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Assessment of Exported Tea Quantity by Soft Computing Model

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Abstract— Assessment plays a major role in the field of prediction. If the Assessment cannot be selected properly, the prediction information becomes incorrect and this scope of work of futuristic planning becomes lost. Therefore it is needed to select an 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 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 least square base linear equation has been applied and therefore after concept of Fuzzy logic with Membership functions of soft computing has been used to optimize the error.

Keywords— Logic, Soft Computing, Least Square Base Linear Equation.

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

2.1 Least square regression based linear equation

In a cause and effect relationship, the **independent variable** is the cause, and the **dependent variable** is the effect. **Least square technique based on linear regression** is a method for predicting the value of a dependent variable *Y*, based on the value of an independent variable *X*. The data taken from field is often accompanied by noise. Even though all control parameters (independent variables) remain constant, the resultant outcome (dependent variable) varies. A process of quantitatively estimating the trend of the outcome is o known as regression or curve fitting which becomes necessary. The curve fitting process fits equations of approximating curves to the raw field data. Nevertheless, for a given set of data, the fitting curve of a given type is generally *not unique*. Thus, a curve with a minimal deviation from all data points is desired. This *best-fitting curve* can be obtained by the method of least squares. The method of least squares assumes that the best-fit curve of a given type is the curve that has the minimal sum of the squared deviations *(least square error*) from a given set of data.

2.1.1 Prerequisites for Regression

Simple linear regression is appropriate when the following conditions are satisfied.

(1) The dependent variable *Y* has a linear relationship to the independent variable *X*. To check this, it is necessary to make sure that the XY scatter plot is linear and that the residual plot shows a random pattern.

(2) For each value of X, the probability distribution of Y has the same standard deviation σ for same number of terms from different places of the available data.When this condition is satisfied, the variability of the residuals becomes

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relatively constant across all values of X, which can be easily checked in a residual plot.
(3) For any given value of X, the following techniques have to be followed:-
(a) The Y values are independent, as indicated by a random pattern on the residual plot.
(b) The Y values are roughly normally distributed (i.e., symmetric and unimodal). A little skewness is allowed if the sample size is large. A histogram or a dot plot shows the shape of the distribution.

2.1.2 The Least Squares Regression Line

Linear regression finds the straight line, called the **least squares regression line** or LSRL that represents best observations in a bivariate data set. Suppose *Y* is a dependent variable, and *X* is an independent variable. The population regression line is:-

$$Y = B_0 + B_1X$$

where B_0 is a constant, B_1 is the regression coefficient, X is the value of the independent variable, and Y is the value of the dependent variable.
For a given a random sample of observations, the population regression line is estimated by:

$$\hat{y} = b_0 + b_1x$$

where b_0 is a constant, b_1 is the regression coefficient, x is the value of the independent variable, and ŷ is the *predicted* value of the dependent variable.

2.1.3 Least Square techniques based on linear equation

Let the equation be $y = a + bx$

so $\sum y = \sum a + \sum bx$

$$\sum y = na + \sum bx \quad \text{.....................(1)}$$

[Where n = number of terms]

Again $y = a + bx$

$$xy = ax + bx^2$$

[Multiplied both sides by x]

so,

$$\sum xy = \sum ax + \sum bx^2 \text{..................(2)}$$

if x in chosen in such a way that $\sum x = 0$

then ,

$$a = \frac{\sum y}{n}$$

and

$$b = \frac{\sum xy}{\sum x^2}$$

Putting the values of a and b in equation $y = a + bx$ the equation of straight line becomes,

$$y = \frac{\sum y}{n} + \frac{x * \sum xy}{\sum x^2}$$

For different values of x, the different values of y have been calculated.

2.2 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.

2.3 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

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(7) Z-SHAPED FUNCTION
(8) Generalized Bell-Shaped Function

2.3.2 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.

2.3.3 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.

III. PROPOSED WORK

For prediction of futuristic forecasted data, certain statistical models like regression analysis using least square technique based on exponential, curvilinear (parabolic) equations and the tables of Orthogonal Polynomial will be used to estimate data based on the neural network. For the fuzzification of data we will use, Triangular Membership Function for the minimum value of average 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 least square techniques, Fuzzy logic and Fuzzy Membership Functions. The selection technique is made based on minimum average error.

4.1 Statistical Model using Least Square Technique
Based on the linear equation, the estimated values and relative error have been calculated. The average error is 18.45%. Now an effort is being made to improve the performance using fuzzy logic. Results are given on Table 1.

Table 1 (Least Square Technique model)

Year	Qty	Estimated value	Estimated Error
1987-88	21107.4	9310.01	55.8922
1988-89	26551.6	14331.2	46.0252
1990-91	23052.3	19352.4	16.0503
1991-92	29339.4	24373.6	16.9256
1992-93	30752.7	29394.7	4.41579
1993-94	28888.5	34415.9	19.1335
1994-95	37586.2	39437.1	4.92448
1995-96	39388.5	44458.3	12.8713
1996-97	45736.6	49479.5	8.18343
1997-98	49672	54500.6	9.72108
1998-99	43304.9	64543	49.0433
1999-2000	69998.9	69564.2	0.62105
2000-01	62948.4	74585.4	18.4865
2001-02	72387.1	79606.5	9.97336
2002-03	90683.7	84627.7	6.67818
2003-04	71563.8	89648.9	25.2713
2004-05	77852.6	94670.1	21.6017
2005-06	106261	99691.3	6.18238

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2006-07	128400	104712	18.4484
2007-08	134961	109734	18.6922

4.2 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, the triangular function is used as membership function and the corresponding fuzzy set are furnished in Table 2 as follows:

Table 2 (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:

(1) 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.

(2) 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.

(3) 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 3

Table 3
(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

V. RESULT

It has been observed that the average error based on least square technique using linear equation, 18.45%. The average error using fuzzy logic is 17.98%. Since the Fuzzy Logic gives the minimum error, the Fuzzy Logic can be used for the Exported Tea Quantity of futuristic years. Based on the result the of fuzzy logic 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	158578.7	10.66
2009-10	156782.5	174436.6	11.26

So it has been observed that the Prediction of Exported Tea quantity for the next 2years i.e. 2008-09 and 2009-10 are 158578.7 and 174436.6 metric ton respectively. It is compared with the actual Quantity and we found very less Error i.e. 10.66% and 11.26% respectively.

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 export mango is 158579 and 174437 metric tons for the years 2008-09, 2009-10 respectively. Similarly using this technique we can Predict the Exported quantity of tea for the Futuristic years.

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