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Assessment of Exported Tea Quantity using Fuzzy Neural Model

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Abstract— In the field of prediction Assessment plays a major role. The prediction result becomes incorrect if a Assessment is not selected properly and the scope of future work becomes lost or unpredictable. Therefore an appropriate technique needs to be selected for the purpose of forecasting. There are lot of soft computing models which are being used in various application for the purpose of forecasting. The performance of fuzzy logic and Artificial Neural Network, in the field of soft computing, are being examined for the purpose of Assessment on the basis of average error. Here an effort is being used to select the proper soft computing technique to predict the futuristic information of quantity of exported tea to be exported in near future. Initially, the concept of Fuzzy Logic based on Fuzzy Membership Function has been applied and therefore after concept of Feed Forward Back propagation Neural Network of soft computing has been used to optimize the error.

Keywords— Fuzzy Logic, Artificial Neural Network, Feed Forward Back Propagation Neural Network, Soft Computing.

I. INTRODUCTION

Monitoring of crop conditions and yield prediction is important for the economic development of any nation. India is the largest producer and consumer of tea in the world and accounts for 31% of global tea production. Various government and private and tea estate managers require advance information about the expected yield of the tea crop from tea plantation estates. Traditionally, crop production forecasts for a tea plantation have been based on crop inventories (estate ledgers) and yield surveys. However, the application of traditional techniques becomes expensive, time consuming, and unreliable for extensive tea plantation estate areas.The use Assessment plays a major role in the area of prediction. If the Assessment technique is not selected properly, the prediction information becomes incorrect and this scope of work of planning becomes lost. Therefore it is needed to select appropriate technique for the purpose of forecasting. A lot of soft computing model is being used in various application systems for the purpose of forecasting. The performance of fuzzy logic, in the field of soft computing, is being examined for the purpose of Assessment. Here an effort is being used to select the proper soft computing technique to predict the futuristic information of exportable quantity of tea in near future.

II. METHODOLOGY

1.1.1 Fuzzy Logic

The word "fuzzy" means "vagueness". Fuzziness occurs when the boundary of a piece of information is not clear. Fuzzy sets have been introduced by Professor Lotfi A. Zadeh (1965) as an extension of the classical notion of set. Classical set theory allows the membership of the elements in the set in binary terms, a bivalent condition that an element either belongs to or does not belong to the set. Fuzzy set theory [5] permits the gradual assessment of the membership of elements in a set, described with the aid of a membership function valued in the real unit interval [0, 1]. For an example the words like young, tall, good and high are fuzzy.

In real world, there exists much fuzzy knowledge, knowledge that is vague, imprecise, uncertain, ambiguous, inexact, and probabilistic in nature. Human thinking and reasoning frequently involve fuzzy information, originating from inherently inexact human concepts. Humans can give satisfactory answers, which are probably true.

However, the existing systems are unable to answer many questions. The reason is, most systems are designed based upon classical set theory and two-valued logic which is unable to cope with unreliable and incomplete information and give expert opinions.

It is desirable that the proposed systems should also be able to cope with unreliable and incomplete information and give expert opinions. Fuzzy sets have been able to provide solutions to many real world problems. Fuzzy set theory is an extension of classical set theory where elements have degrees of membership [11].

Fuzzy controllers are very simple in concept. It consists of an input stage, a processing stage, and an output stage. The input stage maps sensor or other inputs, such as switches, thumbwheels and so on, to the appropriate membership functions and truth values. The processing stage invokes each appropriate rule and generates a result for each, then combines the results of the rules. Finally, the output stage converts the combined result back into a specific control output value.

2.1.2 Fuzzy Membership Functions

The fuzzification [11] on membership values can be done with the help of different membership functions . These functions are as follows:

(1) Gaussian Function
(2) Triangular Function
(3) Trapezoidal Function
(4) SIGMOIDALLY SHAPED FUNCTION
(5) Π-SHAPED FUNCTION
(6) S-Shaped Function
(7) Z-SHAPED FUNCTION
(8) Generalized Bell-Shaped Function

2.1.3 Fuzzy Set Operation

A fuzzy operation creates a new set from one or several given sets. For example, given the sets A and B the intersection is a new fuzzy set with its own membership function. Let the set

A = {0. 2, 0.3, 0.5 0.2, 0.8}.
B= {0, 0, 0.6, 0.8, 0.2}.

Union

The membership function of the union of two fuzzy sets A and B with membership functions μ_A and μ_B respectively is

defined as the maximum of the two individual membership functions. This is called the maximum criterion. As for example, let there are two fuzzy set A= {0.2, 0.3, 0.5, 0.2, 0.8} and B = {0, 0, 0.6, 0.8, 0.2}. The union of two sets A and B is ($A \cup B$) = {0.2, 0.3, 0.6, 0.8, 0. 8}.

$$\mu_{A \cup B} = \max(\mu_A, \mu_B)$$

The union operation in Fuzzy set theory is the equivalent to the OR operation in Boolean algebra.

Intersection

The membership function of the intersection of two fuzzy sets A and B with membership functions and respectively is defined as the minimum of the two individual membership functions. This is called the minimum criterion.

$$\mu_{A \cap B} = \min(\mu_A, \mu_B)$$

The intersection operation in fuzzy set theory is the equivalent to the AND operation in Boolean algebra. The minimum values of two set will be the intersection of the set. As for example, the intersection of two set A and B is ($A \cap B$) = {0, 0, 0.5, 0.2, 0.2}.

Complement

The membership function of the complement of a fuzzy set A with membership function μ_A is defined as the negation of the specified membership function. This is called the negation criterion as

$$\mu_{\bar{A}} = 1 - \mu_A$$

The complement operation in fuzzy set theory is the equivalent to the NOT operation in Boolean algebra.
The complement of A is A^c =1-A which is {0.8, 0.7, 0.5, 0.8, 0.2}. The following rules which are common in classical set theory also apply to fuzzy set theory.

2.1.4 Methods of Defuzzification

Defuzzification methods [12] include max membership principle, centroid method, weighted average method, mean-max membership, center of sums, and center of largest area first.

2.2 Feed Forward Back Propagation Neural Network

The feed forward back propagation neural network (FFBPNN) does not have feedback connections, but errors are back propagated during training. Errors in the output determine measures of hidden layer output errors, which are used as a basis for adjustment of connection weights between the input and hidden layers. Adjusting the two sets of weights between the pairs of layers and recalculating the outputs is an iterative process that is carried on until the errors fall below a tolerance level. Learning rate parameters scale the adjustments to weights. A momentum parameter can be used in scaling the adjustments from a previous iteration and adding to the adjustments in the current iteration.

III. PROPOSED WORK

For prediction of futuristic forecasted data, a statistical model called Fuzzy Logic and Artificial Neural Network has been used. For the fuzzification of data we will use, Triangular Membership Function for the minimum value of average error. Then we will perform Feed Forward Back Propagation Neural Network to estimate the error again and to compare it with the previous error occurred in Fuzzy Logics. These will give us an idea, which is the efficient model for our work that gives less error.

IV. IMPLEMENTATION

The available exported tea information for previous years have been collected and using these, the prediction of exported tea for futuristic years has to be ascertained using Fuzzy logic and Fuzzy Membership Functions. Then from the Fuzzy Input and Fuzzy output Feed Forward Neural Network has been performed. The selection technique is made based on minimum average error.

4.1 Fuzzy Logic

Step- 1

The available data are fuzzyfied based on triangular functions, trapezoidal functions. Based on error analysis, the model with minimum average error has been selected. Since the triangular function gives minimum error, so the triangular function is used as membership function and the corresponding fuzzy set are furnished in Table 1 as follows:

Table 1 (Fuzzy Sets)

YEAR	X	A (20000-50000)	B (50000-80000)	C (80000-110000)	D (110000-140000)	Fuzzy Set
1987-88	21107.4	1	0.03	0	0	A
1988-89	26551.6	1	0.2	0	0	A
1990-91	23052.3	1	0.1	0	0	A
1991-92	29339.4	1	0.3	0	0	A
1992-93	30752.7	1	0.3	0	0	A
1993-94	28888.5	1	0.2	0	0	A
1994-95	37586.1	1	0.5	0	0	A
1995-96	39388.4	1	0.6	0	0	A
1996-97	45736.6	1	0.8	0	0	A
1997-98	49671.5	1	0.9	0	0	A
1998-99	43304.8	1	0.7	0	0	A
1999-2000	69998.9	0.3	1	0.6	0	B
2000-01	62948.3	0.5	1	0.4	0	B
2001-02	72387.1	0.2	1	0.7	0	B
2002-03	90683.7	0	0.6	1	0.3	C
2003-04	71563.8	0.2	1	0.7	0	B
2004-05	77852.5	0.07	1	0.9	0	B
2005-06	106260.6	0	0.1	1	0.8	C
2006-07	128400.2	0	0	0.3	1	D
2007-08	134960.6	0	0	0.1	1	D

Step-2

All the fuzzy logical relationships are obtained as follows

A→A, A→B, B→B, B→C, C→B, C→D, D→D

It is to note that the repeated relationships are counted for only once.

Step-3

Let us define on operator '×' of two vectors.

Suppose C and B are two vectors of dimension m and $D = (dij) = C^T \times B$.

Then the element dij of matrix D of row i and j is defined as

$$dij = \min(Ci, Bj)\ (i, j = 1, 2 \ldots.. m)$$

where, Ci & Bj are the i^{th} & j^{th} element of C & B respectively.

Let $R1 = A^T \times A$, $R2 = A^T \times B$, $R3 = B^T \times B$, $R4 = B^T \times C$, $R5 = C^T \times B$, $R6 = C^T \times D$, $R7 = D^T \times D$

Then $R = URi$ where, R is the 4× 4 matrix and U is the union operator

$$R=\begin{pmatrix} 1 & 1 & 0.6 & 0.2 \\ 0.5 & 1 & 1 & 0.3 \\ 0.5 & 1 & 0.7 & 1 \\ 0.2 & 0.3 & 0.3 & 1 \end{pmatrix}$$

Using the formula (1) and through certain calculations the value of R has been calculated. We find the relationship.

(R) among the set of data and apply this formula $Ai = A_{i-1} .R$ [where A is the employment of year (i–1) and A is the forecasted employment of year i in terms fuzzy sets and '**.**' is the MaxMin operator].

For the Defuzzification we have used our technique:

- If the membership of an output has two or more consecutive maximums then selects the difference of value from first set to last set and divide the value by number of consecutive maximum. Then for forecasted value, add the calculated value with the minimum range of first set.
- If the membership of an output has only one maximum, the mid point of the interval corresponding to the maximum is selected as the forecasting value.
- If more than one membership occur but not consecutive, the selected the minimum value difference of the given data of maximum set and take the midpoint of that for the forecasted value.

Step-4

The forecasted output in Table 2:

Table 2(Triangular Function)

YEAR	X	Fuzzy Input	Fuzzy Output	Output	Error
1987-88	21107.4	1 0.03 0 0			
1988-89	26551.6	1 0.2 0 0	1 1 0.6 0.2	50000	88.31
1990-91	23052.3	1 0.1 0 0	1 1 0.6 0.2	50000	116.89
1991-92	29339.4	1 0.3 0 0	1 1 0.6 0.2	50000	70.41
1992-93	30752.7	1 0.3 0 0	1 1 0.6 0.3	50000	62.58
1993-94	28888.5	1 0.2 0 0	1 1 0.6 0.3	50000	73.07
1994-95	37586.1	1 0.5 0 0	1 1 0.6 0.2	50000	33.02
1995-96	39388.4	1 0.6 0 0	1 1 0.6 0.3	50000	26.94
1996-97	45736.6	1 0.8 0 0	1 1 0.6 0.3	50000	9.32
1997-98	49671.5	1 0.9 0 0	1 1 0.8 0.3	50000	0.66
1998-99	43304.8	1 0.7 0 0	1 1 0.9 0.3	50000	15.46
1999-2000	69998.9	1 1 0.6 0	1 1 0.7 0.3	50000	-28.57
2000-01	62948.3	0.5 1 0.4 0	0.5 1 1 0.6	80000	27.08
2001-02	72387.1	0.2 1 0.7 0	0.5 1 1 0.4	80000	10.51
2002-03	90683.7	0 0.6 1 0.3	0.5 1 1 0.7	80000	-11.78
2003-04	71563.8	0.2 1 0.7 0	0.5 1 0.7 1	45000	-37.11
2004-05	77852.5	0.07 1 0.9 0	0.5 1 1 0.7	80000	2.75
2005-06	106260.6	0 0.1 1 0.8	0.5 1 1 0.9	80000	-24.71
2006-07	128400.2	0 0 0.3 1	0.5 1 0.7 1	80000	-37.69
2007-08	134960.6	0 0 0.1 1	0.3 0.3 0.3 1	60000	-55.54

4.2 Feed Forward Back Propagation Neural Network

Applying FFBPNN on Fuzzy input and Fuzzy output to generate Forecasted output data and Percentage of Error shown in Table 3:

Table 3 (Feed Forward Back Propagation Neural Network)

YEAR	Actual Data (X)	NN Output	Forecasted data	Error
1987-88	21107.4			
1988-89	26551.6	0.99 0.83 0.6 0.88	35000	31.81
1990-91	23052.3	0.99 0.98 0.6 0.30	35000	51.82
1991-92	29339.4	0.99 0.99 0.6 0.24	35000	19.29
1992-93	30752.7	0.99 0.99 0.6 0.33	35000	13.81
1993-94	28888.5	0.99 0.98 0.6 0.34	35000	21.15
1994-95	37586.1	0.99 0.91 0.6 0.21	35000	-6.88
1995-96	39388.4	0.99 0.97 0.6 0.40	35000	-11.14
1996-97	45736.6	0.99 0.99 0.6 0.31	35000	-23.47
1997-98	49671.5	0.99 0.99 0.8 0.39	35000	-29.53
1998-99	43304.8	0.99 0.98 0.9 0.68	35000	-19.17
1999-2000	69998.9	0.99 0.99 0.7 0.45	35000	-49.99
2000-01	62948.3	0.50 0.65 0.99 0.99	95000	50.91
2001-02	72387.1	0.5 0.99 0.99 0.99	95000	31.23
2002-03	90683.7	0.50 0.98 0.99 0.99	95000	4.75
2003-04	71563.8	0.5 0.50 0.7 0.98	125000	74.66
2004-05	77852.5	0.50 0.99 0.99 0.99	125000	60.56
2005-06	106260.6	0.50 0.62 0.99 1	125000	17.63
2006-07	128400.2	0.50 0.50 0.7 0.73	125000	-2.64
2007-08	134960.6	0.30 0.30 0.30 0.30	65000	-51.83

V. RESULT

It has been observed that the average error based on Fuzzy Logic is 17.98%. Where the average error using FFBPNN is 9.63%. Since the FFBPNN gives the minimum error, this technique can be used for the Exported Tea Quantity of futuristic years. Based on the result the of Artificial Neural Network the error has been furnished for the actual quantity of 2008 -2010 in table 4.

Table 4 Result on the tested data

Year	Actual Qty.	Predicted Qty.	Error (%)
2008-09	143300.5	147916.81	3.22
2009-10	156782.5	162116.83	3.40

So it has been observed that the Prediction of Exported Tea quantity for the next 2years i.e. 2008-09 and 2009-10 are 147916.81 and 162116.83 metric ton respectively. It is compared with the actual Quantity and we found very less Error i.e. 3.22% and 3.40% respectively.

VI. CONCLUSION

The said work has been undertaken on the available data from the year 1987-88 to 2007-08. A lot of revenue has been earned by the country through export. If the said information is available in advance, necessary planning work can be decided by the Governments and various other agencies in the country. The estimated value of quantity of exported tea is 147916.81 and 162116.83 metric tons for the years 2008-09, 2009-10 respectively. Using this technique we can predict the Exported quantity of tea for the Futuristic years.

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