A Comparative Study to Assess the Crohn's Disease type using Statistical and Fuzzy Logic Methodology

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Abstract— Crohn's disease is one class inflammatory bowel disease (IBD) affect any part from mouth to anus of gastrointestinal tract. Genome based wide association studies has fruitfully identified vulnerability of loci that can be triggered by environmental factors ensuing troubling inborn or intestinal blockade. In this paper, an effort has been made to assess Crohn's Disease survivability using data mining and soft computing technique. A comparative study among five least squares based statistical models has been done on the data set and fuzzy has been applied to improve the optimal accuracy level of the error of statistical method. It has been further observed that fuzzy logic has outperformed the least squares based statistical models with accuracy rate of 94.44%.

Keywords— Genome Sequencing, Locus, Allele, Least Square based Statistical Methods, Fuzzy, Crohn's Disease

I. INTRODUCTION

Crohn's disease is one class inflammatory bowel disease (IBD) affect any part from mouth to anus of gastrointestinal tract [1]. Abdominal pain, fever, weight loss and diarrhea range of symptoms may be the cause of CR disease which can be bloody for harsh inflammation [1] [2]. Anemia, skin rashes, arthritis, eye inflammation and tiredness may be the other difficulty affects outside the gastrointestinal tract. It may be possible that due to infection or pyoderma gangrenosm or erythema nodosum skin rashes may come out. Any obstruction in Bowel commonly occurs with the huge risk of bowel cancer [1][3].Crohn's disease usually originates on hereditarily prone individuals by a grouping of immune, environmental and bacterial factors. Environmental, immune and bacterial factors combination may be the cause of the Crohn's disease which may further attacks the gastrointestinal tract possibly directed at microbial antigens[4] [6]. to make the immune power of the body weak Crohn's disease is known as the an immune related disease but it has been observed that it is autoimmune. Due to 70 genes [6] [8] [9]. , the main reason of immune trouble of CR is not clear;

It has been observed that tobacco smokers have suffered two times more than non-smokers. Many people of the different country are suffering from the chrons disease due to their life style. And medication or surgery procedure to entirely cure Crohn's disease not exists. Thremanet according the conditions of the disease have to done to stop it for the further enhance.. Methotrexate or thiopurine are the two newly diagnosed, corticosteroid used to get better result for preventing reappearance. Furthermore, to keep the safe distance from the disease it is necessary to keep safe distance from the smoking [1][10][11]. It has been observed the 20 out of 100 are admitted to hospital in North America and Europe due to CR disease.

II. LITERATURE SURVEY

During the last 60 years an apparently rare intestinal state has become a common important clinical difficulty known as Crohn's disease [12] [13]. This disease has become much more common in 1950s and has since emerged as a major gastrointestinal trouble with current estimate of 20000 individuals affected in Great Britain [12] [13] [14] [18]. The disease frequently affects young people shortly after their youth and lasts through out their life; it has some important implications for every patient and those who are involved in their management [16] [19]. Treatments which are experiential and not remedial are mostly based on the use of steroids and surgical resection, both carries a significant morbidity and mortality [15][17][20]. It is not at all surprising that there has been some considerable endeavour to make out the exact cause and although bacteria, viruses and immunological abnormalities that have all been concerned but the direct evidence for identifying the major causative agents are still missing. So it is relevant to review epidemiological data that can provide some lead in quest for aforementioned causative factors [22]. A significant reconsider of current world literature suggests us that it is one of the most frequent diseases in North America and northern Europe, currently emerging in southern Europe and is least common in other areas of world. Scandinavia and Great Britain have the uppermost occurrence figures of Crohn's disease as compared to others [12][13][23]. The Quality of health care available in Scandinavia and Great Britain may partly

explanation their highest figures from these countries. The health care mostly is free and a automated documentation facilitates the collection of epidemiological statistics [24][25]. The type of available health care cannot completely explain the high occurrence statistics because comparable countries like Australia seems that have very low figures although superior data to validate the lacking factor. Its incidence in New Zealand and South Africa is quite inferior as compared to Europe despite of the fact that most of their citizens are European extraction, so the major dissimilarity exits between those countries are ethnic factors. Every challenge to inspect Crohn's disease in several diverse racial groups surrounded by the same country suggests us that the figures are much higher in northern European origin. Prevalence figures of non-white peoples are less consistent due to various reasons. Abdominal tuberculosis and Diarrhoea of uncertain aetiology are extremely common amongst such populations and in areas with a restrictive service the actual occurrence of Crohn's disease would be masked. An added factor includes the variations in diagnostic criteria used in various countries [23] [24]. Similarly a series of 44 cases from India and some small groups of cases are reported from Chile. Further studies from different parts of the world's supports the view that Crohn's disease[31-33] is very common in towns rather than in country areas.Maglinte *et al*. 2003 [34] mentioned the imaging features that support the patient categorization into clinical sub-types of CD. Few author have worked in the domain of cloud, but they did not include Crohn's disease [36][37][38][39][40][41]. Through this review, a study indicated that radiologic features on barium studies were strongly connected with the Crohn's Disease Activity Index. As per our knowledge, no more work has been done in the field of the CD assessment.

III. METHODOLOGY

Multivariate Data Analysis

Multivariate Data Analysis analyze the data arises from more than one variable using the techniques of statistics. In this paper the concept of factor analysis and principal component analysis have been used to eliminate the variables which have the less impact on the data set.

2.1.1 Factor Analysis

Factor analysis is one form of statistical method to used to describe variability among observed and unobserved variables known as factors. It has been observed that eight observed variable mainly reflect the variations in four unobserved variables. Factor analysis searches for such joint variations in response to unobserved latent variables. Based on this pattern , observed variables are modeled as linear combinations of the potential factors with "error" terms. Factor analysis originated in psychometrics and is used in behavioral sciences, social sciences, marketing, product management, operations research, and other applied sciences that deal with large quantities of data. The concept of FA is used as a powerful tool for analyzing data.

Principle Component Analysis (PCA)

Principal component analysis (PCA) used mathematical procedure of orthogonal transformation to convert correlated variables into linearly uncorrelated variables of principal components.

PCA help to indentify the similarities and differences of the variable. Since patterns representation is not available in graphical format and it is to find in data of high dimension. The concept of PCA (Principal Component Analysis) is used as a powerful tool for analyzing data
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Least Square based Statistical Models

In statistics and mathematics, least squares based linear equation used to find the idealized value based on the unknown parameters of the model. The techniques of linear equation used to summarize the data to predict the unobserved values from the same system and try to understand the mechanisms of the underlie the system.

IV. IMPLEMENTATION

The genetic sequences for 387 individual of Crohn's disease containing both normal and chronic database have be taken and out of 387 individual, 144 individuals are affected and 243 individuals are not affected from Crohn's disease[28]. The dataset describes the Genotype for each individual at 103 different locations; the marker 1A indicates the individual's first allele at locus 1 whereas the marker 1B signifies the individual's second allele at locus 1 and so on.

Initially, the concepts of factor analysis [30, 33, 34,] and principal component analysis have been applied on the data set and the detail implementation has been furnished in figure 1.
It is necessary to select suitable methods to form the total effect value on the data set between factor analysis and principal component analysis. Therefore, K- means clustering algorithm has been applied on the available total effect formed by factor analysis and principal component analysis.

It has been observed that factor analysis has given less interred cluster distance as compared to the principal component analysis.

Furthermore, to select the optimal model the concepts of statistical methods have been applied on the total effect formed by factor analysis. The concepts of statistical methods[5,6,7 21,25] have been applied on the total effect formed by factor analysis. The estimated accuracy of least square base statistical models [35] viz. linear equation, exponential equation, curvilinear equation, asymptotic equation and logarithmic equation 93.007%, 92.007%, 91.642%, 93.082 and 92.27% respectively.
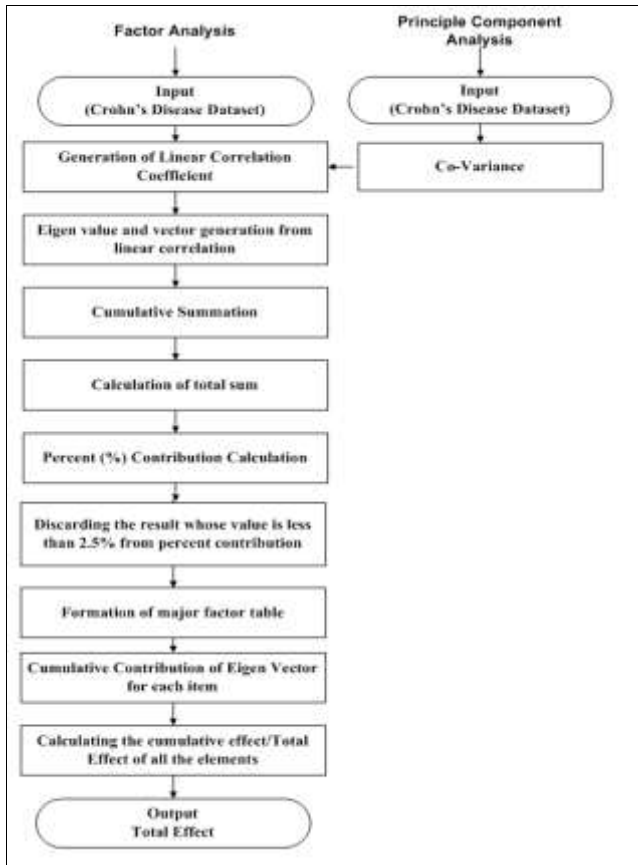
Figure1. Application of Factor and Principal Component Analysis

Therefore, it has been observed that the estimated efficiency of statistical models is less and it need to optimized using the concept of fuzzy logic [25, 26, 27 ,28, 29]. The estimated accuracy using fuzzy logic is 94.44 %.

Implementation using multivariate data analysis (Factor Analysis and PCA)

The step by step implementation of the figure 1 has been furnished in following steps.

Step 1:
The concept of factor analysis has been applied on the data set and the size 206X206 of linear correlation coefficient has been calculated. Here only the attributes of the dataset considered and discarded the status column of dataset.

Step 2:
The eigen value and eigen vector have been calculated based on the above correlation. Due to size of the table(206X206), he size of Eigen value and Eigen vector of size is 206X206.

Step 3:
The Cumulative Summation of Eigen vector has been formed to select the most dominant attributes among all. The output matrix size is (1X206).

Step 4:
Therefore it has been observed that the total percentage contribution of the step 3 is

Total Sum=2.060000000000003e+02

Step 5
Therefore, the percentage contribution of each and every attributes has been calculated to find the most dominant attribute among the entire attribute.

Step 6:
Here the attribute which have percentage contribution less than 2.5% has been discarded and it has been observed that out of them 9 attribute have the percentage contribution greater than 2.5%.

Step 7:
The major factor has been calculated based on Eigen vector and cumulative summation. The output matrix is (206 X 9).

Step 8:
Here the cumulative contribution of Eigen vector has been calculated using the summation of cumulative contributions attributes. The matrix (1 X 206) has been furnished in table 1.

Table 1:Total Effect

Row 1-20	Row 21-40	Row 41-60	Row 61-80	Row 81-100
68.35113	67.79721	68.20377	69.15456	62.74613
68.75938	57.79105	66.72026	66.89165	67.24804
66.93808	65.1591	67.21935	67.53183	66.37885
65.7175	63.34148	58.24171	61.11251	67.91587
64.91788	71.6879	58.78566	63.6676	61.01582
67.10209	56.97024	65.26839	62.57615	60.13437
69.00599	65.78872	62.31075	64.42115	56.53408
65.97561	69.22281	67.43857	65.80346	56.02981
68.68868	66.98639	53.91453	65.90035	55.56278
63.21996	66.59996	63.43179	50.74789	62.11642
67.24971	66.71356	64.72845	64.22483	63.50961
62.42923	67.18586	63.32339	64.23952	67.80002
68.80632	64.12161	60.06563	45.00948	60.99028
68.22983	66.17561	56.73045	52.4282	59.80669
65.89763	66.89917	58.08732	55.62032	59.3543
61.37081	67.60219	66.09888	60.83505	59.14112
68.82368	67.43695	65.6269	61.31687	57.87172
68.7527	69.63304	65.1793	57.1124	62.0721
66.85638	69.60121	68.16303	64.31654	56.89427
68.63135	64.12415	68.77994	69.6199	64.60314

The comparisons of the statistical methods have been furnished in table and figure 2.
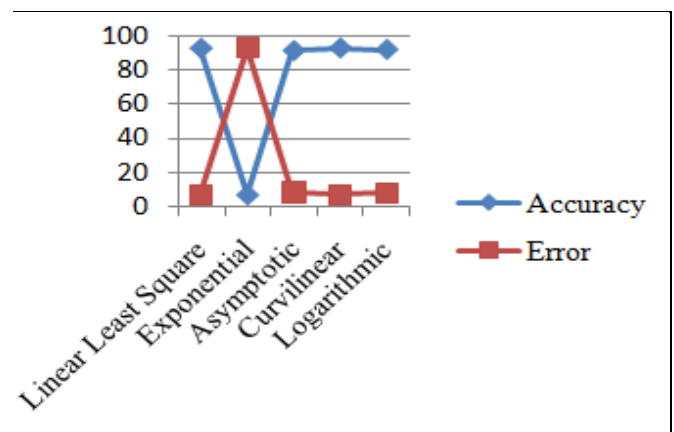

Figure 2: Comparison of Accuracy of Statistical Methods .

Fuzzy Model

Step 1:

It has been observed that the estimated accuracy in statistical methods is very less than the concept of fuzzy logic has been applied. The available data are fuzzified based on the triangular function is used as membership function and the corresponding fuzzy set are calculated:

Step 2:

All the fuzzy logical relationships are obtained as follows:
A total of 30 unique relationships were obtained in this problem study. It has been observed that total 30 changes had ocurred . Here, A6 -> A7 specifies that after A6 a change has occued towards A7.

Step 3:

Let us define on operator '×' of two vectors.
Suppose C and B are two vectors of dimension m and $D = (dij) = CT \times B$.
Then the element dij of matrix D of row i and j is defined
As dij = min (C_i, B_j) $(i, j = 1, 2 \ldots\ldots m)$ where, C_i & B_j are the ith & jth element of C & B respectively.
The relation matrix has been calculated and as there are total 30 relations so we get 30 sparse matrices.

Step 4:

From the fuzzy relationship matrices, a total union is generated and it consists of eight rows and eight columns, as the table was generated taking the union of all 30 fuzzy relationship matrices (8X8) obtained from the previous table, therefore the resultant union matrix is also of 8X8.

Step 5:

We find the relationship (*R*) among the set of data and apply this formula $Ai = Ai–1$. *R*[where *Ai*–1 is the employment of year (*i*–1) and *Ai* is the forecasted employment of year I in terms fuzzy sets and '.is the maxmin operator]..**.**
The estimated fuzzy relation of size 387X8 has been calculated for further processing.

Step 6:

Therefore, the actual data, input fuzzy data, output fuzzy data and relative error has been furnished in table 2. Due to size of the table, only 11 instances have been shown out of the 387 occurrences. Here the actual data signifies the total effect estimated from the factor analysis and the output indicates the value obtained after the defuzzification process**.**

Table 16: Forecasted Output

Sl. No	Actual Data	Input Fuzzy	Output Fuzzy	Output	Error in %
1	68.35113	[0 0 0 0 0 0 0.81 1]	[1.39 1.39 1.24 1.33 1.81 1.81 1.81 1.81]	62.02	9.26
2	68.75938	[0 0 0 0 0 0 0.73 1]	[1.31 1.31 1.166 1.25 1.73 1.73 1.73 1.73]	62.02	9.80
3	66.93808	[0 0 0 0 0 0.07 1 0.92]	[1.56 1.56 1.44 1.52 2 2 2 2]	62.02	7.34
4	65.7175	[0 0 0 0 0 0.30 1 0.69]	[1.53 1.53 1.47 1.54 2 2 2 2]	62.02	5.62
5	64.91788	[0 0 0 0 0 0.45 1 0.54]	[1.50 1.50 1.49 1.55 2 2 2 2]	62.02	4.46
6	67.10209	[0 0 0 0 0 0.04 1 0.95]	[1.57 1.57 1.43 1.52 2 2 2 2]	62.02	7.57
7	69.00599	[0 0 0 0 0 0 0.69 1]	[1.27 1.27 1.12 1.21 1.69 1.69 1.69 1.69]	62.02	10.12
8	65.97561	[0 0 0 0 0 0.25 1 0.74]	[1.53 1.53 1.46 1.53 2 2 2 2]	62.02	5.99
9	68.68868	[0 0 0 0 0 0 0.74 1]	[1.33 1.33 1.18 1.27 1.74 1.74 1.74 1.74]	62.02	9.71
10	63.21996	[0 0 0 0 0 0.77 1 0.22]	[1.45 1.45 1.53 1.57 2 2 2 2]	62.02	1.90
11	67.24971	[0 0 0 0 0 0.01 1 0.98]	[1.57 1.57 1.43 1.52 2 2 2 2]	62.02	7.77

Step 7:

For the defuzzification, our earlier propose defuzzifcation techniques[27] have used.

Step 8:

The accuracy and error has been calculated based on estimated and actual total effect.

V.   RESULT AND DISCUSSION

4.1 Result

The comparison of least square based linear, exponential, asymptotic curvilinear, logarithmic and fuzzy have been furnished in figure 3.
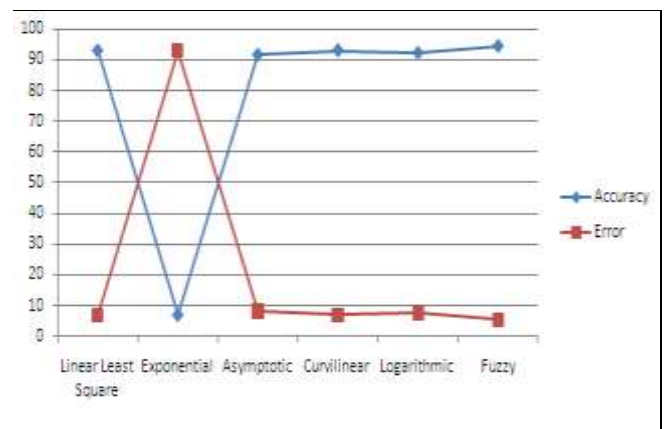

Figure 3: Comparing Statistical and Fuzzy Method

VI.   CONCLUSION

The concept of multivariate data analysis i.e. factor analysis (FA) and Principle Component Analysis (PCA) has been applied on the available data and it has observed that the factor analysis produced better result as compared to the Principle Component Analysis (PCA). Therefore the least square based Statistical method viz. Linear equation, Exponential equation, curvilinear equation, asymptotic equation and Logarithmic equation have been applied on the data set. The Estimated Accuracy of all these methods are **93.007%, 7.007%, 91.642%, 93.082 and 92.27%** respectively. Thereafter to get better result the concepts of fuzzy have been applied on the available data set and it has been observed that it has produced the **94.44%** accuracy with triangular function.

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