Clinical Decision Support System In Computational Methods: A Review Study

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***Abstract*— Clinical Decision Support Systems (CDSS) are computational models designed impact clinical decision making about individual patients at the point in time that these decision are made. Clinical Decision Support Systems (CDSS) form an important area of research. While traditional systematic literature surveys focus on analyzing literature using arbitrary results, visual surveys allow for the analysis of domains by using complex network-based analytical models. In this paper, we present a detailed visual survey of CDSS literature using important papers selected. The aim of this study is to review a number of articles related to CDSS for heart and stroke diseases. In this study several articles are comparable to the computational methods and rules used for data processing. From the analysis of several sources of literature, the computational methods and rules used in CDSS are Principle Component Analysis (PCA), Support Vector Machine (SVM), Naïve Bayes data mining algorithm, Case Based Recommendation Algorithm, Weighted Fuzzy Rules, Ontology Reasoning, TOPSIS Analysis, Genetic Algorithms, Fuzzy Neural network, Case-based reasoning (CBR), Weighted Fuzzy Rules and Decision Tree.**

Keywords*— *Heart and Stroke Diseases; Decision Support Systems; Computational Methods and Rules; Comparative; Reviwe Study

I. INTRODUCTION

Clinical decision support (CDS) systems provide clinicians, staff, patients, and other individuals with knowledge and person-specific information, intelligently filtered and presented at appropriate times, to enhance health and health care [1]. Clinical Decision Support System (CDSS) is a new paradigm that combining between clinical system and decision support system. There are a several of systems that can potentially support clinical decisions. Decision support systems have been incorporated in healthcare information systems for a long time, but these systems usually havesupported retrospective analyses of financial and administrative data. Recently, sophisticated data mining approaches have been proposed for similar retrospective analyses of both administrative and clinical data. Although these retrospective approaches can be used to develop guidelines, critical pathways, or protocols to guide decision making at the point of care, such retrospective analyses are not usually considered to be CDSS [1-2]. These distinctions are important because vendors often will advertise that their product includesdecision support capabilities, but that may refer to the retrospective type of systems, not those designed to assist clinicians at the point of care. However, as the interest has increased inCDSS, more vendors have begun to incorporate these types of systems [2-4].

Many of knowledge based CDSS acrose out of earlier expert systems research, where the aim was to build a computer program that could simulate human thinking. Medicine was considered a good domain in which these concepts could be applied. In the last twenty years, the developers of these systems have begun to adapt them so that they could be used more easily to support real-life patient care processes. Many of the earliest systems were diagnostic decision support systems[5]. The intent of these CDSS was nolonger to simulate an expert's decision making, but to assist the clinician in his or her own decision making. The system was expected to provide informationfor the user, rather than to come up with "the answer," as was the goal of earlier expert systems. The user was expected to filter that information and to discard erroneous or useless information. The user was expected to be active and to interact with the system, rather than just be a passive recipient of the output. This focus on the interaction of the user with the system is important in setting appropriate expectations for the way the system will be used [6-8].

CLINICAL DECISION SUPPORT SYSTEM (CDSS)

CDSS have been developed to assist with a variety of decisions. The example above describes a system designed to provide support for laboratory test ordering. Diagnostic decision support systems have been developed to provide a suggested list of potential diagnoses to the users. The system might start with the patient's signs and symptoms, entered either by the clinician directly or imported from the EMR. The decision support system's knowledge base contains information about diseases and their signs and symptoms.The inference engine maps the patient signs and symptoms to those diseases and might suggest some diagnoses for the clinicians to consider. These systems generally do not generate only a single diagnosis, but usually generate a set of diagnoses based on the available information. Because the clinician often knows more about the patient than can be put into the computer, the clinician will be able to eliminate some of the choices [2.3,6].

There are three parts to most CDSS. These parts are the knowledge base, the inference or reasoning engine, and a mechanism to communicate with the user, the knowledge base consists of compiled information that is often, but not always, in the form of if–then rules. An example of an if–then rule might be, for instance, IF a new order is placed for a particular blood test that tends to change very slowly, AND IF that blood test was ordered within the previous 48 hours, THEN alert the physician. In this case, the rule is designed to prevent duplicate test ordering. Other types of knowledge bases might include probabilistic associations of signs and symptoms with diagnoses, or known drug–drug or drug–food interactions [4,5.8]. The second part of the CDSS is called the inference engine or reasoning mechanism, which contains the formulas

for combining the rules or associations in the knowledge base with actual patient data. Finally, there has to be a communication mechanism, a way of getting the patient data into the system and getting the output of the system to the user who will make the actual decision. In some stand-alone systems, the patient data need to be entered directly by the user. In most of the CDSS incorporated into electronic medical records (EMR) systems, the data are already in electronic form and come from the computer-based patient by record, where they were originally entered by the clinician, or may have come from laboratory, pharmacy, or other systems. Output to the clinician may come in the form of a recommendation or alert at the time of order entry, or, if the alert was triggered after the initial order was entered, systems of email and wireless notification have been employed[4,6,9].

II. METHOD

Clinical decision support system (CDSS) is a model of computing implementation in the medical field. In data processing CDSS has various methods or algorithms. As in general, a CDSS computing system generally consists of input data, data processing and data output. Algorithms used in CDSS include:

A. Principle Component Analysis (PCA)

Principal Component Analysis is method of dimension reduction in feature extraction group (transformation). This method performs the reduction by transforming data into a new dimension. Following the method algorithm. Calculate the covariance matrix of the data by using equation 1 below [1, 3]:

$$cov\ (xy) = \frac{\sum xy}{n} - (\bar{x})(\bar{y}) \quad (1)$$

The results of the PCA is having a new variable which have different dimension to the original variable. To determine the variables which included in the newvariable (principle component) done by rotate the factors using varimax vector [1].

B. Support Vector machine

Support Vector Machine (SVM) is a technique for making predictions, both in the case of classification and regression. SVM has a basic principle of linear classifier, which is a classification case that can be linearly separated, but SVM has been developed so that it can work on non linear problems by incorporating the concept of the kernel in a high dimensional workspace. Initially, SVM was developed for the problem of class classification of two classes, then later developed for multiclassical classification [1.3].

C. Naïve Bayes Algorithm

Bayesian classification is a statistical classification that can be used to predict the probability of membership of a class. Bayesian classification is based on the Bayes theorem which has the ability of classification similar to decesion trees and neural networks. Bayesian classification is proven to have high accuracy and speed when applied to databases with large data. The Bayes Method is a statistical approach toinduction inference on classification problems. First discussed about the basic concepts and definitions in the Bayes Theorem, then using thistheorem to classify inData Mining [2,5]. Bayes theorem has the following general form [2]:

$$P(H|X) = \frac{P(X|H)P(H)}{P(X)} \quad (2)$$

D. Case Base Recommendation

Case based recommenders implement a particular style of content-based recommendation, distinguished by Product representation, Similarity and Specialised feature level similarity knowledge. There are two main classes of recommender system: those that employ collaborative approaches and those that employ case-based approaches. Collaborative approaches exploit user histories, usually in the form of ratings-based profiles. Recommendations come from the profiles of the active user's recommendation partners. The partners are users whose ratings correlate closely with the active user's ratings. A collaborative recommender will recommend items that are not already in the active user's profile but which her partners have rated highly [4,9].

E. Fuzzy System

Fuzzy system is developed by fuzzy logics. Fuzzy logic is a methodology of counting with variable words instead of counting with numbers, the truth value depends on the members they have. The degree of membership in fuzzy has a range of values between 0 (zero) to 1 (one). This is different from the strict set which has a value of 1 or 0 (yes or no). Fuzzy logic is very easy to apply because it is flexible and can be based on human logic with language that is often used daily [6. 8, 10].

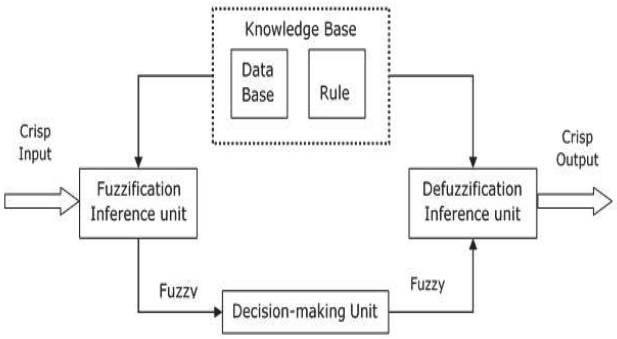

Fig. 1. Fuzzy Inference System [8]

F. Ontology Reasoning

Ontologies are set to play a key role in the Semantic Webby providing a source of shared and precisely defined terms that can be used in descriptions of web resources. Reasoning over such descriptions will be essential if web resources are to be more accessible to automated processes [7,9].

G. Artificial Neural network

Artificial Neural Network (ANN) is an information system processor with certain characteristics and performance that is

close to biological nerves. The neural network is one of the artificial representations of the human brain. This is because information processing is located in a neuron that has a signal. Each input and output neuron has a hidden layer [8].

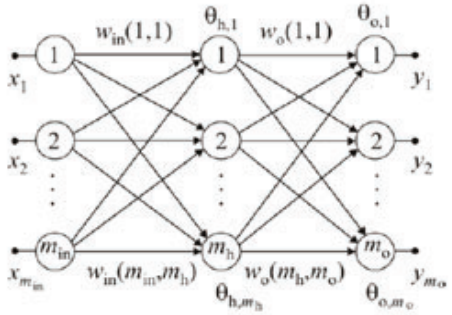

Fig. 2. ANN Architecture [8]

H. Genetic Algorithms

Genetic algorithm (or GA) is a search technique used in computing to find true or approximate solutions to optimization and search problems. This algorithm are are categorized as global search heuristics and particular class of evolutionary algorithms that use techniques inspired by evolutionary biology such as inheritance, mutation, selection, and crossover (also called recombination) [8].

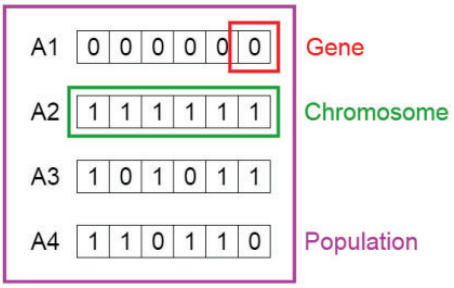

Fig. 3. Genetic Algorithms [8]

I. Decisision Tree learning

Decision tree is a flowchart structure that has a tree (tree), where each internal node indicates a test attribute, each branch represents a test result, and a leaf node represents a class or class distribution. The path in the decision tree is traced from node to root to the leaf node that holds the class prediction. Decision tree is one of the methods used for classification and prediction because it has the ease of interpreting results [10].

III. RESULT

Cardiovascular diseases (CVDs), especially heart and stroke diseases are major causes of disability and premature death throughout the world, and substantially to the escalating costs of health care [11]. The World Health Statistics 2012 reports enlighten the fact that one in three adults world-wide has raised blood pressure–a condition that causes around half of all deaths from stroke and heart disease.WHO estimated by 2030, almost 23.6 million will die due to Heart disease [2].Death from cardiovascular disease in 2014 in Indonesia is around 35% or around 1.8 million cases [1].

CDSS is used for heart and stroke diseases detection and prediction. It uses several methods namely Principle Component Analysis (PCA), Support VectorMachine (SVM), Naïve Bayes data mining algorithm, Case Based Recommendation Algorithm, Weighted Fuzzy Rules, Ontology Reasoning, TOPSIS Analysis, Genetic Algorithms, Fuzzy Neural network, Case-based reasoning (CBR), Weighted Fuzzy Rules and Decision Tree.

From 10 articles related to CDSS such as table 1 above, it can be seen that the CDSS for heart and stroke diseases use variety of algorithms and methods.

IV. CONCLUSION

CDSS is a paradigm or computational model used in decision support in medical fields..The computational methods and rules used in CDSS are Principle Component Analysis (PCA), Support Vector Machine (SVM), Naïve Bayes data mining algorithm, Case Based Recommendation Algorithm, Weighted Fuzzy Rules, Ontology Reasoning, TOPSIS Analysis, Genetic Algorithms, Fuzzy Neural network, Case-based reasoning (CBR), Weighted Fuzzy Rules and Decision Tree.

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TABLE 1. IMPLEMENTATION CDSS IN HEART AND STROKE DISEASES

AUTHOR	USING	METHODS
WihartoWiharto, Hari Kusnantoand HeriantoHerianto (2017) [1]	• **Principle Component Analysis(PCA)** for dimension reduction • **Support Vector Machine(SVM)** for Clasification • **Cross Validation** for validation	Data collection**,** reprocessing**,** classifcation **and** analysis of the testingresults**.**
D Ratnam, P HimaBindu, V.Mallik Sai, S.P.Rama Devi, P.Raghavendra Rao (2014) [2]	**Naïve Bayes** **data mining algorithm**	Knowledge base, decision support, Clasification and extract hiden knowledge. of database.
Gagankumar and RohitKalra (2016) [3]	**Principal Component Analysis (PCA)** and **Support Vector Machine (SVM).**	Selecting and pre-processing data set, normalizing, applying PCA for dimensionality reduction, K-fold for selecting training and testing set and SVM as binary classifier.
Prinsha Prakash [4]	**Case Based Recommendation Algorithm**	Retrieve,reuse, revise and retain.
Ximeng Liu, Rongxing Lu, Jianfeng Ma, Le Chen, and Baodong Qin (2014) [5]	**Naive Bayesian classification**	Trusted Authority (TA), Cloud Platform (CP), Data Provider (DP), Processing Unit (PU), and Undiagnosed Patient (PA).
P.K Anooj (2012) [6]	**Weighted Fuzzy Rules**	(1) Automated approach for the generation of weighted fuzzy rules and (2) Developing a fuzzy rule-based decision support system.
Rung-Ching Chen, Hui Qin Jiang, Chung-Yi Huang, and Cho-TsanBau [7]	**Ontology** **Reasoning and TOPSIS Analysis**	Knowledge base, target inference, ontology and reasoning.
RupaliWagh and S. S. Paygude (2016) [8]	**Genetic Algorithms and Fuzzy Neural network**	Diagnosing heart disease, non-linear problem neuro –fuzzy system (NFS), conventional computer programming or statistical method.
Shaker El-Sappagh and Mohammed Elmogy (2016) [9]	**Case-based reasoning (CBR) and formal ontologies**	Case-based reasoning (CBR), formal ontologies standard medical ontologies and healthcare system.
Padmakumari K. N. Anooj (2011) [10]	**Weighted Fuzzy Rules and Decision Tree**	The medical expert's opinion, machine learning techniques gain knowledge automatically, a weighted fuzzy rule-based clinical decision support system (CDSS)