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A Review on Clinical Decision Support System for Heart Diseases

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***Abstract*: Clinical Decision Support System (CDSS) is a tool which helps doctors to make better and uniform decisions. There are many existing systems present which are used for diagnosing the diseases. For different systems algorithmic aspect changes as per requirement. For every approach there pros and cons. selecting the positive aspect and overcoming the problems is the main motive. There is large amount of heart related data present, which is in unstructured format. Hence by analyzing the data and formatting it into structured manner helps for making the decision. For diagnosing the disease there are many ways in which heart related diseases can be diagnosed and treatment can be provided.**

***Keywords*: CDSS, Patient health Information, Electronic Medical Record, Healthcare, Data mining.**

1. Introduction

Clinical Decision Support (CDS) systems provides clinicians, staff, patients and other individuals with knowledge and person specific information , intelligently filtered and presented at appropriate times, to enhance health and healthcare[2]. CDSS is a tool to assist user in taking clinical decisions of diagnosis. A typical user of CDSS is a physician, nurse or any other paramedical service provider. It gathers the patient health information (PHI) entered by the user in the system. Using pre-determined algorithms or rules, CDSS provides clinically relevant information and conclusions to the user. The rules used in the system can be configured by the administrator. Security of each patient's personal record must be provided [1].

2. Heart diseases

Heart is the vital organ of the body. Without heart the living organism cannot survive. The working of the heart is only to pump the blood in and out. This creates blood circulation in entire body. Blood circulation helps other organs to work efficiently into the body. There are number of factors which affect heart to malfunction such as history of patient as well as hereditary , life style , poor diet, high blood pressure, obesity, percentage of cholesterol, high per tension, smoking and drugs habits etc. [17].

3. Different existing systems

Different CDS Systems that were developed from the early times have brought up to professional's attention in 1950's. De Dombal's system was developed at university of Leeds in the early 1970's by deDombals and his associates. They studied the diagnoses process and developed a computer-based decision aids using Bayesian probability theory [Musen, 2001]. INTERNIST-I was a broad-based computer-assisted diagnostic tool developed in the early 1970's at the University of Pittsburgh as an educational experiment [Miller et al., 1982; Pople, 1982]. MYCIN was a rule-based expert system designed to diagnose and recommend treatment for certain blood infections (antimicrobial selection for patients with bacteremia or meningitis) [Short life, 1976], [5], [3].

Table 1
Existing systems

Sr No.	Properties	MYCIN	De Dombal	Internist-1	DXplain	Quick Medical Reference (QMR)
1.	Developed By	Stanford University	University of Leeds	University of Pittsburgh	Laboratory of Massachusetts General Hospital	University of Pittsburgh
2.	Year	1970	1972	1970	1970	1970
3.	Diseases	blood infections	abdominal pain	knee replacement surgery	2,200 unique diseases	Abdomen Pain Severe, Blood Hepatitis
4.	Classification Approach	IF-THEN rules	Bayesian probability theory	Bayesian probability theory, Decision Tree	probabilistic algorithm	Basic Decision Tree

4. Algorithmic approaches

There are many ways in which diagnosis of diseases can be done. In naïve Bayes classifier technique, the probability of symptoms occurring and diseases is calculated. But at times it becomes calculating probability for each symptom and disease matching becomes tedious [7]. In fuzzy logic technique mainly machine learning is involved. By using weighted system for diagnosis of disease for each symptom can be done [12]. Another way of diagnosing the disease is by using IF-THEN rules which is the simplest technique [12]. In neural network approach incremental learning can be achieved [13]. A

Decision tree approach is a simple technique. It is a flowchart like structure where hierarchal design is created as well as cause effect relationship can be generated [4], [5], [9], [10], [13].

Table 2
Algorithmic approach

Parameters	Naïve Bayes	Neural Network	IF THEN Rules	Decision Tree
Disease	Diabetes, Pneumonia, Abdominal Pain	Malaria	Almost for every Disease	Almost for every Disease
Existing Systems	De Dombal, Quick medical Record (QMR)		MYCIN	Internist-1 Quick Medical Record (QMR)
Evaluation	Complex	Complex	Simple	Simple
Time	More time consumed	More time consumed	Less time	Less time
Disadvantage	Multiple symptoms cannot handle	Users cannot use system effectively	Needs many rules to make decision	Selection of splitting attribute

5. Different approaches for diagnosing heart diseases

For diagnosing the disease in patient, that is where the patient is prone to that disease or not is given by certain measures. Measures described below are mostly utilized in every approach. Approach for Prediction of Heart Disease Using Neural Networks [15].

- TP (True Positive): It denotes the number of records classified as true while they were actually true.
- FN (False Negative): It denotes the number of records classified as false while they were actually true.
- FP (False Positive): It denotes the number of records classified as true while they were actually false.
- TN (True Negative): It denotes the number of records classified as false while they were actually false [15].

Table 3
Matrix for Measures

	a (has heart disease)	b (no heart disease)
a (has heart disease)	TP	FN
b (no heart disease)	FP	TN

Now for applying these measures on different approaches we can analyze the accuracy obtained by each methods. Different approaches have different aspects in diagnosing the diseases. By using the Neural network approach the accuracy secured was around 80- 90% but the hidden layers description cannot be evaluated [14]. In fuzzy logic approach the weighted rules are generated initially and then the fuzzy rule decision is provided [14], [15] and the accuracy obtained id around 79.05%. In naive bayes classification approach helps in predicting whether the patient is prone to heart disease or not and depicting the risk factor for heart attack [11]. The accuracy observed for naive bayes approach was around 90% [14]. Similarly by using Support vector machines concept the accuracy was achieved around 84.12%. While as by using decision tree approach the accuracy increased up to 96% [14].

Table 4
Analysis of methods

Parameters	Neural Network	Fuzzy Logic	SVM	Naïve Bayes	Decision Tree
Algorithms	Back propagation	Thresholds and weights applied on IF – THEN rules	Maximum & optimal margins by Gaussian theorem	Posterior Probability	C4.5 , CART, J48 using splitting attribute entropy.
Measures	Accuracy (AC), Sensitivity (SE), Specificity (SP)	Accuracy (AC), Sensitivity (SE), Specificity (SP)	Accuracy (AC), Sensitivity (SE), Specificity (SP)	Precision Recall	F-measure (F), Precision (P), Recall (R)
Formula for measures	SE = TP / TP + FN SP = FP / TN + FP AC=TP+TN/ TP+FP+TN+FN	SE = TP / TP + FN SP = FP / TN + FP AC=TP+TN/ TP+FP+TN+FN	SE = TP / TP + FN SP = FP / TN + FP AC=TP+TN/ TP+FP+TN+FN	P = TP / TP + FP R = TP / TP + FN	P = TP / TP + FP R = TP / TP + FN F = 2P / P + R
Advantages	Minimizes error in each level.	Specification is obtained	Large data set is analyzed	Minimum error occurs	No domain knowledge is required
Disadvantage	Very slow working	Comparison increases	Range should be precise else outliers are observed	Multiple symptoms cannot handle and dependency in attributes	Selection of splitting attribute
Accuracy	80 - 90 %	78 – 85 %	85 – 90 %	90 – 95 %	94 – 96 %

6. Conclusion

Clinical Decision Support System for heart diseases is very effective tool for diagnosing the diseases. Hence for implementation of such system compared to other approaches for diagnosing purpose Decision Tree technique will be an effective technique in classification. It is a simple tree like flowchart structure which helps in bifurcating the data in respective groups. The main goal of Decision Trees is in the intuitive representation that is easy to understand and comprehend.

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