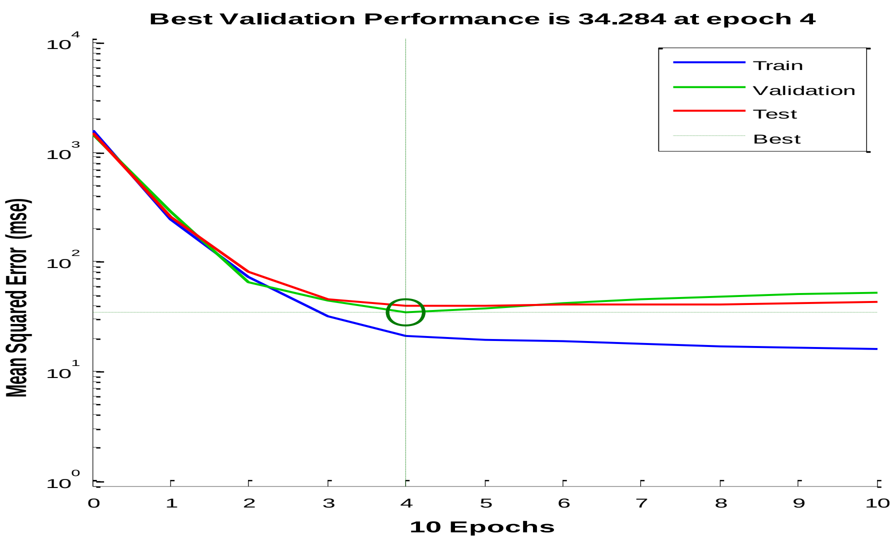


Fig 3: Performance plot of NARX

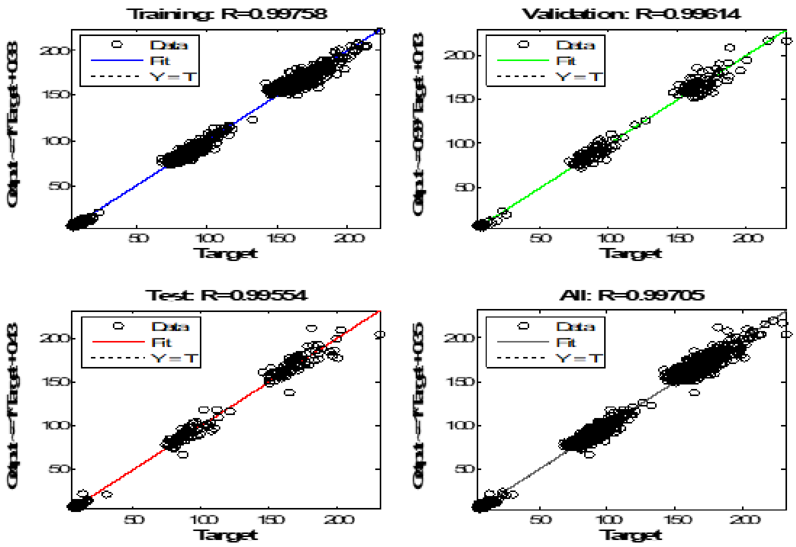


Fig 4: Regression plot of NARX

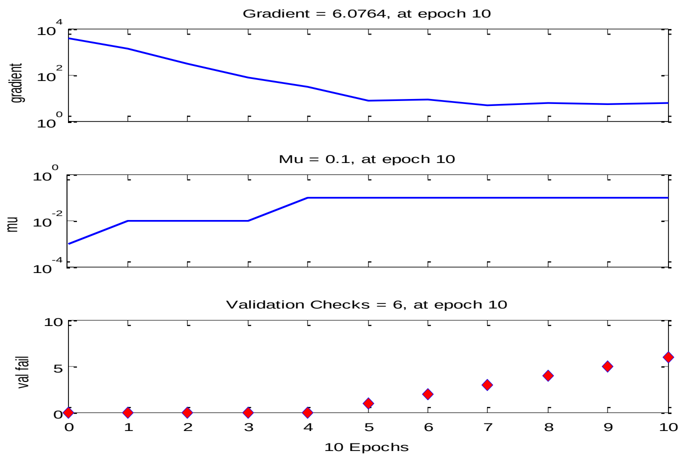


Fig 5 : Training plot of NARX

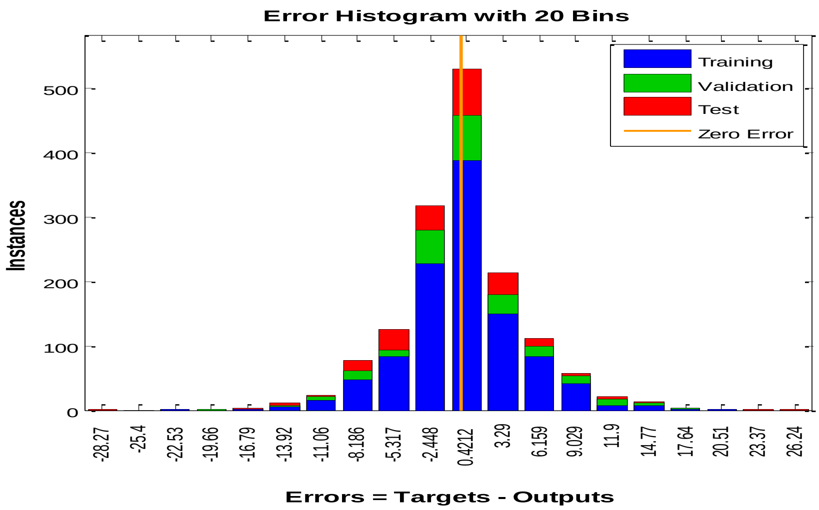


Fig 6 : Error histogram of NARX

B. Performance Evaluation of NARX

General measures of performance error evaluation (target-output) were achieved and summarized in the Table 1 for NARX model (MSE). The results suggested that the NARX model produces a greater predictive capacity for both fit and accuracy.

VI. CONCLUSION

In this project, for calculating prediction of air pollution, we have designed Multilayer Feed Forward Back Propagation Artificial Neural Network with a Levenberg-Marquardt learning Algorithm and training algorithm. Efficiency of network have analyzed with Different hidden layer size as 5,10,15,20,25 . Performance of the network is validated with different metric as a number of epoch, MSE and R-square.

Based on the analysis we observed the following

- A **trainlm** is suitable for calculating pollution mortality.
- On comparison hidden layer , FFBP with epoch of **'10'**have regression of **0.99705**.

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