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Vegetable Price Prediction using Adaptive Neuro-Fuzzy Inference System

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Abstract— **The Agricultural sector is a very important one in the developing countries. In agriculture domain it is very difficult to predict the price of the vegetable, so making use of the prediction technique like neural networks the price is predicted. In this paper a prediction model is established with the help of Adaptive neuro-fuzzy inference system and compares the result with other models. The result for the proposed prediction model is more efficient and accurate than other neural network models for predicting the price of the vegetables.**

Keywords- Data mining, Back-Propagation neural network (BPNN),Redial basis Function (RBF), ANFIS, Vegetible Price.

I. INTRODUCTION

The price of the Vegetable changes frequently which is unstable that makes a great impact in our day to-day life and also difficult to predict the price because it has high nonlinear and high noisy attributes. Price of respective vegetable is predicted using Data mining techniques [1]. Data mining techniques is also used for the classification of agricultural soil [2]. Farmers can get more price in the market with the help of the price prediction of the vegetables. By using this prediction models Government can do the development agricultural planning to stabilize the price of the respective vegetables. In non-linear time series forecasting the Neural Network plays an important role in prediction [3]. There are many different kinds of prediction methods available on the basis of Neural Network are available among them the BPNN and RBF Neural Network are important techniques [4]. In this paper ANFIS model is generated for the price prediction of the vegetable and compare the results with BPNN and RBF model result.

Section II presents Models and Methods. Section III presents Adaptive neuro-fuzzy based prediction , Section IV presents results and discussions and finally Section V presents Conclusion.

II. MODEL AND METHODS

A. Data collection

Normally the price of the vegetable is affected by the factors like climate, festival, supply and demand etc., and it is difficult to collect data set based on these factors . Therefore in this work the experimental data is taken as the price of the vegetable. High frequency data is preferred in short time forecasting i.e daily data. But some time daily data is not available. So, weekly data is used for prediction because it has very less noise. From Jan 2009 to Mar 2012 the price of the tomato data are taken for construction of prediction model and evaluation of the model. Previous weekly price of tomato are taken for simulating the prediction model and later few weekly price are taken for the model testing. The dataset is taken from the paper [5].

B. Data Preparation

In time series forecasting the value at t have a relationship with (t-1,t-2,…t-k) previous values.

$$b_t = f(b_{t-1}, b_{t-2} \ldots, b_{t-k}) \quad (1)$$

In time series forecasting, the data is transformed into a data set which is depending on the number of neurons in the input layer of a particular network and the construction of each data set is as follows:

- Y input values that are correspond to the X normalized previous values of the period t. M_{t-1}, M_{t-2}, …, M_{t-k}
- One output value : M_t (designed target)

. The price data set is divided into two subset, they are one for network training and another for network validation. To find the weekly price prediction of the vegetables, the three layered feed forward network structure is used.

III. ADAPTIVE NEURO-FUZZY BASED PREDICTION

An Adaptive Neuro-Fuzzy Inference System (ANFIS) is one kind of artificial neural network. It is based on the Takagi-Sugeno fuzzy inference system [7]. It was developed in 1990 which integrates both neural network and fuzzy logic principles with the benefits of both in a single structure, where it generates the fuzzy rules and membership functions automatically.

Neuro-adaptive learning methods are used for tuning the parameters of ANFIS membership functions which are similar to those used in the training of neural network. The neuro-adaptive learning method works similarly like an artificial neural networks. The fuzzy inference system's basic structure is a model that associate input description to membership functions of the input, input membership-functions to rules, the rules to a set of output description, the output description to membership-functions of output, finally the output membership functions to a solitary-valued output or a decision associated with the output . The basic FIS structure is shown in the figure 1.

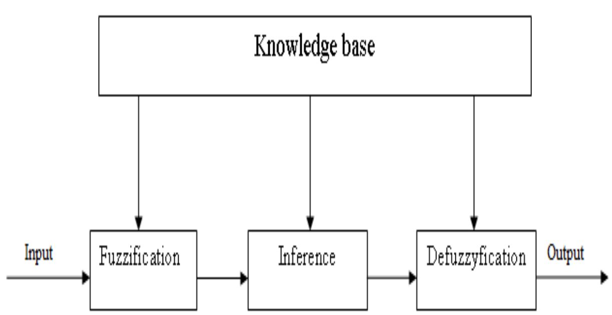

Figure 1. Structure of FIS

The most important aspect of the system should always used the terms of fuzzy if-then rules, because it is based on the fuzzy system reflecting vague knowledge. Among many FIS models, the first order Sugeno-fuzzy model is use for this work. This model is mainly used for its high interpretability and computational effectiveness and built in optimal and adaptive techniques. This fuzzy model provides a systematic approach to generate fuzzy rules from the set of input-output data pairs and the optimal values of the parameters is be found by using LSM. The hybrid learning algorithm combining LSM and BP algorithms is used to solve this prediction problem.

In the Fuzzification process, a membership matrix of order N X M is generated which consists of the degree of member ship of N different patterns to M different classes. Each element in this matrix is a membership function of the form $Mf_{ij}(y_i)$, where y_i is the i-th pattern value of the input pattern vector y with i = 1,2,…N and j=1,2,… M.

1. The Mf can be defined as

$Mf_{ij}(y_i)$ = degree of membership of pattern i to class j,

where the i-th pattern $y_i=x_{i1,}x_{i2},\ldots x_{ik}$

2. The input patter vector y is described as $Y = [y_1, y_{\ldots} y_n]^T$ where 'T' denote the matrix transpose operation. For fuzzification, The generalized bell-shaped MF is used in this work which depends on three different parameters a, b and c as given by the equation

3.

$$Mf(y; a, b, c) = 1 / (1 + (y-c/a)^{2b}) \qquad (2)$$

Where c determines the center of MF; a denotes half-width; and b is used to controls the slopes at the different crossover points.

A. Model Construction

The network structure includes the input layer, the hidden layer and the output layer. There is a connection from one neuron to all other neurons in the next layer, but there is no connection among the neurons in the same layer. Since the previous three weeks price is used to predict the forth week price, there are three neurons in the input layer and one neuron is in the output layer.

The price data of the tomato for weekly, has been taken for prediction and the former price data for the last three week is taken as input and later one week price data as output. The hybrid algorithm is composed of a forward pass and a backward pass. The least squares method is used to optimize the parameters with the principle parameters fixed. Once the optimal parameters are found, the backward pass starts immediately. The gradient descent method is used to adjust optimally the premise parameters corresponding to the fuzzy sets in the input domain. MATLAB is used to construct and simulate the ANFIS model.

Steps for construction of ANFIS model

- Loading the input data set and clean the data
- Creating the initial structure of FIS
- Training the FIS with the training dataset
- Validate the trained FIS with the test data set

The screen shots of Structure of ANFIS are given in the figure 2 and figure 3.

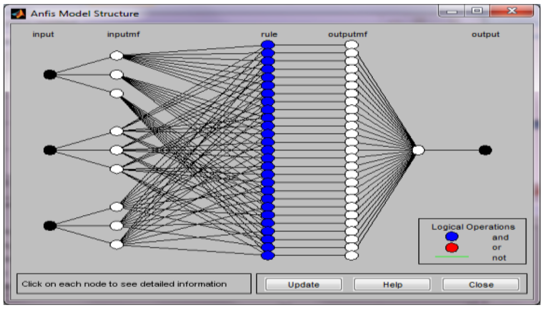

Figure 2. Structure of FIS

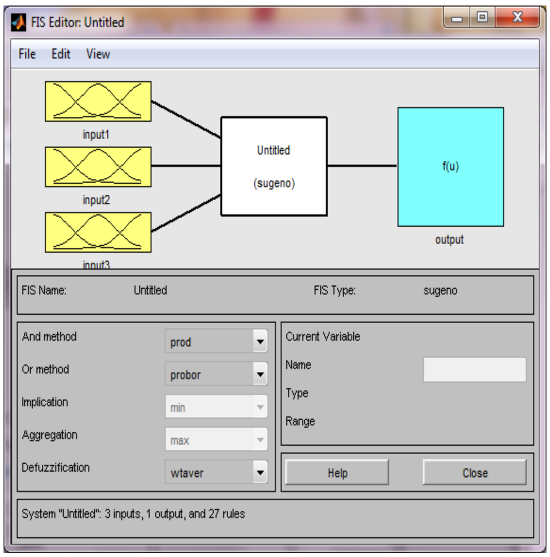

Figure 3. FIS Structure Genreationwith automatically

ANFIS model information as follows:

Number of nodes: 78
Number of linear parameters: 27
Number of nonlinear parameters: 27
Total number of parameters: 54
Number of training data pairs: 161
Number of checking data pairs: 10

To estimate membership function parameters, apply either back propagation form of the steepest decent method or least square method. The ANFIS membership function is shown in the figure 4. The surface viewer for the ANFIS is shown in the figure 5.

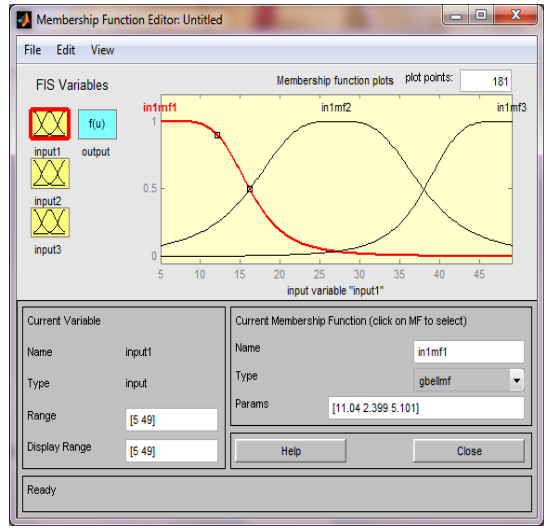

Figure 4. Membership function of ANFIS

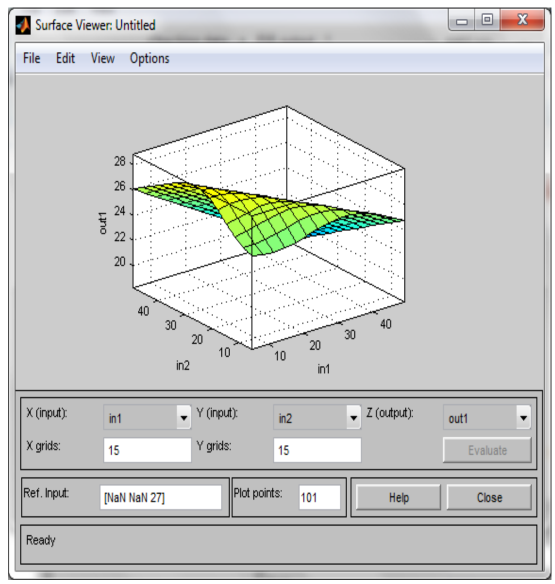

Figure 5. Surface viewer of ANFIS model

B. Training Error and Testing Error of the model

The difference between the actual output data and the output of the fuzzy inference system corresponding to the input value is called training error. The root mean square error of the training data set at each epoch is recorded the training error. Training error and Testing the FIS against the test data are shown in the figure 6 and figure 7.

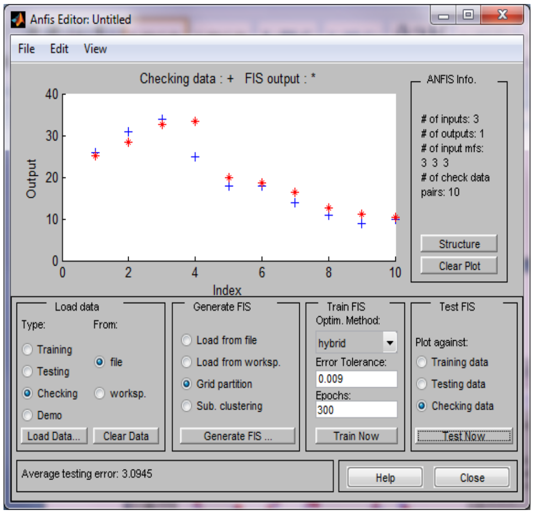

Figure 6. Training Error of ANFIS model

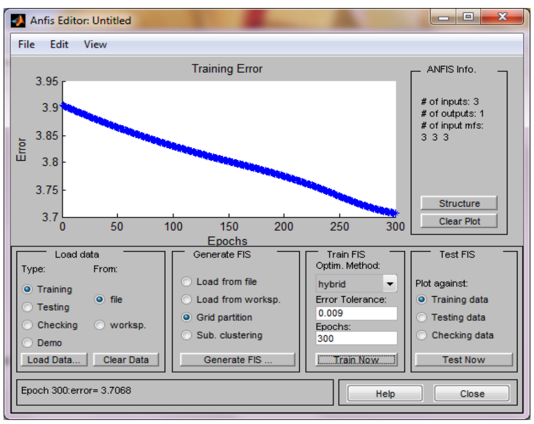

Figure7. Training Error of ANFIS model

In this work the price of the vegetable data set is used to built the ANFIS model and test the model. The proposed ANFIS model gave 96.91% accuracy of the total price prediction.

IV. Results and Discussions

In ther previous work the Back propagation neural network prediction model were used for price prediction and it produced the prediction accuracy of 77.42% [9]. Radial Basis function model was constructed for market price of the vegetable and it gave 85.55% accuracy of prediction in [10]. In this paper the same data set is used to build the ANFIS model and test the model. The proposed ANFIS model gave total prediction accuracy of 96.91%. The result shows that ANFIS network is highly accurate than BP neural network and RBF. The representation of graph is shown in figure 8.

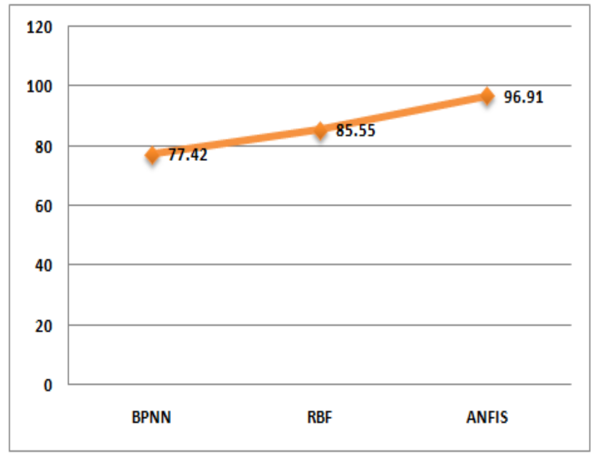

Figure 8. Comparission betweet BPNN, RBF and ANFIS

V. Conclusions

In this paper, ANFIS models is generated for price prediction of vegetable ith the help of MATLAB. The prediction results are analysed and compared the result with BP neural network prediction model and RBF model. The result shows that ANFIS model is better than BP network and RBF model based on the accuracy, training time and training speed. It proved that the ANFIS model is most efficient and accurate than other neural network model for the price prediction of the vegetable.

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