BUSINESS GAIN ESTIMATION USING NEED MATRIX , INTERPOLATION AND NEURO- FUZZY RULE – A NOVEL CONCEPT

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ABSTRACT

Rare work has been done while gain estimation using need matrix, interpolation method and fuzzy rule. The work is based on a unique approach. The non-conventional approaches have been pointed herewith with respect to gain estimation using need matrix, interpolation , statistical means and fuzzy rule. The corresponding graphs based on data chart have also been depicted.

Key Words: *gain estimation, need matrix, interpolation, fuzzy rule*

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1. NEED MATRIX BASED GAIN ANALYSIS

Gain estimation in strategic market management [1-2] needs a forecasting scheme for accuracy estimate. Need matrix based analysis is a unique approach. Forecasting symbolizes expression of gain sensing . Mathematically, $I_S = f(I_M)$ where I_S be information content in forecasting, I_M be information content as per supervised learning rule and f being the mapping function

<u>Case 1:</u>

Now, in extreme unstable state, coordination between learning rule and forecasting degrades significantly.

Let M = { $I_{M1}, I_{M2}, I_{M3} \ldots I_{Mx}$} represents set of information elements of supervised rule and
S= { $I_{S1}, I_{S2}, I_{S3}, \ldots \ldots I_{Sx}$} be the set of information elements of forecasting.

Let f: M → S be a function from M to S. Distinct elements of M mapped to distinct element of S such that whenever $f(I_{Mi}) \neq f(I_{Mj})$ i.e $I_{Si} \neq I_{Sj}$.

This signifies that f: M → S is an injective function.

Case 2:

If the risk of loss level increases considerably, then redundancy followed by fickle-mined nature in forecasting is noted.

Let I_{Mi}, I_{Mj} and I_{Mk} be the information elements of learning rule at consecutive timing instants t_i , t_j, t_k respectively.

Therefore, $I_{Si}=f(I_{Mi})$ and due to incidence of redundancy in forecasting $I_{Sj}=f(I_{Mi})$, $I_{Sk}=f(I_{Mi})$, whereby S denotes a multiset and the frequency of $f(I_{Mi})$ is its multiplicity.

Let {+1,-1} be the set of states of patterns based on present scenario where (+1) indicates validity of a relevant state while (-1) indicates that of irrelevant state.

In four timing instants , state of each of and forecasting has been observed for 2 iterations.

Let $M_1= (+1,-1,-1,+1)$, $S_1 = (+1,-1,+1,-1)$, $M_2= (-1,-1,+1,+1)$, $S_2= (+1,-1,+1,+1)$

Therefore, $$M_1^T S_1= \begin{pmatrix} +1 \\ -1 \\ -1 \\ +1 \end{pmatrix} \begin{pmatrix} +1 & -1 & +1 & -1 \end{pmatrix} = \begin{pmatrix} +1 & -1 & +1 & -1 \\ -1 & +1 & -1 & +1 \\ -1 & +1 & -1 & +1 \\ +1 & -1 & +1 & -1 \end{pmatrix}$$

$$M_2^T S_2= \begin{pmatrix} -1 \\ -1 \\ +1 \\ +1 \end{pmatrix} \begin{pmatrix} +1 & -1 & +1 & +1 \end{pmatrix} = \begin{pmatrix} -1 & +1 & -1 & -1 \\ -1 & +1 & -1 & -1 \\ +1 & -1 & +1 & +1 \\ +1 & -1 & +1 & +1 \end{pmatrix}$$

Therefore, $$M_1^T S_1 + M_2^T S_2 = \begin{pmatrix} +1 & -1 & +1 & -1 \\ -1 & +1 & -1 & +1 \\ -1 & +1 & -1 & +1 \\ +1 & -1 & +1 & -1 \end{pmatrix} + \begin{pmatrix} -1 & +1 & -1 & -1 \\ -1 & +1 & -1 & -1 \\ +1 & -1 & +1 & +1 \\ +1 & -1 & +1 & +1 \end{pmatrix}$$

$$= \begin{pmatrix} 0 & 0 & 0 & -2 \\ -2 & +2 & -2 & 0 \\ 0 & 0 & 0 & +2 \\ +2 & -2 & +2 & 0 \end{pmatrix} = N_M \text{ (need matrix).}$$

Now, next sensed pattern M_3= (-1,+1,-1,-1)

Accordingly, S_3 can be predicted on the basis of N_M (need matrix) as follows:-

$$S_3' = \begin{bmatrix} -1, +1, -1, -1 \end{bmatrix} \begin{pmatrix} 0 & 0 & 0 & -2 \\ -2 & +2 & -2 & 0 \\ 0 & 0 & 0 & +2 \\ +2 & -2 & +2 & 0 \end{pmatrix}$$

$$= \begin{bmatrix} -4, +4, -4, 0 \end{bmatrix}$$

For S_3', assign state (+1) for the elements > 0 and state (-1) for the elements ≤ 0.Accordingly, S_3 = (-1 , +1 , -1 , -1) is predicted .Hence, probability of occurrence of relevant information in forthcoming forecasting S_3 = ¼ = 0.25.

2. PREDICTION USING INTERPOLATION

Suppose we have n real world data as $<x_1, y_1>$, $<x_2, y_2>$… $<x_n, y_n>$ where $x_i \in R$ for each $i \in N_n$ and y_i is a given grade of membership of x_i in a set A (i.e. $y_i = A(x_i)$).We will use Lagrange's interpolation to estimate the polynomial function. Lagrange's interpolation polynomial is: $L(x) = \sum (0 \le j \le n)\, y_j\, l_j(x)$ where, y_j is data in y axis and $l_j = \prod (0 \le f \le n)\, \{(x-x_f) / (x_j-x_f)\}$ and $f \ne j$. The data in y axis is gain enhancement margin. In this context, gain estimation has been carried out in the light of interpolation relative to growth models, Poisson distribution[3] and unit step function.

The polynomial can be easily used to interpolate new values if some data is given. Moreover using Lagrange's polynomial we can estimate new values even at uneven intervals with surplus of accuracy.

Now suppose we have given following data set:

x(time)	1	2	3	4	5
Y	0.5	10	8	12	0.5

Table1 : Gain estimate at uneven intervals with surplus of accuracy

Then above polynomial can be applied for estimating or interpolating values at different values of x that are as follows:

x(time)	1.5	1.9	2.5	3.3	4.5	4.7	4.9
Y	7.78125	9.85625	9.34375	6.91950	9.53125	6.85675	2.96025

Table2 : Gain estimate using interpolation method

Now polynomial function for above data will be $A(x) = -1.625x^4+19.166667x^3-80.125x^2+140.083333334x-77$

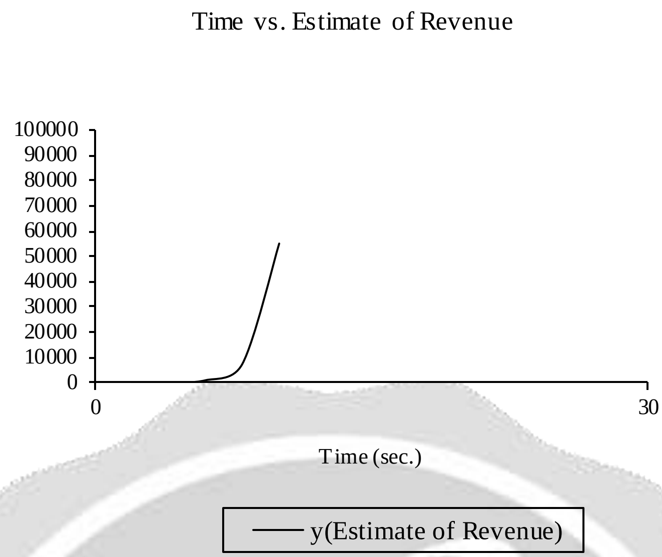

Fig- 1: Exponential Growth curve while plotting revenue with respect to time

Time	Estimate of Revenue
2	18.47
4	136.50
6	1008.60
8	7452.40
10	55066.00

Table -3: Exponential Growth Model Table

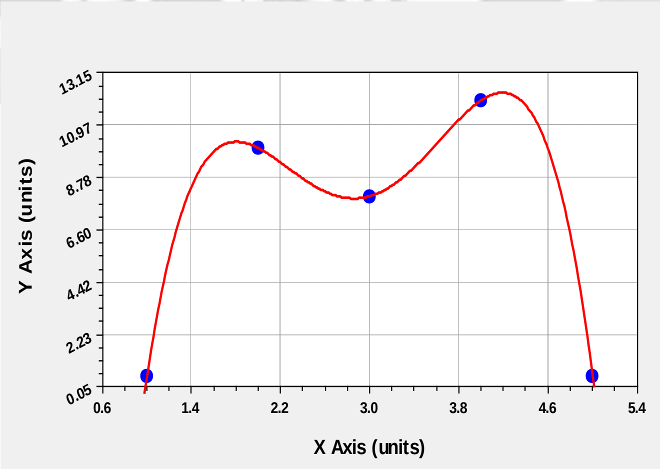

Fig-2: Non-equidistant prediction analysis

Linear fit

Let we have the following data. After applying least square method on it we can predict the nature and representation of polynomial.

x(time)	0	1	2	3	4	5
Y	2	5	8	11	14	17

Table -4: Data chart for linear fit

For above data polynomial function will be y= 2 + 3x.

Non-Linear fit(Sinusoidal fit)

Let we have the following data for non-linear fit.

X(time)	0	1	2	3	4	5	6	7	8
Y	0	3.5	5	3.5	0	-3.5	-5	-3.5	0

X(time)	9	10	11	12	13	14	15	16	
Y	3.5	5	3.5	0	-3.5	-5	-3.5	0	

Table -5: Data chart for non-linear fit

Polynomial function for above data is y = a+bcos (cx+d),

where a = -1.52792026938E-010, b=4.97508174354E+0, c=7.85481641119E-01, d=1.57146414812E+0

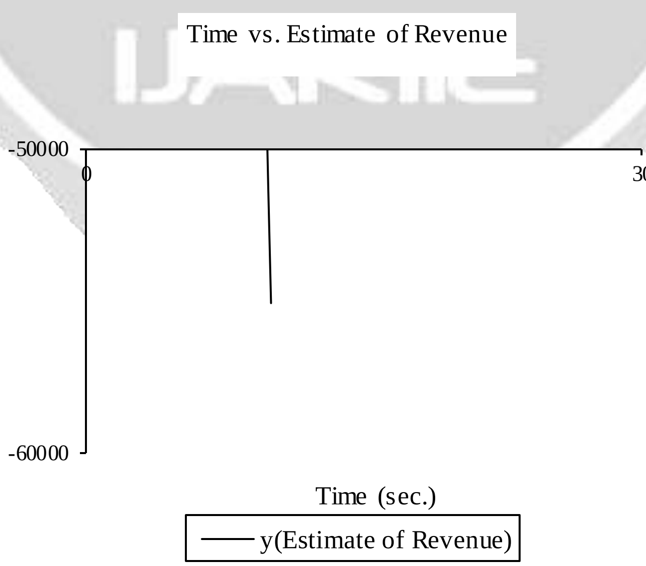

Fig-3: Exponential Decay curve while plotting revenue with respect to time

Time	Estimate of Revenue
2	-18.47
4	-136.50
6	-1008.60
8	-7452.40
10	-55066.00

Table-6: Exponential Decay Model Table

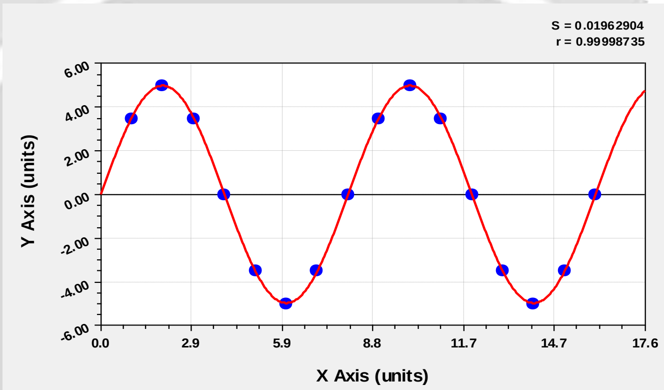

Fig -4: Non-Linear-fit data prediction analysis

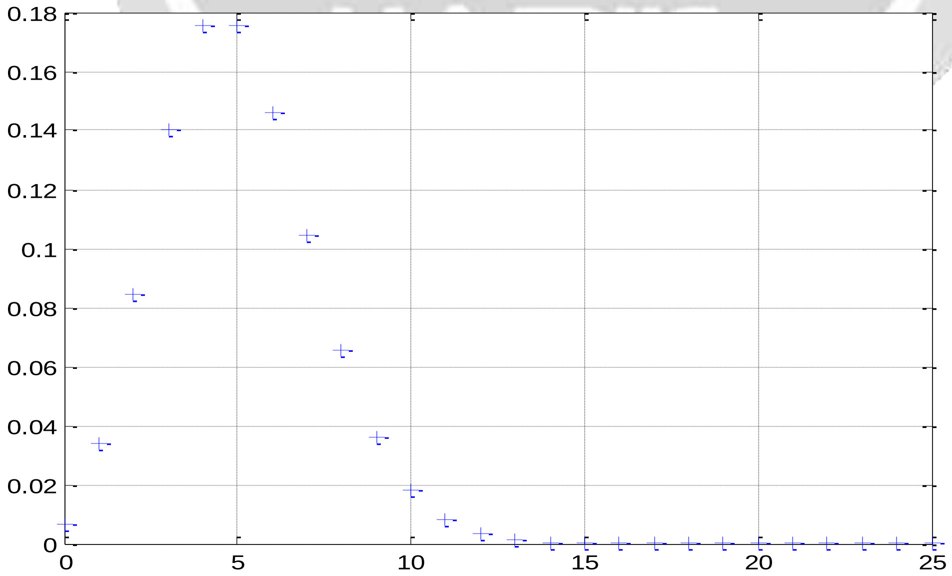

Fig- 5: Poisson Distribution pdf

X	Y
0	0.009
1	0.03
2	0.09
3	0.14
4	0.17
5	0.18
6	0.145
7	0.105
8	0.065
9	0.038
10	0.019
11	0.009
12	0.002
13	0.00075
14-25	0

Table-7: Table of Poisson Distribution pdf

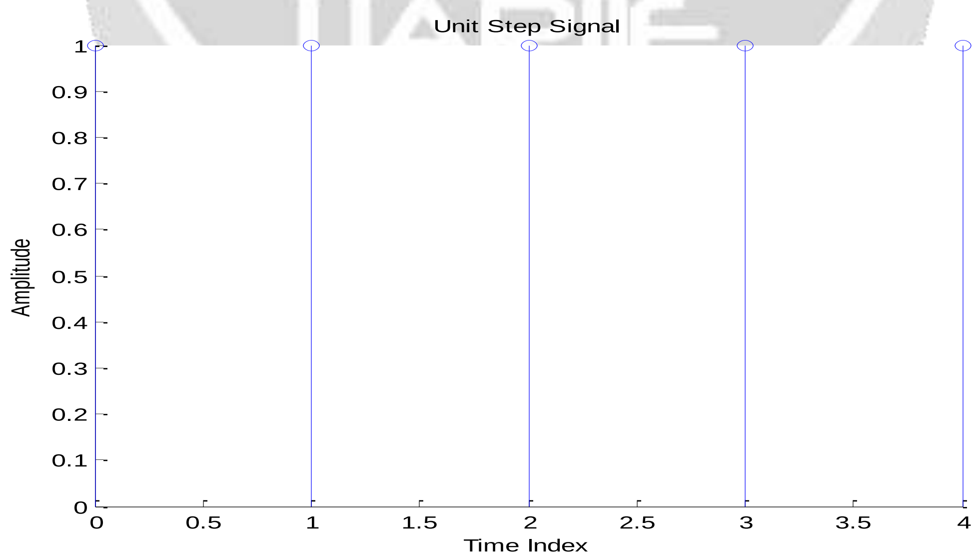

Fig-6: Unit Step Function

X	Y
0	1
1	1
2	1
3	1
4	1

Table 8: Table of Unit Step Function

4. GAIN USING STATISTICAL MEANS AND FUZZY RULE

Statistical means of harmonic mean [4] play a pivotal role in gain estimate.

Theorem : *If a particular timing instant the position of an element is in form of arithmetic mean of two intervals and position of another element is in the form of their harmonic mean, then square root of the product of these two means reveals the geometric mean of the two timing instants.*

Proof: We assume that t_1 and t_2 are two timing instants. Let at t' arithmetic mean is valid act at t", harmonic mean is valid.

$$P_{N,t}' = (t_1+t_2)/2 \quad \text{and} \quad P_{N,t}'' = 2/\{(1/t_1)+(1/t_2)\}$$

Hence, $$P_{N,t}' \cdot P_{N,t}'' = t_1 . t_2$$

$$(P_{N,t}' \cdot P_{N,t}'')^{(1/2)} = (t_1 t_2)^{(1/2)}$$, which is geometric mean of t_1 and t_2 .

The activation value of gain of a business organization can be realized by a fuzzy rule[5] . As per human intuition, which involves contextual and semantic knowledge, gain prediction can be done. Linguistic truth values in terms of gain analysis of a business is involved in this context. For achievement of desired gain , parameter status on the basis of quantitative nature is to be sensed . Neuro-fuzzy inference systems are systematic and facilitate by enhancing prediction accuracy level.The steps in gain prediction for a particular business organization in the light of fuzzy logic control are as follows-

1. Identify the factors on which gain depends viz problem, quality, cost, market-competition, risk-level.
2. Partition universe of discourse.
3. Assign fuzzy values as per scaling in case of factors.
4. Input the respective weights of each factor such that summation of the weights is 1
5. Aggregate fuzzy outputs.
6. Apply defuzzication to form a crisp gain of a business organization.

In case of optimum parameter selection , trials are carried out and the average of the best possible ones are taken into consideration. The features of these types of non-adaptive fuzzy based gain estimation of a business organization are as follows:

1. Uniform weight
2. A_v is excellent ($0.8 < A_v < 1$)
3. Fixed membership function
4. Low accuracy level
5. Hierarchical rule structure

4. CONCLUSIONS

Forecasting symbolizes expression of gain sensing . Mathematically, $I_S = f(I_M)$ where I_S be information content in forecasting, I_M be information content as per supervised learning rule and f being the mapping function. In this context, gain estimation has been carried out in the light of need matrix, interpolation , statistical means and fuzzy rule. Graphical analysis has also been pointed out in the view of exponential growth and decay models, Poisson distribution and unit step function.

5. REFERENCES

[1] Levitt, T. , "Marketing Myopia" *Harvard Business Review*. July-August , pp. 45-56,1960

[2] Aaker, D. A. , *Strategic Market Management*. John Wiley & Sons , Inc.,2005

[5] Olofsson, P. , *Probability, Statistics, and StochasticProcesses*. John Wiley & Sons ,Inc.,2005

[4] Giri, P. K. & Banerjee, *Introduction to Statistics*. Academic Publishers, 1999

[5] Mitchell , T.M., *Machine Learning* , Tata McGraw Hill Companies, Inc.,1997