A New Multilayer Perceptron Model to Detect Heart Disease Severity

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Abstract—**With the recent outbound spread of chronicle heart diseases across the world, gender and age, the medical practitioners are focusing on preventive measures rather than curing methods. Thus the modern research trends are bound to provide the preventive extension to the medical science. Although the medical practices can generate gigantic amount of relevant data pertaining to the diseases, however the medical science fail to deploy any technique to mine the data for predictive models. Thus the data mining and predictive models are the most suitable way to provide the necessary tools for predictive analysis. Hence this work deploys a multilayer perceptron model for predictive detection of heart disease severity based on various parameters. The deployed multi-layered perception uses the back-propagation for optimal supervised learning. The work also deploys a novel principle attribute analysis to understand the orientation of the attributes affecting the results. The final outcome of this work is to analyse the Heart Disease Severity based on proposed multilayer perceptron model.**

Keywords— **HMM, MLP, Rule Based Approach, Genetic Algorithm for Search, Optimal Feature Selection**

I. Introduction

The hearth or the cardiovascular diseases have a huge impact on the death rates[1] in the world especially in the developing countries. Celtia et al in the year of 2000 have proven that cardiovascular diseases cause 25% of the deaths. The work presented by World Bank Country groups in the year of 2001, had cited the health rate by heart diseases around 25%. However the work of Mathers et al presented in the year of 2004, had analyses the death rate as 46%, which is a notable increase in the span of 4 years. It is predicted that in the year of 2020 an approximated 2.5 million people from India are likely to be severely affected by heart diseases. In spite of the best clinical practices and available medications, the death rates are increasing and expected to be 55% in India by the end of 2020.

The focus of this work is to demonstrate a Novel Multilayer Perceptron Model to Detect Heart Disease Severity[2]. Henceforth this work analyses the recent research outcomes from the parallel works.

The present research trends are directing towards a more specific and focused study of predictive models for determining the severity of the heart diseases based on the clinical results and best possible computing techniques [3].

The outcomes from work of Huyan Wang at al had proposed a traditional model for Chinese medical practices based on a computing model to diagnosis based on the Bayesian model.

Also the works been carried out with the perspective of generic programming in order to produce expert systems are notable for prediction and diagnosis of heart diseases[4]. The work of Assanelli et al in the year of 1993 demonstrates the use of ECG data to predict the heart diseases. Meanwhile, Ng, G. and Ong, K has developed a chest pain expert system, which diagnoses the cause of chest pain leading towards the cardiac attacks.

Text classification techniques combined with a Naive Bayes classifier and relational learning algorithms are methods[5] used by Craven in the year of 1999. Hidden Markov Models are used in Craven in the year of 2001, but similarly to Rosario and Hearst produced in the year of 2004, the research focus was entity recognition. A context based approach using MeSH term co-occurrences are used by Srinivasan and Rindflesch for relationship discrimination between diseases and drugs[6]. A lot of work is focused on building rules used to extract relation. Feldman et al. use a rule-based system to extract relations that are focused on genes, proteins, drugs, and diseases and demonstrated in 2002. Friedman et al. go deeper into building a rule-based system by hand-crafting a semantic grammar and a set of semantic constraints

in order to recognize a range of biological and molecular relations[7].

In biomedical literature, rule-based approaches have been widely used for solving relation extraction tasks. The main sources of information used by this technique are either syntactic: part-of-speech (POS) and syntactic structures; or semantic information in the form of fixed patterns that contain words that trigger a certain relation. One of the drawbacks of using methods based on rules is that they tend to require more human-expert effort than data-driven methods. The best rule-based systems are the ones that use rules constructed manually or semi automatically—extracted automatically and refined manually. A positive aspect of rule-based systems is the fact that they obtain good precision results, while the recall levels tend to be low. Syntactic rule-based relation extraction systems are complex systems based on additional tools used to assign POS tags or to extract syntactic parse trees. It is known that in the biomedical literature such tools are not yet at the state-of-the-art level as they are for general English texts, and therefore their performance on sentences is not always the best.

Henceforth this work can be visualized as the potential findings of work and guidelines for the performance of a framework that is capable to find relevant information about diseases and treatments in a medical domain repository. The results that obtained will show that it is a realistic scenario to use NLP and ML techniques to build a tool that capable to identify and disseminate textual information related to diseases and treatments.

Thus this work identifies the problems in the existing and parallel research outcomes as:

- Firstly, a lot of data pertaining to cardiac dieses are available, but the datasets are over populated with multiple parameters. The outcome of processing multiple parameters leads to high computational complexity and processing less parameter may lead to lower order of accuracy in prediction. Hence, there is a clear demand for a technique to identify most appropriate set of parameters to be processed during predictive analysis[8-12].
- Secondly, there are various computation techniques deployed to timely predict with less computational complexity. However, the neural network based programming approaches are proven to be time efficient. Henceforth, there is also a demand for finding the optimal neural network setup for predictive analysis[13-19].

II. Proposed Framework for Pre-Processing

The first step of this proposed work is the pre-processing framework for determining and extracting the influential parameters. The most appropriate algorithm for feature or attribute selection is a Genetic algorithm[20-22], where initially all the attributes are considered as individual subsets and the final combination of the attributes or features are noted as optimal best feature subset. The framework is been proposed here:

Step-1. Calculate and Collect the list of attributes to be ordered in terms of significance:

$$M[] \leftarrow \forall P \exists (\sum_{i=1}^{n} p_i) \quad (1)$$

Where, M denotes the initial set of attributes, P denotes the total available list of attributes.

Step-2. Assign the selection vector as S[L] where L is the size of the initial attribute list. Initially the vector is filled with zeros to denote no optimal subset is selected.

$$\forall S, S[i] \leftarrow 0 \quad (2)$$

Step-3. In this step of the algorithm, the fitness for all the attributes is been calculated so that the ranking can be provided for the features against all other attributes.

$$Info_{Gain}(S_i) = \begin{cases} 1 + Info_{Gain}(Class_i, S_i), \\ if\ Info_{Gain}(Class_i, S_i) \geq Info_{Gain}(Class_{i-1}, S_{i-1}) \\ 1 + Info_{Gain}(Class_i, S_i), Else \end{cases} \quad (3)$$

Step-4. Once the attributes are been ranked, the final selected subset is produced.

$$S[m] \leftarrow Highest(Info_{Gain}(M)) \quad (4)$$

The work analyses the data set provided by UCI machine learning. Each database has the same instance format. While the databases have 76 raw attributes. The descriptions of the dataset parameters are provided here [Table – 1]:

TABLE I: UCI HEART DISEASE DATABASES

Serial Number	Parameter Names	Parameter Descriptions
1	ID	Patient identification number
2	CCF	Social security number (I replaced this with a dummy value of 0)
3	AGE	Age in years
4	SEX	Sex (1 = male; 0 = female)
5	PAINLOC	Chest pain location (1 = substernal; 0 = otherwise)
6	PAINEXER	(1 = provoked by exertion; 0 = otherwise)
7	RELREST	(1 = relieved after rest; 0 = otherwise)
8	PNCADEN	(Sum of 5, 6, and 7)
9	CP	Chest pain type -- Value 1 typical angina -- Value 2 atypical angina -- Value 3 non-anginal pain -- Value 4 asymptomatic
10	TRESTBPS	Resting blood pressure (in mm Hg on admission to the hospital
11	HTN	Not Defined
12	CHOL	Serum cholestoral in mg/dl
13	SMOKE	I believe this is 1 = yes; 0 = no (is or is not a smoker)
14	CIGS	(Cigarettes per day)
15	YEARS	(Number of years as a smoker)
16	FBS	(Fasting blood sugar > 120 mg/dl) (1 = true; 0 = false)
17	DM	(1 = history of diabetes; 0 = no such history)
18	FAMHIST	Family history of coronary artery disease (1 = yes; 0 = no)
19	RESTECG	Resting electrocardiographic results -- Value 0 normal -- Value 1 having ST-T wave abnormality (T wave inversions and/or ST elevation or depression of > 0.05 mv) -- Value 2 showing probable or definite left ventricular hypertrophy by Estes' criteria
20	EKGMO	(month of exercise ECG reading)
21	EKGDAY	(day of exercise ECG reading)
22	EKGYR	(year of exercise ECG reading)
23	DIG	(digitalis used furing exercise ECG 1 = yes; 0 = no)
24	PROP	(Beta blocker used during exercise ECG 1 = yes; 0 = no)
25	NITR	(nitrates used during exercise ECG 1 = yes; 0 = no)
26	PRO	(calcium channel blocker used during exercise ECG 1 = yes; 0 = no)
27	DIURETIC	(diuretic used used during exercise ECG 1 = yes; 0 = no)
28	PROTO	Exercise protocol 1 = Bruce 2 = Kottus 3 = mchenry 4 = fast Balke 5 = Balke 6 = Noughton 7 = bike 150 kpa min/min 8 = bike 125 kpa min/min 9 = bike 100 kpa min/min 10 = bike 75 kpa min/min 11 = bike 50 kpa min/min 12 = arm ergometer
29	THALDUR	Duration of exercise test in minutes
30	THALTIME	Time when ST measure depression was noted
31	MET	Mets achieved
32	THALACH	Maximum heart rate achieved
33	THALREST	Resting heart rate
34	TPEAKBPS	Peak exercise blood pressure (first of 2 parts)
35	PEAKBPD	Peak exercise blood pressure (second of 2 parts)
36	DUMMY	
37	TRESTBPD	Resting blood pressure
38	EXANG	Exercise induced angina (1 = yes; 0 = no)
39	XHYPO	(1 = yes; 0 = no)
40	OLDPEAK	ST depression induced by exercise relative to rest
41	SLOPE	The slope of the peak exercise ST segment -- Value 1 upsloping -- Value 2 flat -- Value 3 downsloping
42	RLDV5	Height at rest
43	RLDV5E	Height at peak exercise
44	CA	Number of major vessels (0-3) colored by flourosopy
45	RESTCKM	Irrelevant
46	EXERCKM	Irrelevant
47	RESTEF	Rest raidonuclid Ejection fraction
48	RESTWM	Rest wall Motion abnormality 0 = none 1 = mild or moderate 2 = moderate or severe 3 = akinesis or dyskmem
49	EXEREF	Exercise radinalid Ejection fraction
50	EXERWM	Exercise wall Motion
51	THAL	3 = normal; 6 = fixed defect; 7 = reversable defect
52	THALSEV	Not used
53	THALPUL	Not used
54	EARLOBE	Not used
55	CMO	Month of cardiac cath (perhaps "call")
56	CDAY	Day of cardiac cath
57	CYR	Year of cardiac cath
58	NUM	Diagnosis of heart disease (angiographic disease status) -- Value 0 < 50% diameter narrowing -- Value 1 > 50% diameter narrowing (in any major vessel attributes 59 through 68 are vessels)
59	LMT	Not Defined
60	LADPROX	Not Defined
61	LADDIST	Not Defined
62	DIAG	Not Defined
63	CXMAIN	Not Defined
64	RAMUS	Not Defined
65	OM1	Not Defined
66	OM2	Not Defined
67	RCAPROX	Not Defined
68	RCADIST	Not Defined

69	LVX1	Not used
70	LVX2	Not used
71	LVX3	Not used
72	LVX4	Not used
73	LVF	Not used
74	CATHEF	Not used
75	JUNK	Not used
76	NAME	Last name of patient

Henceforth, the proposed framework constructs a correlation matrix to rank the attributes most likely to influence the results. Bayes net structure is presented here [Table – 2]:

TABLE II: Bayes Net Structure

MERIT	SCALED	Parameter Subsets
0.61438	0.80802	4 7 13 14 19 22 24 25 26 27 29 30 31 32 36 39 40 41 42 44 48 53 55 57 59 60 61 63 65 66 68 70 72 73
0.56553	0.59578	2 4 5 6 7 11 13 19 27 29 30 31 32 40 41 43 44 45 48 49 51 52 54 55 57 59 60 61 62 63 64 65 66 67 70 71 72 73
0.61334	0.80347	4 7 13 14 17 19 22 24 25 26 27 29 30 31 32 36 39 40 41 42 44 48 53 55 57 59 60 61 63 65 66 68 70 72 73
0.57217	0.62464	4 7 13 14 15 19 20 22 24 25 26 27 29 30 31 32 36 39 40 41 42 44 48 53 55 57 59 60 61 63 66 68 70 72 73
0.54682	0.51454	2 6 7 8 9 11 14 20 22 24 25 26 27 29 30 33 36 38 39 40 41 42 43 44 48 51 53 59 60 62 63 64 65 67 68 70 72 73
0.55164	0.53548	2 4 5 7 9 11 13 17 19 27 29 30 31 32 39 40 41 42 44 47 51 53 54 55 57 59 60 61 63 65 66 68 70 72 73
0.57864	0.65273	4 7 13 14 19 22 24 25 26 27 30 31 32 36 39 40 41 43 44 45 48 49 51 52 54 55 57 59 60 61 62 63 64 65 66 67 70 72 73
0.42837	0	2 3 5 6 7 11 12 13 18 19 22 23 29 30 31 32 40 41 43 44 45 48 51 55 57 59 61 62 63 64 65 67 69 70 72 73
0.46084	0.14101	4 7 9 12 13 14 19 20 22 24 25 26 27 29 30 31 32 36 39 40 41 42 44 53 55 56 57 59 60 61 63 65 66 68 70 72 73
0.58916	0.69843	2 4 5 6 7 11 13 19 21 22 27 29 30 31 32 39 40 41 43 44 45 48 55 57 59 60 62 63 64 65 67 70 72
0.60163	0.75263	2 4 5 7 11 13 19 22 27 29 30 31 32 39 40 41 43 44 45 48 55 57 59 60 62 63 64 65 67 70 72 73
0.60201	0.75429	2 4 5 7 11 13 19 22 27 29 30 31 32 39 40 41 44 45 55 57 59 60 62 63 64 65 67 70 72 73
0.55207	0.53733	2 3 6 7 11 13 18 19 22 23 29 30 31 32 40 41 44 45 48 51 55 57 59 61 62 63 64 65 67 69 70 72
0.56235	0.58199	4 7 13 14 19 22 24 25 26 27 29 30 31 32 36 39 40 41 42 44 47 48 51 52 53 54 55 57 59 60 61 63 65 66 68 70 72 73
0.5808	0.66213	4 13 14 19 22 24 25 26 27 29 30 31 32 36 39 40 41 42 44 48 53 55 57 60 61 63 66 68 70 72 73
0.6035	0.76075	2 5 7 11 13 19 22 27 29 30 31 32 38 39 40 41 43 44 45 48 55 57 59 60 62 63 64 65 67 70 72
0.47965	0.22275	2 4 5 7 11 13 19 21 22 27 29 30 31 32 34 39 40 41 43 44 45 48 55 57 59 60 62 63 64 65 67 70 72 73
0.56274	0.58368	2 4 5 7 11 13 19 27 29 30 31 32 39 40 41 43 44 45 48 49 51 52 54 55 57 59 60 61
		62 63 64 65 66 67 70 72 73
0.44954	0.09193	4 7 12 13 14 19 22 24 25 26 27 29 30 31 32 35 36 37 39 40 41 42 44 48 53 55 57 59 60 62 63 64 67 70 72 76

Thus, finally the list of most appropriate attributes influencing the dieses is been listed here [Table – 3]:

TABLE III: ATTRIBUTES INFLUENCING THE DIESES

Serial Number	Parameter Names
4	SEX
7	RELREST
12	CHOL
13	SMOKE
14	CIGS
19	RESTECG
22	EKGYR
24	PROP
25	NITR
26	PRO
27	DIURETIC
29	THALDUR
30	THALTIME
31	MET
32	THALACH
36	DUMMY
39	XHYPO
40	OLDPEAK
41	SLOPE
42	RLDV5
44	CA
48	RESTWM
53	THALPUL
55	CMO
57	CYR
59	LMT
60	LADPROX
61	LADDIST
63	CXMAIN
65	OM1
66	OM2
67	RCAPROX
68	RCADIST
70	LVX2
72	LVX4
73	LVF

Hence, the rest of the work demonstrates the multilayer perceptron neural network model to predict the severity of the disease[23-26].

As this work is intended to predict the heart dieses severity, hence the following parameters are also been included with the consideration of redundant attributes. Henceforth the optimal set of attributes for further analysis is listed here [Table – 4]:

TABLE IV: ATTRIBUTES INFLUENCING THE DIESES

Serial Number	Parameter Names
4	SEX
7	RELREST

12	CHOL
13	SMOKE
14	CIGS
19	RESTECG
22	EKGYR
24	PROP
25	NITR
26	PRO
27	DIURETIC
29	THALDUR
30	THALTIME
31	MET
32	THALACH
36	DUMMY
39	XHYPO
40	OLDPEAK
41	SLOPE
42	RLDV5
44	CA
48	RESTWM
53	THALPUL
55	CMO
57	CYR
59	LMT
60	LADPROX
61	LADDIST
63	CXMAIN
65	OM1
66	OM2
67	RCAPROX
68	RCADIST
70	LVX2
72	LVX4
73	LVF

III. Proposed Multilayer Perceptron Model

The proposed multilayer perceptron model[27] is made with the sole purpose to reduce the confusion matrix and increase the accuracy of the clustering for diseases based on severity. Henceforth here the work proposes the multilayer perceptron model [Figure – 1].

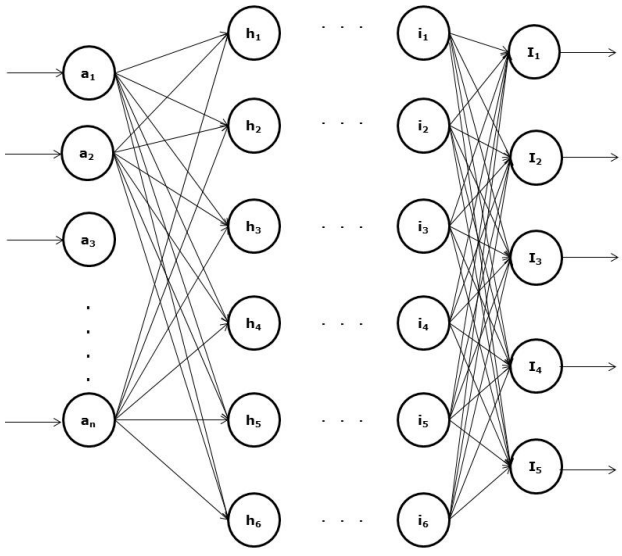

Figure 1: 8 Layer Proposed Multilayer Perceptron Model

The proposed MLP is arranged as the input layer is responsible for processing the inputs during the training, the hidden layers are available for considering the weight adjustment and finally the five output nodes are clustering the results in five distinguished categories. The detail of the MLP is discussed in this section of the work [Table – 5].

TABLE V: MLP CHARACTERESTICS

Attribute of MLP	Detail Description
Back Propagation Learning Rule, variable number of hidden layers	1 to 5 Layers
Random Number Seed	0
Learning Rate	0.1
Learning Rate Function	Static learning rate
Constant Bias Input	1.0
Training Iterations	500
Training Mode	Batch Training - weight changes are applied at the end of each epoch
Transfer Function	Sigmoid (Logistic), S-shape function between +1 and 0
Momentum	0.2
Weight Decay	0.1
Bias Input Value	1.0
Inputs	36
Output Layer	5
Total Neurons	5
Total Nodes	226

The mathematical model of the proposed method is explained here:

$$I_i = \sum_{i=1}^{n} a_i \bullet \sum_{j,k=1}^{n+1} w_{jk} \pm \theta \qquad (5)$$

Here I denote the output layer of the MLP.

$$\theta = \frac{1}{2} \sum_{i=1\, j,k=1}^{n,n+1} (w_{jk} - a_i)^2 \qquad (6)$$

Here θ denotes the weight adjustments.

The auto-adjustable hidden layer depends on the number of active attributes in the dataset instance.

From, Eq – 3,

$$j,k = MAX(S[i] \leftarrow Info_{Gain}(S_i)) \qquad (7)$$

The results are been discussed in further section of the work.

IV. Results and Discussion

The objective of this work is to increase the accurately identify and cluster the dataset[25,28,30] for multiple levels of dieses severity. Thus firstly, the categories of the severity are identified [Table – 6].

TABLE VI: CLUSTERS INFORMATION

Dieses Severity	Cluster Name
No Disease	0
Disease – 1 Major Blood Vessel Blocked	1
Disease – 2 Major Blood Vessels Blocked	2
Disease – 3 Major Blood Vessels Blocked	3
Disease – 4 Major Blood Vessels Blocked	4

After the analysis of the dataset, the following clustering results are been obtained [Table – 7]:

TABLE VII: SEVERITY BASED CLUSTERING

Cluster Names	0	1	2	3	4
0	188	0	0	0	0
1	0	37	0	0	0
2	0	0	26	0	0
3	0	0	0	28	0
4	0	0	0	0	15

The Classification error are also been visually analyzed [Figure – 2].

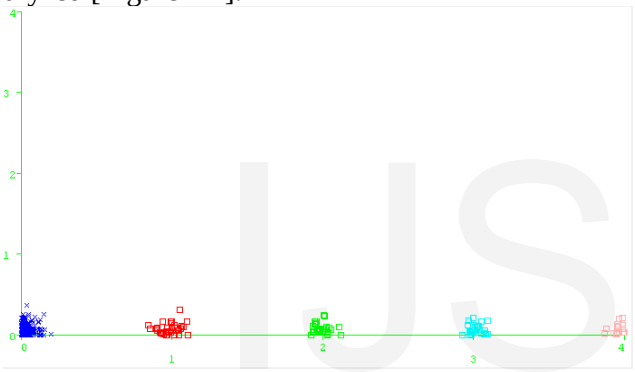

Figure 2: Classification Error

The margin curve of the analysis is presented for visual analysis [Figure – 3].

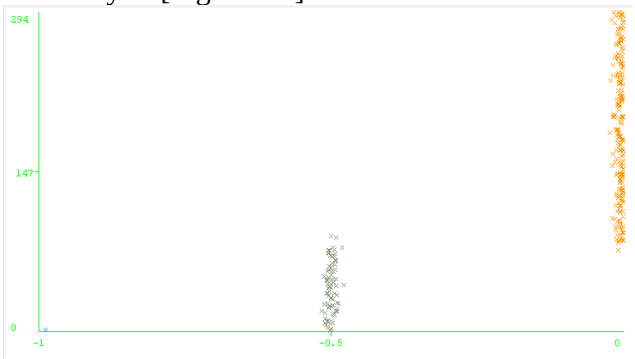

Figure 3: Marginal Curve

The threshold curve for cluster 0 to cluster 4 is presented here [Figure – 4 to 8]:

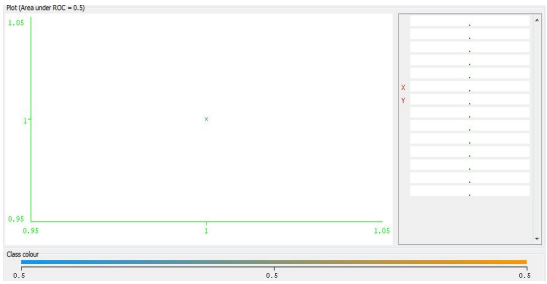

Figure 4: Threshold Curve – Cluster 0

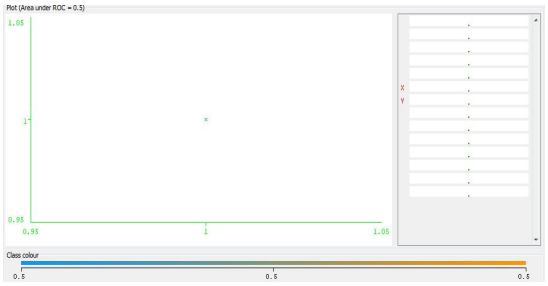

Figure 5: Threshold Curve – Cluster 1

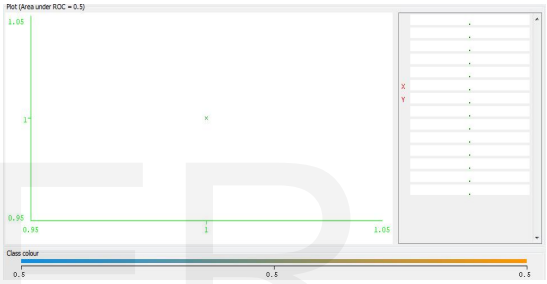

Figure 6: Threshold Curve – Cluster 2

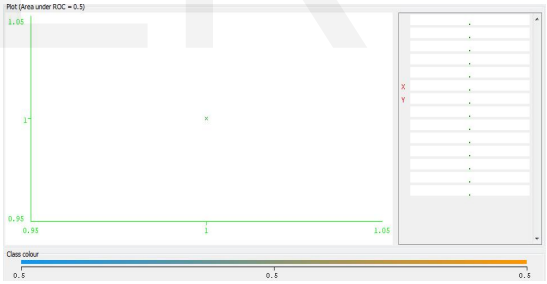

Figure 7: Threshold Curve – Cluster 3

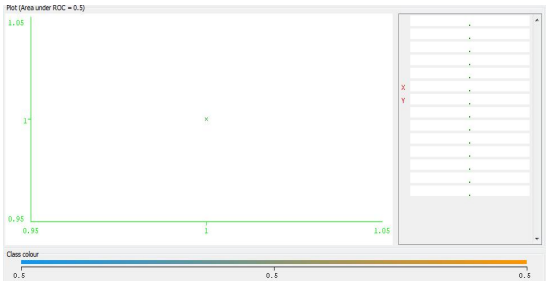

Figure 8: Threshold Curve – Cluster 4

The cost benefit analysis for the proposed method on all clusters are been analysed visually [Figure – 9 to 13].

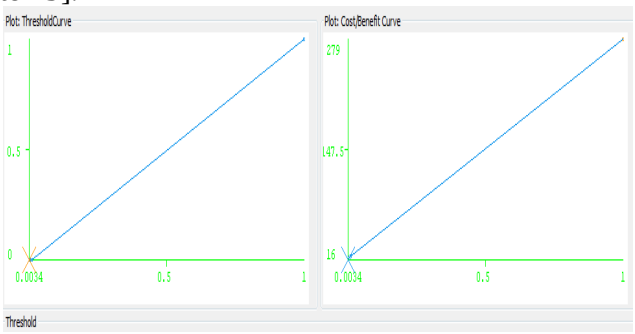

Figure 9: Cost / Benefit Analysis – Cluster 0

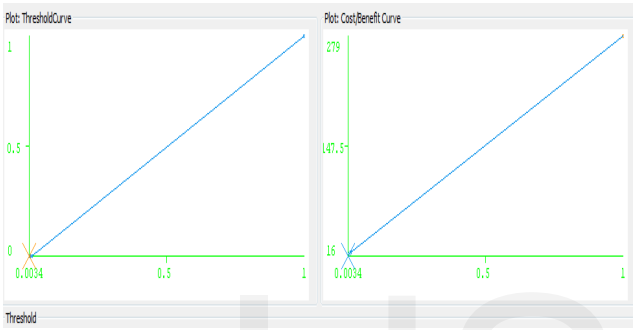

Figure 10: Cost / Benefit Analysis – Cluster 1

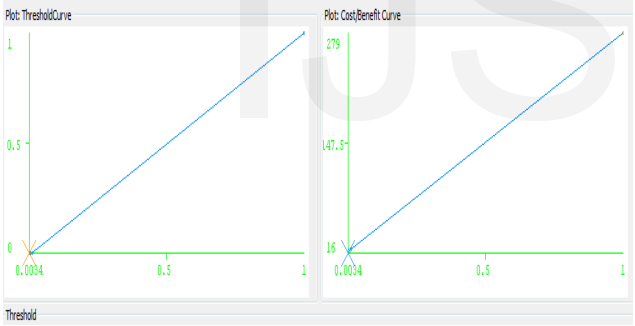

Figure 10: Cost / Benefit Analysis – Cluster 2

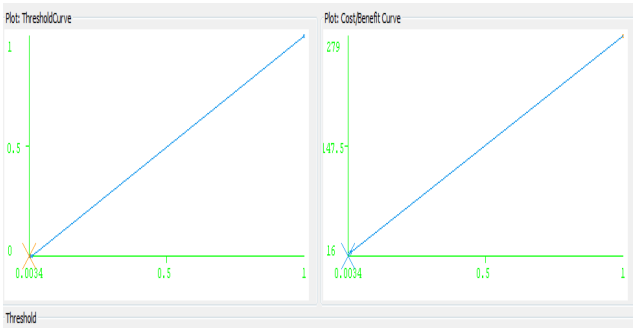

Figure 11: Cost / Benefit Analysis – Cluster 3

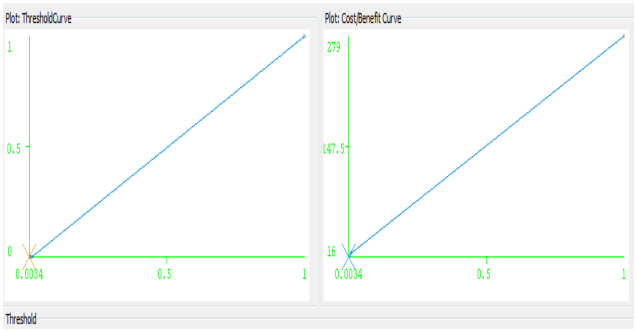

Figure 12: Cost / Benefit Analysis – Cluster 4

The work also analyses the Precision, Recall, F-Measure and ROC Area for each clusters [Table – 8].

TABLE VIII: PRECISION, RECALL, F-MEASURE AND ROC AREA ANALYSIS

Class	TP Rate	FP Rate	Precision	Recall	F-Measure	ROC Area
0	1	1	0.639	1	0.78	0.5
1	0	0	0	0	0	0.5
2	0	0	0	0	0	0.5
3	0	0	0	0	0	0.5
4	0	0	0	0	0	0.493
Weighted Avg.	0.639	0.639	0.409	0.639	0.499	0.5

V. CONCLUSION

The work analyses the current advancements[29-31] in the space of cardiovascular disorders. The problems identified by the recent advancements as a clear demand for a technique to identify most appropriate set of parameters to be processed during predictive analysis and a demand for finding the optimal neural network setup for predictive analysis. The first part of the work demonstrates the optimal genetic algorithm based searching techniques to find the optimal set of attributes for better and timely prediction of the clustering techniques. The constructions of the most appropriate attributes set is been automated for any given dataset. Also the work results in to a MLP based auto adjustable 7 layered algorithm for correct and accurate clustering of the data. The work demonstrates zero overlapping of the data during clustering data.

REFERENCES

[1] Asha Gowda Karegowda and M.A. Jayaram, March 6-7, 2009. Cascading GA & CFS for Feature Subset Selection in Medical Data Mining. International Conference on IEEE International Advance Computing Conference (IACC'09), Thapar University, Patiala, Punjab India.

[2] D. Goldberg .1989. Genetic Algorithms in Search, Optimization, and Machine learning, Addison Wesley,

[3] I. H. Witten, E. Frank. 2005. Data Mining: Practical machine learning tools and techniques. 2nd Edition, Morgan Kaufmann, San Francisco.

[4] J. Han And M. Kamber. 2001. Data Mining: Concepts and Techniques. San Francisco, Morgan Kauffmann Publishers.

[5] Jennifer G. Dy. 2004. Feature Selection for Unsupervised Learning, Journal of Machine Learning, pp845-889.

[6] M.A.Jayaram, Asha Gowda Karegowda.2007. Integrating Decision Tree and ANN for Categorization of Diabetics Data. International Conference on Computer Aided Engineering, December 13-15, 2007, IIT Madras, Chennai, India.

[7] Mark A. Hall ,Correlation-based Feature Selection for Machine Learning, Dept of Computer science, University of Waikato .http://www.cs.waikato.ac.nz/ mhall/thesis.pdf

[8] Manoranjan Dash, Kiseiok Choi, Petr Scheuermann, Huan Liu. 2002. Feature Selection for Clustering – a Filter Solution. In Proceedings of the Second International Conference on Data Mining.

[9] M. Dash 1, H. Liu2. March 1997. Feature Selection for Classification, Intelligent Data Analysis 1 (131–156, www.elsevier.com/locate/ida]

[10] Ron Kohavi, George H. John.1997. Wrappers for feature subset Selection, Artificial Intelligence, Vol. 97, No. 1-2. pp. 273-324.

[11] Shyamala Doraisamy ,Shahram Golzari ,Noris Mohd. Norowi, Md. Nasir B Sulaiman , Nur Izura Udzir. 2008. A Study on Feature Selection and ClassificationTechniques for Automatic Genre Classification of Traditional Malay Music. ismir2008.ismir.net/papers/ISMIR2008 256.pdf(2008).

[12] Volfer Rotz, and Tilman Lange. 2003. Feature Selection in Clustering Problems", In Advances in Neural Information Processing Systems 16.

[13] Y.Saeys, I.Inza, and P. LarrANNaga,. 2007. A review of feature selection techniquesin bioinformatics, Bioinformatics, 23(19),, pp.2507-2517.

[14] Z. Haiyang, "A Short Introduction to Data Mining and Its Applications", IEEE, 2011

[15] J. Han and M. Kamber, "Data Mining: Concepts and Techniques", Morgan Kaufmann, 2nd , 2006

[16] R. Agrawal, T. Imielinski, and A.N. Swami, "Database Mining: A Performance Perspective," IEEE Trans. Knowledge and Data Engineering, vol. 5, no. 6, pp. 914-925, Dec. 1993.

[17] J.R. Quinlan, "Induction of Decision Trees," Machine Learning, vol. 1, no. 1, pp. 81-106, 1986.

[18] J.R. Quinlan, C4.5: Programs for Machine Learning. Morgan Kaufmann, 1993.

[19] Y. Bengio, J. M. Buhmann, M. Embrechts, and J. M. Zurada, "Introduction to the special issue on neural networks for data mining and knowledge discovery," IEEE Trans. Neural Networks, vol. 11, pp. 545-549, 2000.

[20] D. Michie, D.J. Spiegelhalter, and C.C. Taylor, "Machine Learning, Neural and Statistical Classification", Ellis Horwood Series in Artificial Intelligence, 1994.

[21] J.R. Quinlan, "Comparing Connectionist and Symbolic Learning Methods," S.J. Hanson, G.A. Drastall, and R.L. Rivest, eds., Computational Learning Theory and Natural Learning Systems, vol. 1, pp. 445-456. A Bradford Book, MIT Press, 1994.

[22] J.W. Shavlik, R.J. Mooney, and G.G. Towell, "Symbolic and Neural Learning Algorithms: An Experimental Comparison," Machine Learning, vol. 6, no. 2, pp. 111-143, 1991.

[23] P. Clark and T. Niblett, "The CN2 induction algorithm. Machine learning", 3(4):261-283, 1989.

[24] Y. Freund and L. Mason. The alternating decision tree algorithm. In Proceedings of the 16th International Conference on Machine Learning, pages 124-133, 1999.

[25] UCI Machine Learning Repository: http://archive.ics.uci.edu/ml/datasets.html

[26] Weka: http://www.cs.waikato.ac.nz/~ml/weka/

[27] I. H. Witten, E. Frank, and M. A. Hall, Data Mining: Practical Machine Learning Tools and Techniques, 3rd ed. Morgan Kaufmann, 2011

[28] P. J. Werbos, "Backpropagation Through Time: What It Does and How to Do It", IEEE, 1990

[29] H. Lu, R. Setiono, and H. Liu, "Effective Data Mining Using Neural Networks", IEEE, 1996

[30] Classification Tree for Risk Assessment in Patients Suffering From Congestive Heart Failure via Long-Term Heart Rate Variability Paolo Melillo, *Member, IEEE*, Nicola De Luca, Marcello Bracale, and Leandro Pecchia," IEEE Journal Of Biomedical And Health Informatics, Vol. 17, No. 3, May 2013.

[31] Mary Emma Gorham Bigelow, Brian G. Jamieson,Chi On Chui, Yufei Mao, Kyeong-Sik Shin,Tony Jun Huang," Point-of-Care Technologies. for the Advancement of PrecisionMedicine in Heart, Lung, Blood,and Sleep Disorders" IEEE Journal of Translation Engineering in Health and Medicine,August,2016.

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