

## A PROPOSED MODEL FOR THE ANALYSIS OF CORONARY HEART DISEASE DATA USING KARINX MACHINE LEARNING TECHNIQUE

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**Abstract:** Heart disease prediction is the major research carried out nowadays to find the disease in the chosen data set of medical records. A number of computer oriented techniques utilized for the identification of heart diseases in order to find whether the diseases available in the chosen data set or not. One such method is used in this research work namely Type 2-Fuzzy technique and it has been concerning as the finest way to decrease this indistinctness. Newly, numerous researches have been available in terms of Coronary Heart Disease (CHD) diagnosis. The approach used in this research work is assist in envisage illness probability which gives extract result. The Type-2 Fuzzy methodology conventions are applied to calculate the chances of Coronary Heart Disease (CHD) as minimum, average or maximum. Usually the doctors consider the following attributes such as diabetes, fatness, agitated anxiety, smolder, deprived fasting, tension, etc to predict Coronary Heart Disease (CHD). The Karinx machine learning model is applied to find the Coronary Heart Disease (CHD) and yields appropriate platform to predict heart diseases in fast and efficient manner. A comparative analysis is carried out in this work to find the performance of the Karinx model with Probabilistic Neural Network (PNN), Support Vector Machines (SVM), Fuzzy Adaptive Resonance Theory (FARTMAP), Adaptive Neuro Fuzzy Inference System (ANFIS), Knuth Morris Pratt (KMP) algorithms. This research work yields the best results with accuracy rate of 98.1% in order to find the coronary heart disease in the chosen data set.

**Keywords:** Coronary Heart Disease, Illness Treatments, Disease Imprecision, Machine Learning, Type-2 Fuzzy Method

### 1. INTRODUCTION

Coronary Heart Disease (CHD) is caused majorly due to the fatty deposits formed on the walls of arteries around the heart. These fatty deposits are said to be atheroma. Atheroma converts the arteries narrower which also restrict the flow of blood in the heart muscle. Other causes of atherosclerosis to increase in significant way are active smoking, passive smoking, very high blood pressure, highly cholesterol, increased levels of lipoprotein, lack of exercises, diabetes, obese and family heredity. General basis of Huntington's Disease (HD) embrace Coronary Artery Disease (CAD), plus a preceding huntington's disease, High blood pressure (HBP), Atrial fibrillation (AF), Valvular Heart Disease (VHD), surfeit alcohol exploit disease,

and Comprehensive Metabolic Panel (CMP) of an unidentified reason. These reasons heart stoppage or attack are found by altering the identification formation or the purpose of the heart. This two stage loom augment the routine of our effort as it assists in envisage illness ventricular heart stoppage – Heart Stoppage with Abridged Expulsion Portion (HSAEP), and Heart Stoppage with Potted Discharge Portion (HSPDP) are pedestal on whether the capability of the left side to indenture, or to unwind, is pretentious. The strictness of the heart stoppage is stage by the rigorousness of indication with implement [2][3]. Heart stoppage would not alone be the identical symptom for heart attack as either hemagglutinin in heart weight damaging suitable to an artery provide the heart) or cancer in blood surge impede all told due to stoppage of the heart to force well.

Additional illness that might have indication analogous to heart failure contains fatness, Kidney Function (KF), liver harms, Tumor-Derived Activated Cells (TDAC). Analysis is pedestal on indication, objective result, and Erectile Dysfunction (ED), Bleeding Time (BT), Epirubicin Cyclophosphamide (EC), Cancer Research Group (CRG) could be helpful to decide the original reason [1] [5]. Treatment based on the sternness and reason of the illness. In public with constant steady meek Heart Failure (HF), treatment normally consists of existence alteration such as stop smoke, bodily work out, and nutritional change, as fine as pills prescription.

In individuals amid Huntington's Disease (HD) suitable to Left Ventricular Diastolic Function (LVDF), angiotensin change, Environmental Illness (EI), angiotensin receptor obstructs along with beta obstructs are suggested. For individuals with relentless illness Arteria-Artery (AA) or Hemoglobin with a gas could be worn. Daily it is helpful for thwart solution preservation and the resultant tininess of inhalation occasionally, based on the reason, an entrenched mechanism such as a pacesetter or as certain cardiac operation may be suggested. In several reasonable or rigorous belongings, Cardiac Resynchronization Therapy (CRT) or Cerebral Cavernous Malformation (CCM) could be of help for treatment [4] [6].

The rest of this work is organized as follows. Section 2 have an in-depth analysis of various research work carried out by others are explained by means of literature survey. Section 3 collects the materials and different methods associated with heart disease in terms of an individual either men or women. Section 4 describes results and discussion on finding the executive model of algorithm. Finally, Section 5 concludes the research work via its findings.

## **2. LITERATURE REVIEW**

Coronary heart disease is one of the crucial thinking of people which lead to sudden heart stroke. Ultimate goal of this situation is to check review of other people on heart disease, so literature review is carried out from various headers of heart disease namely systems of coronary heart disease, Medical Conclusion Tribulations, Type-2 Fuzzy Logic Medical Diagnosis and Type-2 Fuzzy Logic Heart Diagnosis Dramatization Reason. By comparing the works of others with different algorithms, one would achieve unique model of finding type 2 fuzzy heart disease with prompt accuracy rate and specification rate with unique attributes.

### **2.1. Symptoms of Coronary Heart Disease**

A ventricular help piece of equipment (for the left side heart, right side heart, or mutually side ventricle), or infrequently a heart relocate could be suggested in individuals with rigorous infection that persevere although every additional procedure [7].

This proposed method formed as type-2 Fuzzy reason method for identify CHD with the plan to support quick identification amongst unrestricted as healthy as knowledge apparatus for subordinate doctors. In this learning, we expand a Type-2 Fuzzy reason methods with contribution variables signify issue to decide the presence of CHD. The choice is cautiously getting the specialist vision and advice. The standard of the assortment is to think the realism of a being to get the interpretation of the effort variables frequently. Our loom fluctuate starting additional works in the necessary could be full with small medical practice but conserve important analytic outcome. The system of Type-2 Fuzzy reason conjecture locomotive is cautiously planned by doctors to reveal the ability of the Type-2 Fuzzy reason method to collect and relocate specialist acquaintance into helpful doctor's data [9] [10].

## **2.2. Medical Conclusion Tribulations**

HD is a familiar, expensive, and possible deadly situation plus it is the primary reason of mutually staying in hospital plus admittance among big child in 2019, it pretentious about 30 million publics worldwide. Generally, about 5% of people have HD plus in individuals above the period of 66, this augment to -9%. Affected people are envisaging increasing. The hazard of demise is concerning 39% the initial year after identification, although by the next time the hazard of demise is fewer than 9% for individuals who stay living. This quantity of threat of demise is alike to several tumors [8] [11].

## **2.3. Type-2 Fuzzy Logic Medical Diagnosis**

Identification of CHD (HD with damage thrust ability) requires the concurrent incidence of at slightest two of the subsequently key measure or solitary main principle in coincidence with both of the insignificant condition. most important criterion comprises an inflamed heart on a upper body scan, and a third heart echo, APE, incident of arouse up beginning snooze puffed for space, splinter on LA, CVP additional than RA, JVD, optimistic AJT, and load thrashing additional reply to handling is also mention occasionally confidential as a negligible measure. slight criterion embraces an unusually rapid heart speed more than normal per minute, night-time cough, complexity mouthful of air with substantial movement, PE, a reduce in the imperative capability by solitary utmost evidence, liver improvement, plus BAE. Small criterion is suitable merely if they might not be qualified to an additional hospital situation such as PHT, CLD, C otherwise the nephritic condition. FHS criterion is 90% responsive and 88% exact for recognize people with explicit CHD. TheType-2 Fuzzy system heaviness these structure in begin the treatment of HD [12] [25].

## **2.4 Type-2 Fuzzy Logic Heart Diagnosis Dramatization Reason**

HD is usually level by the quantity of efficient mutilation discuss by the sternness of the HD as reproduce as New York Heart Association (NYHA) purposeful categorization. The New York Heart Association practical program (1-4) initiate with category I, which is distinct as an individual who knowledge no restraint in some actions with refusal indication from normal actions. Group with the New York Heart Association category 2 HD has small, kind limits with day by day actions. Anyone is contented at respite or with soft effort with the New York Heart Association category 3 HD, a noticeable restraint occurs with some exploit. The individual is contented simply at respite. Someone with the New York Heart Association category 4 HD is suggestive at respite and suit moderately painful with some bodily action. This attain credentials the harshness of indication and might be worn to charge answer to cure. Although its employ is extensive, the New York Heart Association attain is not extremely reproducible

and do not dependably envisage the on foot detachment or apply patience on official test [14]. The American Heart Association operational assembly begins four step of HD in 2001 procedure with rules, The heart function performance method is helpful since period 1 include before heart stoppage a period wherever involvement with handling might seemingly avoid series to obvious indications [13] [15].

Heart Blood Pressure, once the heart thrust red blood cells, compel of the blood thrust alongside the parapet of the artery reason force. If the force increase and continue high above the occasion it's call HBP which might damage the cadaver in numerous habits that is we mention rising the hazard of heart fondle, kidney stoppage. HBP is one of the reasons for sudden heart attack [16]. High Cholesterol is an unwanted skin material originates in the full of fat leave in the blood liner. Amplify in the greasy drop do not permit enough blood to run in throughout the artery because heart harasses. UHD (Ultra High Definition) consumption also a lot quick victuals augment blood force and fat root the hazard of heart harasses. CS (Cesarean section) indemnity the inside layer of artery and make up a greasy substance called thermos which tapered the artery grounds heart harass. LPA (Line Probe Assay) need a work out increase fat percent in blood liner which additional boost the threat of heart harasses.

### 3. MATERIALS AND METHODS

Coronary Heart images of scans are initially collected in hospital or scan center. Those scanned images are taken as input or the data are collected from repositories in first step of data acquisition. Data are processed in preprocessing on finding the accuracy in the view of scanning. Thus these data are separated in feature extraction and processed for classification. Result after classification would be accurate in terms of clarity and naked eye viewing. Each and every step in these flow is uniquely processed for the finding the highest accurate rate. Comparing the methodology of data is done after the feature extraction taken place. Each data is scanned and processed for the flow of steps on classification of data collection.

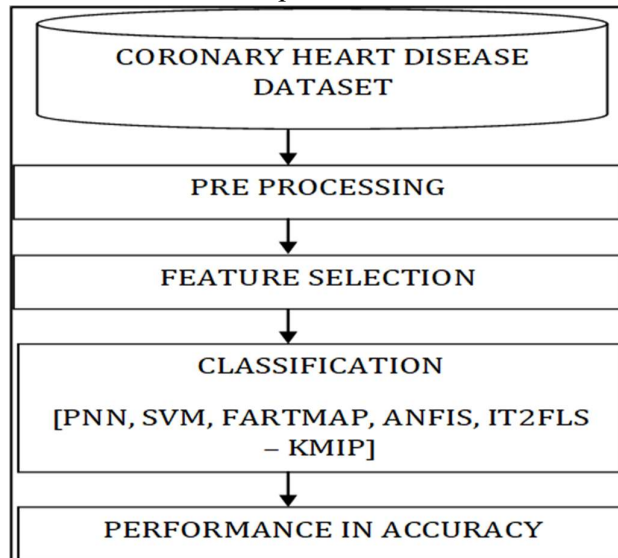


Figure 1: Architecture of Proposed Model

Figure 1 describes the flow of processes carried out in this research work. First of all, the image scans from various patients are collected and taken as dataset for execution. Next the collected

data are check again and again repeatedly in pre-processing. Then unique attributes are considered for feature extraction. Compare with various classifications such as PNN, SVM, FARTMAP, ANFIS and KMP. By comparing with these algorithms, unique model would be established. The data is collected from “300” patient both men and women of CHD particulars data preprocess information and accusation significance. Estimate technique using to haul out the finest parameters. Classify result precision will be evaluated and present. Lastly the assessment metrics and conclusion are derived after the comparison of algorithm with the proposed method.

### 3.1 Description of Dataset

Depends description of the difficulty, the suitable dataset was 300 data selected. Coronary Heart Disease dataset have got a group of helpful variables which are input and essential for the recognition of which stage level disease in patients. Each and every feature has an input to the set tag being Coronary Heart Disease (CHD) or not Coronary Heart Disease (NOT CHD).

$$A = \frac{i}{i+j} \tag{1}$$

MEN (204) :  $A = 204/300 = 0.68$

WOMEN (96) :  $A = 96/300 = 0.32$

Patient data are collected in terms of scan image of heart and patient history from a total number of 300 people. In this total numbers male are 204 in count and female are 96 in count. Randomly taken input from different people both men and women from the total number such that 68% and 32% distinct percentages of count are taken for input.

**Table 1: Description of Data Set**

Number of Attribute	Attribute	Description
1	Gender	Female or Male
2	Family History	Yes/No
3	Alcohol History	N-never, S -sometimes, F-frequent
4	Smoke History	N-never, S -sometimes, F-frequent
5	Specific Gravity	1.005 -1.030
6	Albumin	g/L
7	Urea/Blood Urea Nitrogen(BUN)	mg/dL
8	Chronic Heart Disease	Stage

Table1 shows the attributes and its description of the people taken as data in terms of family, specific gravity, BUN, alcohol history, albumin, smoke history and the stage of which they are living on. From these data, the analysis would be taken for classification of algorithm in sorting out which attribute the heart diseases have occurred. It may be in terms of gender or alcohol consumption or regular smoking or family heredity.

### 3.2 Data Preprocessing

In this research work, it includes planned cover on Type-2 Fuzzy pedestal implement. The current method is uncomplicated solitary that can recognize enter in stipulations of patient tolerant essential data plus medicinal examination. The preparation position is distinct by every restriction linked to CHD via time, gender, Blood level, fat level, Blood difficulty, Heart pumping sound, work out make angina, plus Chest ache category. The current Type-2 Fuzzy and data mining method will produce Type-2 Fuzzy pedestal system under manifold stricture that is alienated in two levels. Data is repeatedly checked for finding the heart disease features which are not only occurs from heart attack but also due to cancel cells or liver failure. By preprocessing the heart disease is caused due to which syndrome and by what means would be found only using pre-processing of the image scans.

The method generates a Type-2 Fuzzy pedestal data plus the query locomotive to procedure on documentation. The structure development on this list revisits the probability incidence of heart illness shows numerical [17] [19].

### 3.3 Feature Extraction

Features were selected based on experiments conducted. The highlighted columns indicate the features which appeared more than better times and thus were selected as significant features. The selected eight (8) features are sex, Cerebral Palsy (CP), Auditory hallucinations (AH), Urinary specific gravity (SG), Serum Hepatitis (SH), Alcohol History (A), Blood Urea Nitrogen (BUN), Congenital heart defects (CHD), Fasting blood sugar (FBS), etc.

The confidence level generated for these 10 rules and the chosen important features 8 are exposed in this part. Features have been used for heart disease prediction based on the top 10 rules. The most significant feature in predicting heart disease is CP. This feature exists in all the 10 rules generated that predict heart disease. Thal, Old peak exist in 10 rules out of the 8 rules in predicting heart disease.

### 3.4 Classification Algorithms

The partial examination and prejudice of the medical profession, Suspicions and deficient in medical understanding deprived point outcome in treatments. Coronary heart disease complexity has to subsist predictable through medical conclusion [20] [21].

If x is S1 and e is C1 then

$$L1 = Z_1 b + Y_1 e + R_1 \quad (2)$$

If x is S2 and e is C2 then

$$L2 = Z_2 b + Y_2 e + R_2 \quad (3)$$

Each of the operational of the level in functional structural design might clarify Op, I which is outcome from the ith join of a level named k.

Here in karinx – proposed method each and every joins are called adaptive and they have a join purpose connected to them.

$$P_{Li,j} = \mu H_i(C) \text{ for } D = 1,2, (\text{or}) \quad (4)$$

$$T_{li,j} = \mu G_{i-2}(C) \text{ for } D = 3,4$$

$$O_{2i,j} = S_j = \mu M_j(a) \text{ for } z = 1,2 \quad (5)$$

All nodes resemble and carry the firing strength of each rule. T - Operator might be worn like AND operator. In this level we contain set nodes that are sticker as Norm. These nodes compute the part of the Ith rule's dismissal power in row with the figure of all rules dismissal power.

$$O_{3i,j} = \frac{K_j}{K_j + K_j} r = 1,2 \quad (6)$$

Normalized firing strengths represent the output. Here all the join is called adaptive and they have a join purpose connected to all nodes

$$O_{4i,j} = Y_j P_i = V_j (C_j X + n_j y + r_j) \quad (7)$$

Every inward signals are known to outcome and they are agreed consider to they are all indication.

$$Outcomeoflevel5 = O_{5i,j} = \sum Q_i \sum Q_j N_i / \sum Q_i \quad (8)$$

In this classification different algorithms are compared to form the appropriate and unique approach model called Karinx which is involved in the modulation of overall join approach with the segment of I rule adaptive connect formation on behalf of the node. Each and Every dismissal power of the row is figured out using various algorithms such as PNN, SVM, FARTMAP, ANFIS, KMP. These algorithms are compared with the Suspicious 1 and Suspicious 2 is modulated by the functional structure level of K by every join connected to the operational attributes predicted to the medical outcomes of image scans.

#### 4. Results and Discussion

Coronary Heart Disease about while sign erect positive contained by the coronary artery. This artery provides heart weight with oxygen prosperous red blood cells. Sign is finished positive of fat overweight, calcium, plus extra material initiate in the red blood cells above occasion and sign solidify and thin the artery, falling blood run to chest weight [18].

Ultimately, a locale of sign might break, reason a red blood cells coalesce to structure on the outside of the sign. If the coalesce befall big sufficient, it might typically or totally block the run of oxygen prosperous red blood cells to the division of the heart weight supply by the blood vessel. This might direct to heart harasses to using Type-2 Fuzzy logic prevent attack. Upper body hurt or uneasiness that happens while not sufficient oxygen prosperous red blood cells are graceful to a part of heart weight. CAD might sense like stress or grasp in the heart [20] [24].

Different stages of processing are discussed in finding the higher accuracy of heart disease where first stage means initial stage. Second stage means modification of sides specification where third stage provides the back face of the concurrent heart at the huge 3D directions and the four stage would refer to the enlarged version of the ultrasound scan where manipulation to find the performance measures would be changed and checked here to provide the appropriate result by means of perfection attempt of finding heart disease from the given source of scanned image.

HEART ULTRASOUND SCAN	DESCRIPTION
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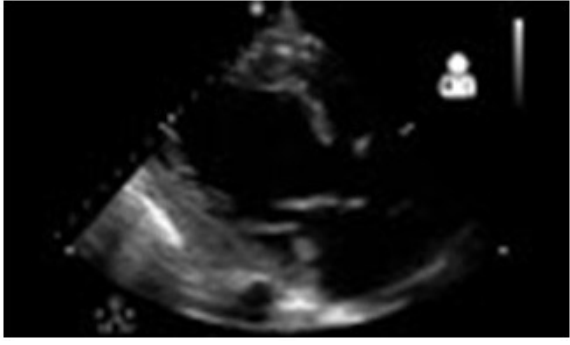
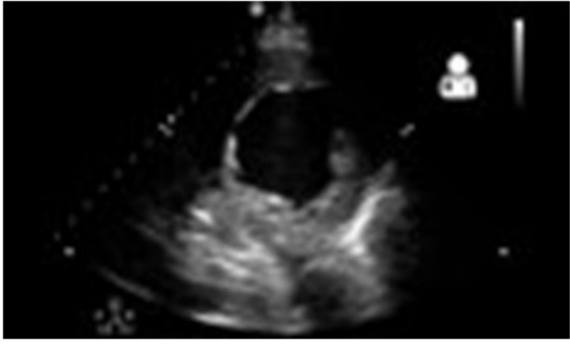

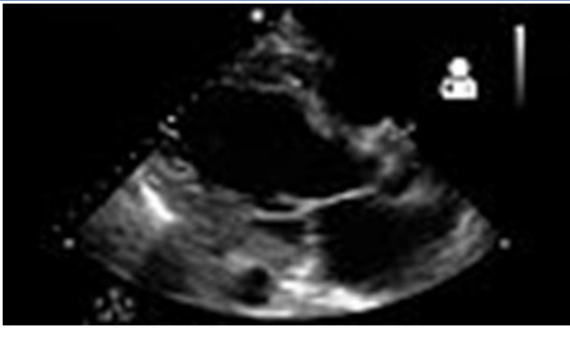
	<p><i>First stage UD finding heart disease ultrasound figure is exemplify by 'PLUS SYMBOL'</i></p>
	<p><i>Second stage UD finding heart disease ultrasound figure is exemplify by 'PLUS SYMBOL'</i></p>
	<p><i>Third stage UD finding heart disease ultrasound figure is exemplify by 'PLUS SYMBOL'</i></p>
	<p><i>Four stage UD finding heart disease ultrasound figure is exemplify by 'PLUS SYMBOL'</i></p>

Figure 2: Heart Ultrasound Scan - Progression

Figure 2 shows that the heart ultrasound scan has been taken as input to compare with various algorithm like PNN, SVM, etc. and with Karinx – proposed method to distinguish the high perform in our proposed method, since recognition of heart disease may also occur due to pains in different parts of the body which in terms of hurt, also might arise in hand, leg, neckline, chin, or backside. A heart harasses arise while red blood cells run to a region of heart weight is totally barren. This avoids oxygen prosperous red blood cells starting attainment that part of



heart weight, reason it to pass away. With no fast action, a heart hit might direct to severe harms or decease.

**Table 2: Comparison of existing Methods with Karinx method**

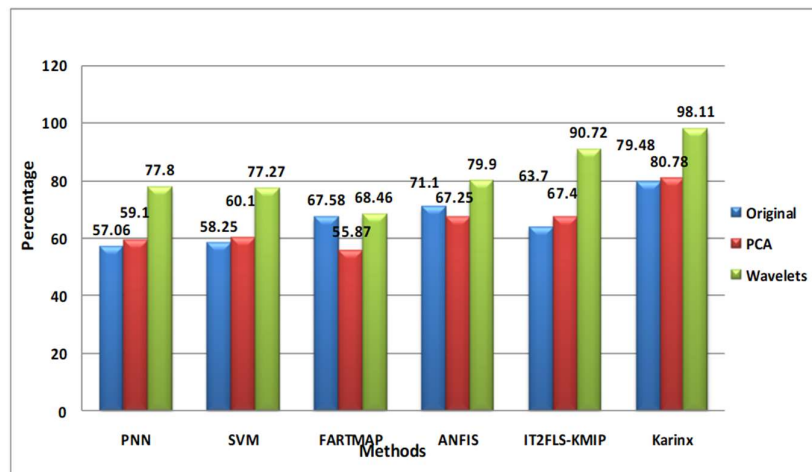
Methods	Accuracy (%)		
	Original	PCA	Wavelets
PNN	57.06	59.10	77.80
SVM	58.25	60.10	77.27
FARTMAP	67.58	55.87	68.46
ANFIS	71.10	67.25	79.90
IT2FLS-KMIP	63.70	67.40	90.72
Karinx	79.48	80.78	98.11

Table 2 shows the results of comparison analysis for the following classification methods such as PNN, SVM, FARTMAP, ANFIS, IT2FLS-KMIP and the proposed model Karinx based on accuracy. In which it's clearly understand that, the proposed model yields the accuracy of 98.11% when comparing with other existing models.

**Table 3: Performance of Karinx for CHD**

Accuracy rate	98.1%
Sensitivity rate	97.4%
Specificity rate	96%

Table 3 shows the accuracy rate from the Karinx algorithm where the accuracy of this algorithm rate lies on 98.1% with also stimulates sensitivity to 97.4% and specifically speaking on particular of measures 96% is produced. Lastly, the testing is in the standard away on the Type-2 Fuzzy and data mining storage area and the outcome in danger guess guarantee that the future doctor conclusion holds method enhanced result evaluate with the data mining method in provisos of accurateness, understanding and exactness [22].



**Figure 3: Comparison of Models**

While comparing the models from figure 3 in terms of their originality, PCA values and wavelets propagation Karinx model leads in percentage. In this overcome, Karinx proposed method performance is high, so the coronary heart disease would be found easily by comparison of the above algorithms that. Karinx hits the clarity in providing the accurate results in terms of originality, PCA and wavelets.

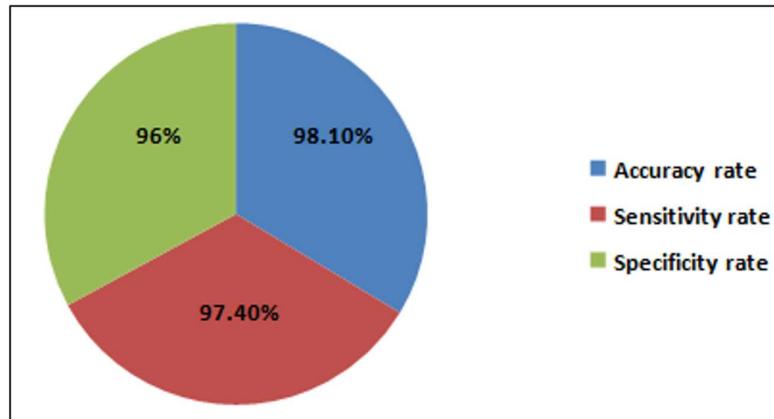


Figure 4: Accuracy Measures

In figure 4, Accuracy measures are calculated by comparing the hurt from different parts of the body of the patient of CHD. In Accuracy rate, the clarity of the image understanding is determined. In Sensitivity rate, the hurt of different part is taken for consideration. In Specificity ratio, each and every parts of body of patient are calculated.

## 5. Conclusion

The treatment of CHD is a complex one to treat in these present conditions, it could be real inappropriate to declare specialist method which will be substitute for the doctor's or information panel of the medical influencer. Now, the appropriate aspects were created following the concern of data mining method plus these characteristic be worn to create the Type-2 Fuzzy convention that biased support over the incidence present in the knowledge data records. These biased Type-2 Fuzzy systems were worn to make the scientific choice sustainable via Type-2 Fuzzy supposition method. Lastly, the testing is standard away on the Type-2 Fuzzy and data mining storage area thus the outcome in danger guessed -guarantee that the future doctor conclusion holds method by enhanced results evaluating with the data mining method in provisions of accurateness, understanding concepts and exactness. Prediction in heart stoppage can be live with evaluation in numerous conducts, includes medical prophecy Type-2 Fuzzy rules plus heart exercise tough record. Medical guess system uses a compound of experimental issue such as lab analysis plus blood weight to approximation prediction. Amongst numerous medical guess systems for scanning acute heart stoppage, the 'fuzzy rule' faintly external produced additional system in helping public and recognize individuals at small peril of decease during hospital admit time. Hence, it is proved that the proposed model- Karinx compared with the results of other algorithms, performance on coronary heart disease in type 2 Fuzzy method is much better. So Karinx method have achieved the goal of finding the heart disease perfectly using various other aspects over those people whether it is men or women.

## References

- [1] Emelia J Benjamin, Salim S Virani, Clifton W Callaway, Alanna M Chamberlain, Alexander R Chang, Susan Cheng, Stephanie E Chiuve, Mary Cushman, Francesca N Delling, Rajat Deo, Sarah D de Ferranti, Jane F Ferguson, Myriam Fornage, Cathleen Gillespie, Carmen R Isasi, Monik C Jiménez, Lori Chaffin Jordan, Suzanne E Judd, Daniel Lackland, Judith H Lichtman, Lynda Lisabeth, Simin Liu, Chris T Longenecker, Pamela L Lutsey, Jason S Mackey, David B Matchar, Kunihiko Matsushita, Michael E Mussolino, Khurram Nasir, Martin O'Flaherty, Latha P Palaniappan, Ambarish Pandey, Dilip K Pandey, Mathew J Reeves, Matthew D Ritchey, Carlos J Rodriguez, Gregory A Roth, Wayne D Rosamond, Uchechukwu K A Sampson, Gary M Satou, Svati H Shah, Nicole L Spartano, David L Tirschwell, Connie W Tsao, Jenifer H Voeks, Joshua Z Willey, John T Wilkins, Jason Hy Wu, Heather M Alger, Sally S Wong, Paul Muntner (2018)., "Heart Disease and Stroke Statistics – 2018 Update A Report from the American Heart Association", *Circulation*, Vol. 137, No. 12, pp. e67-e492.
- [2] World Health Organization (2018), "Non communicable diseases country profiles 2018", Geneva, url: <https://apps.who.int/iris/bitstream/handle/10665/128038/9789241?sequence=1>.
- [3] Parvin R, Abhari A (2012), "Fuzzy database for heart disease diagnosis", *Proceedings of Medical Processes Modeling and Simulation*.
- [4] Farlex. (Ed.) (2009), *Medical Dictionary*, url: <https://medical-freelibrary.com/coronary+heart+disease>.
- [5] Innocent PR., John, RI, Garibaldi, JM (2004), "Fuzzy methods for medical diagnosis", *Applied Artificial Intelligence*, Vol. 19 No. 12, pp. 69-98.
- [6] Hembra S, Islam, N (2017), "Fuzzy Logic: A Review", *International Journal of Computer Sciences and Engineering*, Vol. 5 No. 2, 61-63.
- [7] Thakur S, Raw SN, Sharma R (2016), "Design of a Type-2 Fuzzy Model for Thalassemia Disease Diagnosis: Using Mamdani Type-2 Fuzzy Inference System (FIS)", *International Journal of Pharmacy and Pharmaceutical Sciences*, Vol. 8 No. 4.
- [8] Zhenning Y, Vijayashree J, Jayashree J (2017), "Fuzzy logic based diagnosis for liver disease using CBC (Complete Blood Counts)", *J. Comput Math Sci*, Vol. 8, pp. 202-209.
- [9] Asogbon MG, Samuel OW, Omisore MO, Awonusi O (2016), "Enhanced neuro-fuzzy system based on genetic algorithm for medical diagnosis", *J Med Diagn Meth*, Vol. 5 No. 205.
- [10] Abidin B, Dom RM, Rahman ARA, Bakar RA, Demiralp M, Baykara N, Mastorakis N (2009), "Use of Type-2 Fuzzy neural network to predict coronary heart disease in a Malaysian sample", *Proceedings 8th WSEAS International Conference on Telecommunications and Informatics*, pp. 76-80.
- [11] Adeli A, Neshat M (2010), "A Type-2 Fuzzy expert system for heart disease diagnosis", *Proceedings International Multi Conference of Engineers and Computer Scientists*.
- [12] Cinetha K, Maheswari PU (2014), "Decision Support System for Precluding Coronary Heart Disease (CHD) Using Type-2 Fuzzy Logic", *International Journal of Computer Science Trends and Technology*, Vol. 2 No. 2, pp. 2347-857.
- [13] Hassan N, Sayed OR, Khalil AM, Ghany MA (2017), "Fuzzy soft expert system in prediction of coronary artery disease", *International Journal of Type-2 Fuzzy Systems*, Vol. 19 No. 5, pp. 1546-1559.

- [14] Srinivas K, Rao GR, Govardhan A (2014), "Rough-Fuzzy classifier: A system to predict the heart disease by blending two different set theories", *Arabian Journal for Science and Engineering*, Vol. 39 No. 4, pp. 2857-2868.
- [15] Bache K, Lichman M (2013), "UCI Machine Learning Repository [<http://archive.ics.uci.edu/ml>]", University of California, School of Information and Computer Science, Irvine, CA.
- [16] Abbasi, M.M., Kashiyarndi, S (2006), "Clinical decision support systems: a discussion on different methodologies used in health care", Marlaedalen University Sweden.
- [17] Abidin, B., Dom, R.M., Rahman, A.R.A., Bakar, R.A (2009), "Use of Type-2 Fuzzy neural network to predict coronary heart disease in a Malaysian sample", In: *Proceedings of Turkey*, May 30–June 1.
- [18] Agrawal, R., Imielinski, T., Swami. A (1993), "Mining association rules between sets of items in large databases", In: *Proceedings of 1993 ACM SIGMOD International Conference on Management of Data*, Washington, DC, pp. 207–216.
- [19] Ali.S, Chia, P Ong K. (1999), "Graphical knowledge-based protocols for chest pain management", In: *Proceedings of the Conference on Computers in Cardiology*, Hannover, Germany, pp. 309–312.
- [20] Anderson, J (1997), "Clearing the way for physicians' use of clinical information systems", *Communication of the ACM*, 83–90.
- [21] Bradley A. P (1997), "The use of the area under the roc curve in the evaluation of machine learning algorithms", *Pattern Recognition*, 30 (7), 1145–1159.
- [22] Chen. J, Greiner. R (1999), "Comparing Bayesian network classifiers", In: *Proceedings of UAI-99*, Stockholm, Sweden, pp. 101–108.
- [23] De, S.K., Biswas, A., Roy, R (2001), "An application of intuitionistic Type-2 Fuzzy sets in medical diagnosis", *Type-2 Fuzzy Sets and Systems* 117(2), 209– 213.
- [24] Ephzibah E.P (2010), "Cost effective approach on feature selection using genetic algorithms and LS-SVM classifier", *IJ CA Special Issue on Evolutionary Computation for Optimization Techniques*, EC OT.55, pp. 55–56.
- [25] Besime Erin, Rahib H. Abiyev (2019), "Diagnosis of Common Diseases Using Type-2 Fuzzy System", In *Proceedings of the 3rd International Conference on Machine Learning and Soft Computing* (pp. 239-243).