



# INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

## HEART DISEASE PREDICTION USING MACHINE LEARNING

Munna Kumar , 1 Rahul Kumar Chawda ,Assistant Professor, HOD Faculty of IT , 2 Mr.Shrikant Singh ,Assitant Professor of Computer Science and Engineering, Kalinga University,Naya Raipur,India

**Abstract:** In hardly any earlier a very long time all throughout the planet the justification broad number of passings is cardiovascular infection or Heart related illness and in India as well as from one side of the planet to the other has arisen as a dangerous infection. So for the right treatment and in time finding for this illness the need of possible, exact and dependable framework is experienced. For mechanization of investigation of the complex and tremendous information, to the different clinical dataset of Machine Learning strategies and techniques are applied. As of late numerous specialists for the medical services industry help with the assistance of different procedures of AI, this thus helps the experts in the system of the heart related illness conclusion. AI overview of different models that acknowledges such procedures and calculations and their presentation investigation is introduced in this paper. Inside the scientists few entirely elegant Model upheld administered learning calculations are Arbitrary backwoods (RF), Decision Tree (DT), Naïve Bayes, group models, K-Nearest Neighbor (KNN) and Backing Vector Machine (SVM).

**Keywords:** Ensemble Models, Random Forest; Decision Tree; Support Vector Machines; Machine learning, Naïve Bayes; K-Nearest Neighbor; Cardiovascular Diseases, AI

### 1. Introduction

With the utilization of the available information handling instruments that are disparate for the various practices in information preparing that are vital in the heart condition gauge are the principle particular substance of this paper. The actual body inverse parts may get trouble, if the guts doesn't work as expected, inverse parts like kidney, mind, and so on Working of guts might get affected by the infection of heart condition. One of the

primary explanations behind death is heart condition in the present situation. Almost 12 million individuals for each annum pass on in light of the heart illness as expected by the WHO-World Health Association [1]. Illnesses like assault, cardiovascular, thump furthermore, coronary are not many of the heart infections. A heart condition that is caused in view of the commencement of fundamental sign to be high or then again the veins which passes across the mind, such blood vessels reducing, obstructing or reinforcing is known as Thump. In current circumstance office prevalence is one of the prime difficulties looked by the Healthcare business. The assistance guidelines are characterized by the serving patient with the viable treatment and essentially right conclusion of the illness. Unsatisfactory results that are unfortunate are brought about by the helpless finding. Clinical records of the information or records are broadly enormous, however these information or records are from different various establishments [2]. The significant part of those information is doctors done understandings. Inside the information base orders to fill or finish the qualities that are precluded is required by the information preparing as the data on the planet may be conflicting, inadequate or loud. As one of the significant reasons if passing in the antiquated time was known as but cardiovascular infections, due to these were the most reasonable and avoidable sicknesses [3]. Sickness well-time judgment on which the illness exact and complete the board is transferred on. There is a significant requirement for recognizing the patient with high-hazard a methodological and precise apparatus age and heart contamination opportune examination by mining information is required [4]. Heart

condition extraordinary side effects may be appeared by the differential individual bodies also, can be in like manner differing. Stomach issues and smallness of breath, torment, arms, shoulders torments, neck torment, jaw torment and back torment are incorporated frequently. Stroke and blood vessel coronaries sickness and coronary disappointment are remembered for the spread of various heart sicknesses [5]. Across the globe as a incomparable ongoing sort of infection is recognized as yet heart condition and simultaneously are likewise the most avoidable one. Two principle starting points of the heart condition chief are opportune examination of the infection it is a second rate anticipation or a day to day existence in a sound manner is the fundamental counteraction [6]. In the challenges of heart condition early counteraction and judgment an exceptional job is appeared by executing consistent registration that are sub-par avoidances. To help this huge issue different tests are incorporated like exercise resistance test, echocardiography, chest X-beams and angiography [7]. Regardless, precise clinical gear accessibility is required and these tests are costly. Capacity what's more, planning of the patient's data set huge and legitimate record is made by the heart specialists. From a particularly sort of the datasets, for significant data mining amazing imminent is conveyed by this [8]. In different patients to work out heart conditions hazard factor a tremendous exploration is going no, different scientists are utilizing various projects of information mining draws near and distinctive measurable methodologies [9]. For heart infection the tally of hazard factors is recognized by the measurable investigation by considering heart condition absence of work out, heftiness, preparing in family, absolute cholesterol and hypertension, diabetes, fundamental sign, age and smoking [10]. It is vital to have coronary illness attention to the patients that are close to have a perpetual heart condition for there legitimate medical services and counteraction [11]. For distinguishing gut illnesses different procedures of information preparing that for helping the doctor or expert are available is utilized by the scientists. By and large utilized methods that are utilized are as following Naïve Bayes, k-closest and choice tree. Other different orders based techniques utilized are SVM (Support Vector Machine), straight Kernel self-sorting out map, consecutive negligible improvement and neural organizations, piece thickness and stowing calculation [12]. The portrayal of the techniques that were utilized in the examination are given obviously in the ensuing segment.

## 2. RELATED MATERIAL AND METHOD

### A. BACKING VECTOR MACHINE

In both of the relapse and order work of the Backing Vector Machines (SVM) is finished. Portrayal of the information point is done of the space and into gathering's order and thus, in a similar gathering the focuses with comparative properties fall in the SVM model [13].

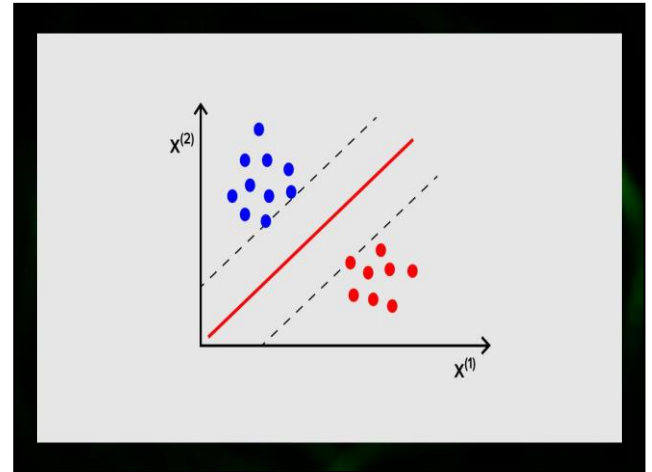


Fig .1 Representation of Support Vector Machine

In direct SVM, the gave informational index as p-measurement vector is considered, that by the limit of p-1 planes will be isolated otherwise called hyper-plane [14]. As in the figure 2 among the information bunches for relapse or characterization issues, these planes put down the stopping points or separate the information space. The measure of hyper plane on the prospect of distance between the classes it isolates, the choice of the straightforward hyper-plane is finished. In particular most extreme edge hyper-plane is between 2 classes the arrangement that has the most extreme margined [14].

Meaning of n information focuses:

$$(X_1, Y_1) \dots \dots, (X_n, Y_n) \dots \dots .1$$

Here genuine vector is addressed by  $X_1$  and 1 or -1 is  $Y_1$ , the

class to which  $X_1$  has a place is addressed. Development of hyper-plane should be possible so to the distance

between to classes minimization  $y=1$  and  $y=-1$ , is characterized as follows -

$$W \cdot X - b = 0 \dots 2$$

Here Normal vector is addressed by  $W$  and balance of hyper plane is  $b$ .

### B.Radial Basis Function (RBF) Kernel Support Vector Machine

On the straight and non-direct information demonstrate of the effectiveness of the Backing vector machine is appeared. To group nonlinear

information execution of the Radial base capacity is done[15].

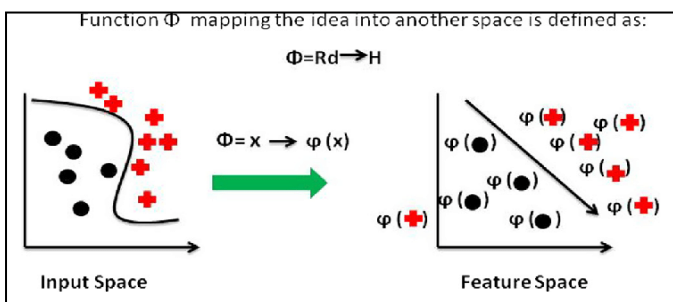


Fig.2 Representation of Radical Basis Function (RBF) Kernel support vector machine

Piece support vector machine. Part work assumes vital part to place information into include space. Numerically, piece stunt (K) is characterized as:

$$K(x_1, x_2) = \exp\left(-\frac{|x_1 - x_2|^2}{2\sigma^2}\right) \dots .3$$

A Gaussian capacity is otherwise called Radial premise work (RBF) piece. In Figure 3, the information space isolated by include map (Phi). By applying condition 1& 2 we get:

$$f(x) = \sum_i^N \alpha_i y_i k(x_i, x) + b \dots .4$$

By applying condition 3 of every 4 we get new capacity, where N addresses the prepared information

$$f(x) = \sum_i^N \alpha_i y_i \exp\left(-\frac{|x_1 - x_2|^2}{2\sigma^2}\right) + b \dots .5$$

**C. k-Nearest Neighbour (k-NN)**

Yielding superb outcomes in spite of the fact that it is a solitary calculation by the k-Nearest neighbor. It's an occasion based, nonparametric what's more, lethargic learning calculation [16]. In both the relapse too as the arrangement issue usage of this issue is frequently done. To the search out the class k-NN which the has a place with the unlabeled item, in the arrangement. Setting a 'k' for this where k is number of neighbors to be thought of that overall is odd and subsequently closest to the article information focuses distance is determined by the techniques, for example, Minkowski distance, Manhattan distance or Hamming distance, Euclidean's distance [17]. The 'k' closest neighbor after the space computation are chosen as the resultant class of new item that is determined or dissected on the possibility of the votes of the neighbors. The outcome with the most elevated precision is anticipated by the k-NN[18].

**D. Fake neural organization (ANN)**

The usefulness of the human mind is imitated by the fake neural organization. In for the most part as a bunch of hubs it is seen called as counterfeit neurons. At any rate to each other all of that hub can communicate data. By some state 0 or 1 neurons are addressed [19]. To each hub task of some weight may be done to characterize inside the framework the significance or strength. Into the layers of numerous hubs; it arrives at the yield layer by the data goes from first layer input layer and subsequent to going through center layers covered up layers, into some significant data the information is changed by each layer and the predefined yield is given in the long run [20]. In neurons working significant job is played by enactment and move work. All the weighted info is summarized by move work:

$$z = \sum_{x=1}^n w_i x_i + w_b b \dots \dots \dots .6$$

To explicit reach the yield of the exchange work is leveled by the initiation work. In can be straight just as nonlinear. Straightforward initiation work is:

$$f(z) = z \dots \dots \dots .7$$

As no constraints are applied on the information by the capacity, use of sigmoid capacity is done that can be communicated as follows:

$$a = \sigma(z) = \frac{1}{1+e^{-z}} \dots \dots \dots .8$$

**E. Multifaceted Dimensionality Reduction (MDR)**

The methodology for portrayal and area of the autonomous factors solidification that will here and there impact the variable that are reliant is known as Multifaceted Dimensionality Reduction (MDR). When all is said in done, it's intended to get the cooperation in the middle of the factors that will influence the framework yield. It isn't reliant upon such a utilized model or boundaries that when contrasted with the practice framework will improve it [21]. The at least two ascribes are taking and joined into one trait. The information space portrayal is changed by this transformation. The class variable forecast by framework execution improvement is lead by this. In Machine Learning usage of the different MDR augmentations is finished. Not many of them are

as follows covariates, hazard scores, chances proportion, fluffy strategies and numerous more. In expectation of the heart related infections or cardiovascular infections Machine learning calculation has a colossal scope as often closed by this [22]. Sometimes, the previously mentioned strategies execution very well where as in couple of cases the strategies show extremely terrible showing. It shows an incredibly well exhibition when utilized together with the PCA and the Alternating choice tree though due to overfitting in different cases choice trees perform inadequately. As by taking care of the issue of overfitting execution of Group model and Random Forest is okay as they utilize various calculations, simply in the event of Random Forest different Choice Trees are utilized [23]. The Naïve Bayes classifier upheld models where show no time calculation and along with this for some cases very well execution was appeared by the SVM. In the guts related infection forecast Backing Vector Machines shows precise outcomes however there is as yet a tremendous extension for the examination work to be accomplished for the high dimensional information taking care of and overfitting. On the right group of calculations gigantic extent of examination is conceivable to be utilized on a particular information sort [24].

### III. PROPOSED METHODOLOGY

In this exploration paper a model "Enhanced DNN utilizing Talos" was sent and to others the strategies were looked at it was tracked down that this was more proficient when contrasted with others. As contrasted with others it likewise gave high exactness. A few stages were trailed by us in this model execution. Choosing a numerical portrayal was associated with Dimensional Decrease in a manner to such an extent that majority of can be connected by one yet not with all, subsequently just incorporation of fundamental data was done inside the given information with change [25]. It may comprise huge loads of measurements and characteristics by the errand the information that is thought of, yet equivalent effect on the yield isn't appeared by every one of the characteristics. Computational intricacy may be influenced by the quantity of highlights or traits being outsized and may additionally lead to overfitting that gives helpless outcomes [26]. Consequently as a essential advance Dimensional Reduction can be seen, overall by two techniques this can be accomplished that are-have choice and Highlight Extraction [27].

**A. Highlight Extraction during**, springing from the first include set is the substitution set of highlights. Including a change of highlights in include extraction. By and large, non reversible is the change done, as inside the interaction few or numerous valuable data are lost [28]. For include expansion, in and head segment examination or PCA is utilized. With the direct change calculation might be prominently utilized in Principal Component Analysis. It look the course to boost the difference inside the element space furthermore, commonly symmetrical bearings are additionally looked. The least difficult recreation is given by the around the world algorithm[29].

**B. B. Highlight Selection during** this, unique highlights subset is chosen. By Correlation based Feature Selection or CFS key highlights are picked with Best First Search strategy Subset Assessment is consolidated for back dimensionality scaling. To select the first critical component work of chi square measurements test is finished.

### IV. Calculations and Techniques Used.

In 1951 K – Nearest Neighbor, presented by Hodges et al. In which for design order a nonparametric strategy that prominently was called as the K-Nearest Neighbor rule. One among the chief components is K-Nearest Neighbor strategy but at the same time is a valuable and viable method for characterization. It is by and large utilized for characterization purposes with no or less need information and about the data makes no suppositions about the information appropriation. The calculation incorporates looking inside the preparation set to data point, the k closest information point, the ordinary worth of the found information focuses thereto is relegating and in which the objectives esteem is inaccessible. Precision of 83.16% in 21 KNN when the sufficiently to 9 is the value of k during utilizing the strategy of 10-cross approval. With the precision of 70.26% better than some other procedure it acts in 22 KNN alongside the Ant State Optimization and thus 0.526 is the blunder rate. An amazingly great precision of 87.5% is obtained[30].

(i) **K-NN:- Machine learning** calculation that is non-parametric may be a K-NN. It's a managed learning calculation. Structure the information document it predicts the yield.



**K-NN Algorithms: K-NN algo following not many advances.**

K-NN algo following not many advances are:

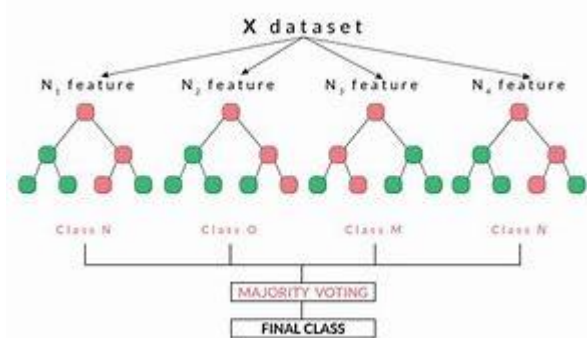
1. Pick K a value.
2. From all cases figure the obscure case space
3. In the preparation information pick the k-perceptions to the obscure datum that is closest.
4. From the KNN utilizing the principal mainstream reacts anticipating the reacts of the obscure datum.
5. Stop. Into test and preparing dataset the parting is done of this calculation information. For model preparing and building the work of the preparation dataset is finished. In everyday the root of the measure of the perception is set as the worth of k. On the model fabricated based the test information [31].

(ii) **Decision Tree** may be of administered learning calculation is Decision tree. In the arrangement issue this framework is for the most part used. With absolute and persistent characteristics it easily performs. Into at least two comparable sets the populace is separated populace by this calculation that upheld the first huge indicators. Every single credits entropy is first determined by the Decision tree calculation. With most extreme entropy or greatest data acquired the dataset is spilt with the indicators or factors help. With the left out credits these two stages are performed recursively[32]. With the 77.55% of precision is the most exceedingly terrible presentation of the choice tree however with the 82.17% exactness it shows better

execution when the choice tree is utilized with the procedure of boosting. With the 42.8954% an effectively indicated rate the terrible showing of choice tree can be seen while it additionally utilizes dataset that is same yet for carrying out choice tree utilizes the J48 calculation and henceforth gets the precision of 67.7% that is a limited quantity however show an enhancement for the beforehand precision acquired of 71.43%, it has utilized with head segment examination rotating choice tree with the 92.2% exactness. The most straightforward outcome on utilizing the blend of with the forward choice and choice tree-based classifier that gets the weighted precision of the 78.4604% and this accomplish by the Kamran Farooq et al.

(iii) **Random Forest** an extra managed machine learning calculation is known as Random Forest. For both the

errand of order just as the relapse this framework are utilized oftentimes yet in the characterization task it for the most part performs better. As the name proposes prior to giving a yield different choice trees are considered in the Random timberland procedures. Overall it is choice tree's troupe. On the suspicion that there will be assembly to the legitimate choice by the more prominent quantities of trees, this is the expectation on which this framework is based. Constituent framework is utilized for arrangement then it chooses the class while in the relapse for each decision trees it takes mean of all the yield. With the high dimensionality with huge datasets it functions admirably.



In figure 5, outstandingly well execution is appeared by the irregular woods. A critical high exactness of 91.6% is seen in the Random woodland highlights of Cleveland dataset than any of the techniques that are inverse. A precision of 97% is accomplished in the People's Hospital dataset. A 0.86 f-measure is accomplished in arbitrary woods technique in 20. To foresee coronary heart condition Random timberland in 21 and it gets a precision of 97.7%.

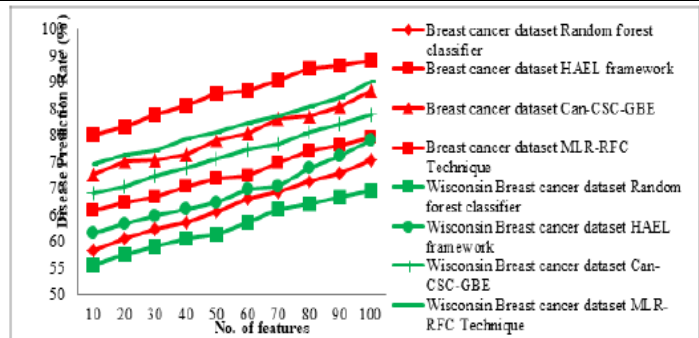


Figure 4: Measure of disease prediction rate.

(iv) **Ensemble Model** at least two related at this point extraordinary models of investigation are utilized in the troupe model and the results delivered are joined in one score in 22 utilized an ANN, KNN and SVM outfit for the exactness of 94.12%. Showing of the mass vote based model that incorporates Backing Vector Machines, Decision tree and Naïve Bayes classifiers giving 74% delicate, 82% precision and for UCI heart condition dataset 93% of details. In 24, a Naïve Bayes classifier, SVM and Gini Index are comprised in this outfit that in anticipating syncope sickness gives 98% exactness. Table.1 In outfit demonstrating at least two related however diverse logical models.

File	Age	Sex	Op	Test	Chol	Fbs	Brest	Thalc	Exam	Old	Slope	CA	TBA	Target
Con	383	303.0	303.0	383.0	383.0	383.0	383.0	303.0	303.0	303.0	383.0	383.0	383.0	383.0
mea	24	0.603	0.966	131.6	246.2	0.148	0.328	149.6	0.536	1.039	1.399	0.729	2.313	0.544
sil	9.0	0.466	0.466	17.53	51.83	0.336	0.325	22.90	0.469	1.161	0.616	1.022	0.612	0.498
min	29.00	0.000	0.000	94.00	126.0	0.000	0.000	71.00	0.000	0.000	0.000	0.000	0.000	0.000
25%	47.50	0.000	0.000	130.0	211.0	0.000	0.000	153.5	0.000	0.000	1.000	0.000	2.000	0.000
50%	55.00	1.000	1.000	130.0	240.0	0.000	1.000	153.0	0.000	0.000	1.000	0.000	2.000	1.000
75%	61.00	1.000	2.000	140.0	274.5	0.000	0.000	166.0	1.000	1.000	2.000	1.000	3.000	1.000
max	77.00	1.000	3.000	200.0	274.5	1.000	2.000	202.0	1.000	4.200	2.000	4.000	3.000	1.000

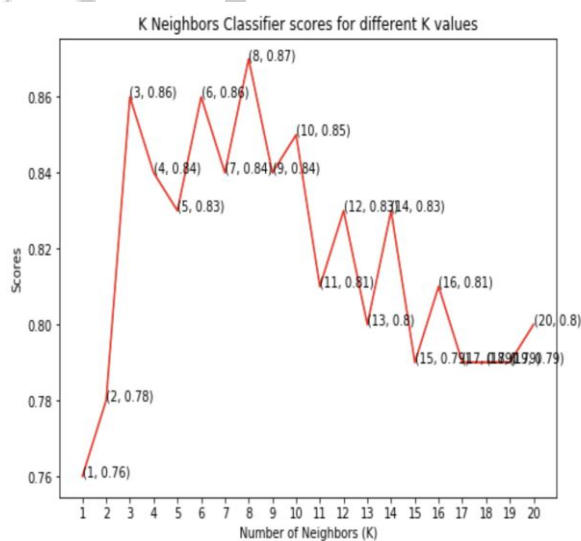
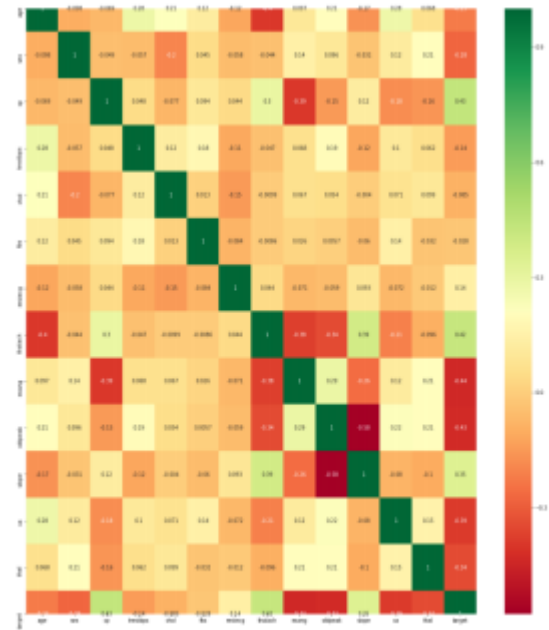


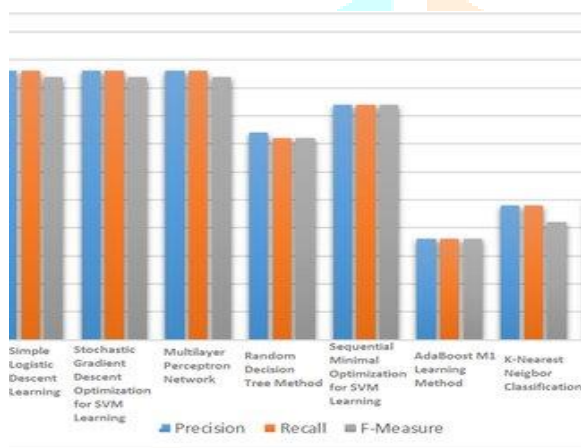
Fig. 6: K neighbors Classifier scores for different values

Sr.No.	Classification Algorithms	Accuracy
1	Logistic Regression	84.25004050021001
2	SVM	80.78000529001220
3	Naïve Bayes	
4	Hyper-parameter optimization	86.16000511002407
5	K-NN	98.06637004078605
6	Random forest	95.41045606229145

## V.RESULT:

Not many order calculations are applied in this paper like Arbitrary woods, KNN, and so on. On the dataset of coronary illness and all exactness of grouping is estimated in the table referenced beneath. On the off chance that the objective classes are of equivalent size around it's a decent practice to work with such dataset.

Table.2 Classification Algorithms and Accuracy.



## 6. CONCLUSION

By and large, that follows your system segment in a legitimate arrangement is the outline of this paper. In contrast with the other streamlining and calculation, it for forecast gives great outcomes. Utilizing a Talos enhancement we send machine learning. In DNN, another streamlining strategy is Talos streamlining. To other improvement Talos streamlining gives better exactness. To datasets of coronary illness Talos streamlining is applied and gives forecasts that are acceptable. With the assistance of Talos improvement

## References

[1]. Tarun Dhar Diwan, Dr.H.S.Hota, Dr. Siddhartha Choubey "Multifactor Authentication Methods: A Framework for Their Selection and Comparison" accepted for publication in International Journal of Future Generation Communication and Networking Vol. 13, No. 3, (2020), pp. 2522–2538, ISSN: 2233- 7857 (Web of Science).

[2]. Tarun Dhar Diwan, Dr.H.S.Hota, Dr. Siddhartha Choubey "A Novel Hybrid Approach for Cyber Security in IoT network Using Deep Learning Techniques" accepted for publication in International Journal of Advanced Science and Technology ISSN:2394-5125, ISSN: 2005-4238 (Scopus indexed Journal).

[3]. Tarun Dhar Diwan, Dr.H.S.Hota, Dr. Siddhartha Choubey entitled "Development of Real Time Automated Security System for Internet of Things (IoT)" accepted for publication in International Journal of Advanced Science and Technology Vol. 29, No. 6s, (2020), pp. 4180 – 4195, ISSN: 2005- 4238 (Scopus indexed Journal).

[4]. Tarun Dhar Diwan, Dr.H.S.Hota, Dr. Siddhartha Choubey "A Proposed Security Framework for Internet of Things: An Overview" presented in international Conference held on 20-22.December,2019, MTMI, Inc. USA in Collaboration with at amity Institute of Higher Education, Mauritius.

[5]. Tarun Dhar Diwan, Dr.H.S.Hota, Dr. Siddhartha Choubey "Control of Public Services for Public Safety through Cloud Computing Environment" presented in international Conference held on 04-05 January,2020, Organized by Atal Bihari Vajpayee University, Bilaspur in association with MTMI, USA and sponsored by CGCOST, Raipur (C.G), India.

[6]. Tarun Dhar Diwan, Dr.H.S.Hota, Dr. Siddhartha Choubey "A Study on Security and Data Privacy issues of IoT based Application in Modern Society" presented in international Conference held on 04-05 January,2020, Organized by Atal Bihari Vajpayee University, Bilaspur in association with MTMI, USA and sponsored by CGCOST, Raipur (C.G), India.

[7]. C.BeulahChristalinLatha,S.CarolinJeeva,Improvingtheaccuracyofpredictionofheartdiseaseriskbasedonensemblesclassificationtechniques,<https://doi.org/10.1016/j.imu.2019.100203>, July 2019.

[8]. Avinash Golande, Pavan Kumar T, Heart Disease Prediction Using Effective Machine Learning Techniques, International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277- 3878, Volume-8, Issue-1S4, June 2019.

[9]. S.Nandhini, Monojit Debnath, Anurag Sharma, Pushkar. Heart Disease Prediction using Machine Learning, International Journal of Recent Engineering Research and Development (IJRERD) ISSN: 2455-8761, www.ijrerd.com Volume 03 – Issue 10,,PP. 39-46, October 2018.

[10]. A.Sahaya Arthy, G. Murugeswari "A survey on heart disease prediction using data mining techniques" (April 2018).

[11]. Hamid Reza Marateb and Sobhan Goudarzi, "A noninvasive method for coronary artery diseases diagnosis using a clinically interpretable fuzzy rule-based system," Journal of Research in Medical Sciences, Vol. 20, Issue 3, pp.214-223, March 2015.

[12]. K.R. Lakshmi, M.Veera Krishna, and S.Prem Kumar, "Performance Comparison of Data Mining Techniques for Predicting of Heart Disease Survivability," International Journal of Scientific and Research Publications, Vol.3, Issue 6, pp.1-10, June 2013.

[13]. R. Sharmila, S. Chellammal, "A conceptual method to enhance the prediction of heart diseases using the data techniques", International Journal of Computer Science and Engineering, May 2018.

[14]. Purushottam, Prof. (Dr.) Kanak Saxena, Richa Sharma, "Efficient Heart Disease Prediction System", 2016, pp.962-969.

[15]. Ashwini Shetty A, Chandra Naik, "Different Data Mining Approaches for Predicting Heart Disease", International Journal of Innovative in Science Engineering and Technology, Vol.5, May 2016, pp.277-281.

[16]. Mr. Chala Beyene, Prof. Pooja Kamat, "Survey on Prediction and Analysis the Occurrence of Heart Disease Using Data Mining Techniques", International Journal of Pure and Applied Mathematics, 2018.

- [17]. V. Krishnaiah, G. Narasimha, N. Subhash Chandra, "Heart Disease Prediction System using Data Mining Techniques and Intelligent Fuzzy Approach: A Review" IJCA 2016.
- [18]. K.Sudhakar, Dr. M. Manimekalai "Study of Heart Disease Prediction using Data Mining", IJARCSSE 2016.
- [19]. NagannaChetty, Kunwar Singh Vaisla, NagammaPatil, "An Improved Method for Disease Prediction using Fuzzy Approach", ACCE 2015.
- [20]. VikasChaurasia, Saurabh Pal, "Early Prediction of Heart disease using Data mining Techniques", Caribbean journal of Science and Technology, 2013
- [21]. ShusakuTsumoto, "Problems with Mining Medical Data", 0-7695- 0792-1 I00@ 2000 IEEE.
- [22]. Y. Alp Aslandoganet. al., "Evidence Combination in Medical Data Mining", Proceedings of the international conference on Information Technology: Coding and Computing (ITCC'04) 0- 7695-2108-8/04©2004 IEEE.
- [23]. Carlos Ordonez, "Improving Heart Disease Prediction Using Constrained Association Rules," Seminar Presentation at University of Tokyo, 2004.
- [24]. Franck Le Duff, CristianMunteanu, Marc Cuggiaa, Philippe Mabob, "Predicting Survival Causes After Out of Hospital Cardiac Arrest using Data Mining Method", Studies in health technology and informatics, Vol. 107, No. Pt 2, page no. 1256- 1259, 2004.
- [25]. Boleslaw Szymanski, Long Han, Mark Embrechts, Alexander Ross, KarstenSternickel, Lijuan Zhu, "Using Efficient Supanova Kernel For Heart Disease Diagnosis", Proc. ANNIE 06, intelligent engineering systems through artificial neural networks, vol. 16, page no. 305-310, 2006.
- [26]. Kiyong Noh, HeonGyu Lee, Ho-Sun Shon, Bum Ju Lee, and Keun Ho Ryu, "Associative Classification Approach for Diagnosing Cardiovascular Disease", Springer 2006, Vol:345, page no. 721- 727.
- [26]. Hongyu Lee, Ki Yong Noh, Keun Ho Ryu, "Mining Bio signal Data: Coronary Artery Disease Diagnosis using Linear and Nonlinear Features of HRV," LNAI 4819: Emerging Technologies in Knowledge Discovery and Data Mining, May 2007, page no. 56-66.
- [27]. Niti Guru, Anil Dahiya, NavinRajpal, "Decision Support System for Heart Disease Diagnosis Using Neural Network", Delhi Business Review, Vol. 8, No. 1, January - June 2007.
- [28]. Hai Wang et. al., "Medical Knowledge Acquisition through Data Mining", Proceedings of 2008 IEEE International Symposium on IT in Medicine and Education 978-1-4244- 2511-2/08©2008 Crown.
- [29]. SellappanPalaniappan, RafiahAwang, "Intelligent Heart Disease Prediction System Using Data Mining Techniques", (IJCSNS), Vol.8 No.8, August 2008.
- [30]. LathaParthiban and R.Subramanian, "Intelligent Heart Disease Prediction System using CANFIS and Genetic Algorithm", International Journal of Biological, Biomedical and Medical Sciences, Vol. 3, Page No. 3, 2008.
- [31]. Chaitrali S. Dangare, Sulabha S. Apte, Improved Study of Heart Disease Prediction System using Data Mining Classification Techniques", International Journal of Computer Applications (0975888) Volume 47No.10, June 2012

