IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

ANALYSIS ACCURACY AND PERFORMANCE OF DATA MINING TECHNIQUES IN HEALTHCARE

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ABSTRACT

Data mining is growing technique in disparate research fields due to its limitless approaches and applications to mining the data in an targeted manner. Owing to the changes, the current world acquiring, it is one of the optimize technique (approach) for predicting future result and its analysis. With advanced researches in healthcare sector monstrous of data are available, but the main difficulty is how to make cultivate the existing information into a useful practices. To solve this barrier the concept of data mining is introduced and it best technique suited. Data mining have a great potential to enable healthcare systems more efficiently and effectively by using its data. Hence, it improves care of patient and reduces costs involve. This paper analysis various Data Mining techniques such as classification, association, healthcare, clustering and regression discussed. In this paper it also highlights applications, challenges and future work of Data Mining in healthcare.

KEYWORDS: Data   Mining,   Classification,   Clustering,   Association, Healthcare, Knowledge discovery

INTRODUCTION

In the early 1975's, the storage of data or information was very much. But Because of the advancement in the field of information gathering tools or technique and priceless work WWW in the last twenty-five years, data now easily stored electronically and easy to extracted information in the form of knowledge become easy because of data mining techniques.

A database required to store a large amount of data, which is continuously and rapidly increasing. This information's will be very useful in decision making process in any field. Data mining is the process of extracting the useful information from a extremely large collection of data which was previously unknown [1]. A number of relationships are hidden among such collection of data. For example, a relationship Between patients and no. of days stayed. [2].

With the help of figure 1 five stages are identified in knowledge discovery process [3, 4, and 5].

Which the system identified are interpreted into knowledge in this level or stage.

Data mining steps:

First, **Selection** data is selected on the behalf of some criteria in this stage. For example, a bicycle owns by all those people, we can determine subsets of data in this way.

Second, in the **preprocessing** stage removes all the information which is actually not necessary in data. It is also known as data cleansing stage.

Third, in **transformation** stage only those useful data extracted which is use in particular research. for example only data related to a particular demography is very useful in market research area.

Fourth, It is a stage knowledge discovery process. This stage is useful for extracting the meaningful patterns from data from large data.

The meaningful patterns analyses s is used for making useful decisions.

Role of Data Mining in Healthcare

Usually all the healthcare companies maintained and stored their data in electronic formats across the world. Like Patients and parties involved in healthcare industries. The storage of healthcare type of data is increased at a very rapidly now-a-days. Electronic data increasing rapidly, In other words, we can say that healthcare data becomes very complex and difficult to store. By using the traditional methods it become difficult to extract the meaningful information or knowledge from it. But due to huge advancement in field of data mining of statistics, mathematics and very other disciplines it is now possible to extract the meaningful patterns from it. Data mining is useful to analyze and generate knowledge from healthcare data.

Data Mining normally extracts the useful patterns/knowledge which was previously not known. These patterns can be integrated into the knowledge and with the help of this knowledge use to take essential decisions can becomes possible now. A lot of benefits are provided by the data mining. Some of them are as follows: it plays a very important role in investigation of   detection of fraud and abuse, provides better medical treatments, detection of diseases at earliest possible stages, intelligent healthcare decision support system by using data mining techniques, etc [2]. Due to all these reasons researchers are greatly influenced and invest time and money because of the capabilities of data mining. In the healthcare field researchers widely used the data mining techniques. There are various techniques of data mining. Some of them are classification, clustering, regression, etc. Each and every medical information related to patient as well as to healthcare organizations is useful. Now-a-days researchers uses data mining tools in distributed medical environment to provide better medical services to a large proportion of population at a very low cost, better customer service and relationship management, better and optimize management of healthcare resources.

TECHNIQUES OF DATA MINING
Classification
Classification is one of the most popularly used methods of Data Mining in Healthcare sector. It divides data samples into target classes by classify dataset. The classification technique predicts the target class for each data points. With the help of classification approach a risk factor can be associated to patients by analyzing their patterns of diseases. It is a supervised learning approach having known class categories. Binary and multilevel are the two methods of classification. In binary classification, only two possible classes such as, "high" or "low" risk patient may be considered while the multiclass approach has more than two targets for example, "high", "medium" and "low" risk patient. Data set is partitioned as training and testing dataset. It consists of predicting a certain outcome based on a given input. Training set is the algorithm which consists of a set of attributes in order to predict the outcome. In order to predict the outcome it attempts to discover the relationship between attributes. Goal or prediction is its outcome. There is another algorithm known as prediction set. It consists of same set of attributes as that of training set. But in prediction set, prediction attribute is yet to be known. In order to process, the prediction it mainly analyses the input. The term which defines how "good" the algorithm is its accuracy. Consider a medical database of Pawti Medical Center, training set consists all the information regarding patient which were recorded previously. Whether a patient had a heart problem or not is the prediction attribute there. With the help of table 1 given below we demonstrates the training sets of such database.

Table 1 – TRAINING AND PREDICTION FOR MEDICAL DATABASE

Training Set

Age	Heart rate	Blood pressure	Heart problem
45	75	140/64	Yes
29	83	101/60	No
35	69	105/57	No

Prediction Set

Age	Heart rate	Blood pressure	Heart problem
33	89	142/82	?
45	52	102/56	?
87	83	138/61	?

In order to use the knowledge, classification predicts rules used. Prediction rules are divided the data in the form of IF-THEN rules. With the help of above example, a rule predicting the first row in the training set may be represented as follows:

IF (Age=45 AND Heart Rate>75) OR (Age>44 AND Blood pressure>139/60) THEN Heart problem=yes
   Else Heart problem=no.

Following are the various classification algorithms used in healthcare:

K-Nearest Neighbor (KNN)

K-Nearest Neighbor (K-NN) classifier is one of the simplest and easiest classifier that discovers the unidentified data point using the previously known data points (nearest neighbor) and classified data points according to the voting system which is used to classify the data [6]. Consider there are various objects. It would be surely beneficial for us if we know the characteristics features of one of the objects in order to predict it for its nearest neighbors because nearest neighbor objects have similar characteristics. The majority votes of K-NN can play a very important role in order to classify any new instance, where k is any positive integer (small number). It is one of the most simple data mining techniques. It is mainly known as Memory-based classification because at run time training examples must always be in memory [32]. Euclidean distance is calculated when we take the difference between the attributes in case of continuous attributes. But it suffers from a very serious problem when large values bear down the smaller ones. Continuous attributes must be normalized in order to take over this major problem so that they have same influence on the distance measure between distances [33].

K-NN has a number of applications in different areas such as health datasets, image field, cluster analysis, pattern recognition, online marketing *etc*. There are various advantages of KNN classifiers. These are: ease, efficacy, intuitiveness and competitive classification performance in many domains. If the training data is large then it is effective and it is robust to noisy training data. A main disadvantage of KNN classifiers is the large memory requirement needed to store the whole sample. If there is a big sample then its response time on a sequential computer will also large.

Decision Tree (DT)

DT is considered to be one of the most popular approaches for representing classifier. We can construct a decision tree by using available data which can deal with the problems related to various research areas. It is equivalent to the flowchart in which every non-leaf nodes denotes a test on a particular attribute and every branch denotes an outcome of that test and every leaf node have a class label. Root node is the top most node of a decision tree. For example, with the help of medical readmission decision tree we can decide whether a particular patient requires readmission or not. Knowledge of domain is not required for building decision regarding any problem. The most common use of Decision Tree is in operations research analysis for calculating conditional probabilities [34]. Using Decision Tree, decision makers can choose best alternative and traversal from root to leaf indicates unique class separation based on maximum information gain [35]. Decision Tree is widely used by many researchers in healthcare field. Several advantages of decision tree as follows: Decision trees are self–explanatory and when compacted they are also easy to follow. Even set of rules can also be constructed with the help of decision trees. Hence, representation of decision tree plays a very important role in order to represent any discrete-value classifier because it can be capable to handle both type of attributes, nominal as well as numeric input attributes. If any datasets have missing or erroneous values, such type of datasets can be easily handled by decision trees. Due to this reason decision tree can be considered to be nonparametric method. The meaning of above sentence is that there is no need to make assumptions regarding distribution of space and structure of classifier. Decision trees have several disadvantages. These are as follows: Most of the algorithms (like ID3 and C4.5) require that the target attributes have only discrete values because decision trees use the divide and conquer method. If there are more complex interactions among attributes exist then performance of decision trees is low. Their performance is better only when there exist a few highly relevant attributes. One of the reasons for this is that other classifiers can compactly describe a classifier that would be very challenging to represent using a decision tree. A simple illustration of this phenomenon is replication problem of decision trees [36], and the greedy characteristic of decision trees leads to another disadvantage. This is its over-sensitivity to the training set, irreverent attributes and to noise [37].

Support Vector Machine (SVM)

Vapnik *et al.* [38- 39] was the first one who gave the notion of SVM. Among all the available algorithms it provides

very accurate results. It is gaining popularity because it can be easily extended to problems related to multiclass though it was mainly developed for problems related to binary classification [40-41]. In order to be useful for various effective and efficient tasks it is capable of creating single as well as multiple hyper planes in high dimensional space. The main aim of creating hyper plane by SVM in order to separate the data points. There are two ways of implementing SVM. The first technique employs mathematical programming and second technique involves kernel functions. With the help of training datasets non linear functions can be easily mapped to high dimensional space. Such situation can only be possible when we use kernel functions. Gaussian, polynomial, sigmoid etc. are some examples of kernel functions. For the classification of data points hyper plane is used. The primary task of hyper plane is to maximize the separation between data points. Support vectors are used in order to construct the hyper plane. There are various advantages of SVM. Some of them as follow: First one is that, it is effective in high dimensional spaces. Another one is that, it is effective in cases where number of dimensions is greater than the number of samples. Third one is that, it is memory efficient because it uses a subset of training points in the decision function (called support vectors), and next is that, it is versatile because different kernel functions can be specified for the decision function. Some of the disadvantages of SVM as follow: First one is that, if the number of features is much greater than number of samples then SVM is more likely to give poor performances, and the one is that, it does not directly provide probability estimates. These are calculated using an expansive five –fold cross-validation.

Neural Network (NN)

In the early 20th century it was developed [42]. Before the introduction of decision trees and the Support Vector Machine (SVM) it was regarded as the best classification algorithm which is far better result and techniques as compare to previous data [43]. This was one of the reasons which automatically encouraged NN as the most widely used classification algorithm in various biomedicine and healthcare fields and data classification [44, 45, and 46]. For example, NN has been widely used as the algorithm supporting the diagnosis of diseases including cancers, MRI [47-51] and predict outcomes [52-54]. In NN, basic elements are neurons or nodes. These neurons are interconnected and within the network they worked together in parallel in order to produce the output functions. From existing observations they are capable to produce new observations even in those situations where some neurons or nodes within the network fails or go down due to their capability of working in parallel. An activation number is associated to each neuron and a weight is assigned to each edge within a neural network. In order to perform the tasks of classification and pattern recognition neural network is mainly used [55]. The basic property of an NN is that it can minimize the error by adjusting its weight and by making changes in its structure. It minimizes the error only due to its adaptive nature. NN are capable to produce predictions of greater accuracy. One of the major advantages of NN is that it can properly handle noisy data for training and can reasonably classify new types of data that is different from training data. There are also various disadvantages of NN. First is that it requires many parameters, including the optimum number of hidden layer nodes that are empirically determined, and its classification performance is very sensitive to the parameters selected [56]. Second is that its training or learning process is very slow and computationally very expensive.

Bayesian Methods or Bayesian algorithm

For Bayesian method probabilistic learning method of classification is used. With the help of these classification algorithm we can easily obtained result [6]. Bayes theorem of statistics a very important algorithm in the field of data mining and play a very important role in it. While in medical domain attributes such as patient symptoms and their health state are correlated with each other but Naïve Bayes Classifier assumes that all attributes are independent with each other. This is the major disadvantage with Naïve Bayes Classifier. If attributes are independent with each other then Naïve Bayesian classifier has shown great performance in terms of accuracy. In healthcare field they play very important roles. Hence, researchers across the world used them there are various advantages of BBN. One of them is that it helps to makes computation process very easy. Another one is that for huge datasets it has better speed and accuracy.

Regression

Regression is very important technique of data mining. With the help of it, we can easily identify those functions that are useful in order to demonstrates the correlation among different various variables. It is mainly a mathematical tool. With the help of training dataset we can easily construct it.

Consider two variables 'P' and 'Q'. These two types of variables are mainly used in the field of statistics. One of them is known as dependent and another one is independent variables. The maximum number of dependent variables cannot

be more than one while independent can be exceeds one. Regression is mostly used in order to inspect the certain relationship between variables. With the help of regression technique we can easily entrenched the addiction of one variable upon others [85]. Regression can be classified into linear and non-linear on the basis of certain count of independent variables. In order to appraisal associations between two types of variables in which one is dependent variable and another one is independent variables (one or more), linear regression used. In order to construct the linear model, linear function is utilized by linear regression. But there is limitation while we use linear approach because both types of variables are known already and hence, its main purpose is to trace a line that correlates between both these variables [86]. We cannot use linear regression for categorized data. It is restricted only to numerical data. With the help of logistic regression the categorical data can be used. Such type of data is used by non-linear regression and logistic regression is basically a type of non-linear regression. Logistic regression with the help of logit function can predict the probability of occurrence. However, between variables logistic regression cannot consider linear relationship [87]. Due to all these reasons regression is widely used in medical field for predicting the diseases or survivability of a patient.

Regression Examples in Healthcare
Divya *et al.,* proposed Weighted Support Vector Regression (WSVR) which used weight factor on the basis of sensor reading for providing continuous monitoring to patients in order to provide them better healthcare services. In this research, on the basis of experimental result, it has been found that the proposed approach had better accuracy than simple vector regression [88].

Logistic regression for the estimation of relative risk for various medical conditions such as Diabetes, Angina, stroke etc [89].

Xie *et al.,* proposed a regression decision tree algorithm in order to predict the number of hospitalization days in a population. Proposed algorithm was developed using extensive health insurance claims data sets. Experimental

results displayed that proposed algorithm was performed significantly in general population as well as in sub-populations in order to predict future hospitalization [90].

Alapont *et al.,* used WEKA for different learning methods like Linear Regression, LeastMedSq, SMOreg, Multilayer Perception, KStart, Tree M5P etc. In the research, experiments were carried out using 10-fold cross validation. After experiments were carried out, it has been found that Linear Regression and Tree M5P gave best results for the effective utilization of hospital resources, improved hospital ranking and better customer relationship services [91].

Clustering technique in data mining
Clustering is defined as unsupervised learning that occurs by observing only independent variables while supervised learning analyzing both independent and dependent variables. It is different from classification which is a supervised learning method. It has no predefined classes. Because of this reason, clustering may be best used for studies of an exploratory nature, mainly if those studies encompass large amount of data, but not very much known about data (such as mass of data generated by microarray analysis). The goal of clustering is descriptive while goal of classification is predictive (Veyssieres and Plant, 1998). The main task of unsupervised learning method means clustering method is to form the clusters from large database on the basis of similarity measure [6]. The goal of clustering is to discover a new set of categories, the new groups are of interest in themselves, and their assessment is intrinsic. In classification tasks, an important part of the assessment is extrinsic. Clustering partitioned the data points based on the similarity measure [6]. Clustering groups data instances into subsets in such a manner that similar instances are grouped together, while different instances belongs to different groups. Clustering approach is used to identify similarities between data points. Each data points within the same cluster are having greater similarity as compare to the data points belongs to other cluster. Clustering of objects is as ancient as the human need for describing the salient characteristics of men and objects and identifying them with a type. Therefore, it grasp various scientific disciplines: from mathematics and statistics to biology and genetics, each of which uses different terms to describe the topologies formed using this analysis. From biological "taxonomies", to medical "syndromes" and genetic "genotypes" to manufacturing "group technology"— the problem is identical: forming categories of entities and assigning individuals to the proper groups within it. Following are the various clustering algorithms used in healthcare:

Partitional Clustering

The maximum number of data points in the datasets is 'n'. With the help of 'n' data points the maximum possible number of 'k' clusters is obtained. In order to obtained the 'k' clusters from 'n' data points partitional clustering method is used. In this method, each 'n' data points is relates to one and only 'k' clusters while each 'k' clusters can relates to more than 'n' data points. Partitional clustering algorithms require a user to input k, (which is the number of clusters). Generally, partitional algorithms directly relocate objects to k clusters. Partitional algorithms are categorized according to how they relocate objects, how they select a cluster centroid (or representative) among objects within a (incomplete) cluster, and how they measure similarities between objects and cluster centroids. Before we obtained the clusters this method requires to define the required number of cluster which we may have to obtained from datasets. On the basis of similarities between objects and cluster centroids this method is partitioned into two categories. These are K-means and K-Mediods. One of the most popular algorithms of this approach is K-means [3]. First of all it randomly selects k objects and then decomposes these objects into k disjoint groups by iteratively relocating objects based on the similarity between the centroids and objects [92, 93]. In k-means, a cluster centriod is mean value of objects in the cluster. The next algorithm is K-mediods. In order to group the cluster it used mediods. Mediod is very important because in the database it is that data point which is most centrally located. In order to improve the healthcare services related to public healthcare domain Lenert *et al.*, utilize the application of k-means clustering [94] and by using the clustering technique Belciug *et al.* detect the recurrence of breast cancer [95]. Escudero *et al.*, used the concept of Bioprofile and K-means clustering for early detection of Alzheimer's disease [96]. The major advantage of partitional clustering algorithms is their superior clustering accuracy as compared with hierarchal clustering algorithms that is the result of their global optimization strategy (i.e., the recursive relocations of objects) [97,98]. Another advantage is, partitional algorithms can handle large data sets which hierarchal algorithms cannot (i.e., better scalability) and can more quickly cluster data [97, 98]. In other words we can say that, partitional algorithms are more effective and efficient than hierarchical algorithms. One major drawback to the use of partitional algorithms is that their clustering results depend on the initial cluster centroids to some degree because the centroids are randomly selected. Each time when partitioned algorithms run different clustering results are obtained.

Hierarchical Clustering

In order to partition the data points this method can be used two approaches. Data points can be partitioned in a tree way known as hierarchical way by using either top down or bottom up approaches. On the basis of partitioned process this method can be classified as Agglomerative and Divisive. The maximum number of data points can be n. A number of data points among n data points may have similarity with each other. The main aim of agglomerative approach is to merge such data points into a single group [3]. Divisive approach initially takes this single group and iteratively partitioned it into smaller group until and unless each data point relates to one and only one cluster [3]. There are three types of hierarchical clustering algorithms: First one is single-link, another one is complete-link, and the last one is average-link. The single-link clustering algorithm select the closet pair of objects from two groups and measure the similarity between objects as group similarity. The complete-link algorithm calculates the similarity between the most distant pair of objects from two groups. The average-link algorithm selects all pairs of objects from two groups and averages all possible distances between objects. The most similar two groups, those having the shortest distance are merged together after calculating similarities or distances between groups. Among the various hierarchical algorithms the average-link algorithm provides the best accuracy in most cases [97]. A main advantage of the use of hierarchical clustering algorithms is the visualization capability that shows how much objects in the data set are similar one another. In addition, with the utilization of a dendrogram, researchers can reasonably guess the number of clusters. This is a distinguishing feature of hierarchical algorithms because other clustering algorithms cannot provide this very useful feature, especially when there is no additional information available about the data itself.

Density Based Clustering

Density based clustering methods play a very important role in biomedical research because they are capable of handle any cluster of arbitrary shape. Recent researches prove that this method can be efficiently and effectively beneficial in order to extract the meaningful patterns from a very large database which mainly consist biomedical images. Besides density based clustering method, partitional clustering and hierarchical clustering methods do not extract the meaningful patterns from biomedical images database because these two methods are capable to handle only the clusters of spherical shape not the clusters of arbitrary shape. To remove the problem of patitional clustering and

hierarchical clustering methods density based clustering method evolved. On the basis of density distribution function following are the main approaches of density based clustering: DBSCAN, OPTICS, and DENCLUE [3]. Celebi *et al.,* used density based clustering approach in order to obtained the useful patterns from a very large biomedical images database. These patterns play a very important role in order to determine homogeneous colour [99]. There are various advantages of the density based clustering. First one is that in density based clustering approach in advance the number of clusters does not required. Another one is that, it can easily handle the clusters of any arbitrary shape. And the last one is that it can be used very effectively and efficiently even in noisy situations. In other words it is performed equally well in noisy situations. One major disadvantage of density based clustering is that, if there is a lot of variation in densities along with data points then it cannot be able to handle such variations in data points. Another one disadvantage is that, distance measure is the primary factor which calculates its result.

DATA MINING CHALLENGES IN HEALTHCARE
As we know that a lot of healthcare data is generated and stored by various healthcare organizations. But there are various challenges related to healthcare data which may play serious hurdles in the making proper decisions. The first challenge with healthcare data is the format of data being stored is different in different healthcare organizations. Till date there is no standard format is laid down for data being stored. In epidemic situations this lack of standard format can make the epidemic situations even more worse. Suppose that an epidemic disease is spread within a country at its different geographical regions. The country health ministry requires that all the healthcare organizations must share their healthcare data with its centralized data warehouse for analysis in order to take all the essential steps so that epidemic situation may get resolve. But since the formats of data is different. Hence, the analysis of data may take longer time than usual. Due to this it may be possible that the situation may become out of control. The healthcare data is very useful in order to extract the meaningful information from it for improving the healthcare services for the patients. To do this quality of data is very important because we cannot extract the meaningful information from that data which have no quality. Hence, the quality of data is another very important challenge. The quality of data depends on various factors such as removal of noisy data, free from missing of data etc. All the necessary steps must be taken in order to maintain the quality in healthcare data. Data sharing is another major challenge. Neither patients nor healthcare organizations are interested in sharing of their private data. Due to this the epidemic situations may get worse, planning to provide better treatments for a large population may not be possible, and difficulty in the detection of fraud and abuse in healthcare insurance companies etc. Another challenge is that in order to build the data warehouse where all the healthcare organizations within a country share their data is very costly and time consuming process.

CONCLUSION AND FUTURE WORK
For above define and discussed algorithm its accuracy, working efficiency and performance is of greater importance. But due to presence of some factors in every algorithm can greatly lost the above discussed property of accuracy and performance of the algorithm. Classification one of the algorithm which is also belongs to such an algorithm. Classification algorithm is very sensitive toward noisy data. If there is any noisy data is present in dataset then it causes very serious problems regarding to the processing power of classification. It not only slows down the task of classification algorithm of that data but also degrades its performance. Hence, In any case before applying classification algorithm it must be necessary to remove all those attributes from datasets who later on acts as noisy attributes in the datasets. Feature selection methods play is also a very important method. It creates a platform for classification. Important role in order to select those attributes who improves the performance of classification algorithm.

Clustering techniques are very useful especially in pattern recognitions and classification. But sometime they suffer from a problem on choosing the right algorithm because regarding datasets they do not have information before. We can choose partitioned algorithm only when we know the number of clusters. Hierarchical clustering is used even when we do not know about the number of clusters. Hierarchical clustering provides better performance when there is less datasets but as soon as volume of datasets increases its performance degrades. To overcome this problem random sampling is very beneficial.

In hierarchical clustering, if the data is too large to be presented in a dendrogram, the visualization capability is very

poor. One possible solution to this problem is to randomly sample the data so that users can properly understand the overall grouping/similarity of the data given dataset using the dendrogram that is generated with the sampled data. The main drawback to the use of hierarchical clustering algorithms is cubic time complexity. This complexity is such that the algorithms are very much limited for very large data sets. As the result, the hierarchical algorithms are much slower (in computational time) than partitioned clustering algorithms. They also use a huge amount of system memory to calculate distances between objects.

The privacy regarding to patient's confidential information is very important. Such type of privacy may be lost during sharing of data in distributed healthcare environment. Necessary steps must be taken in order to provide proper security so that their confidential information must not be accessed by any unauthorized organizations. But in situations like epidemic, planning better healthcare services for a very large population etc. some confidential data may be provided to the researchers and government organizations or any authorized organizations.

In order to achieve better accuracy in the prediction of diseases, improving survivability rate regarding serious death related problems etc. various data mining techniques must be used in combination.

To achieve medical data of higher quality all the necessary steps must be taken in order to build the better medical information systems which provides accurate information regarding to patients medical history rather than the information regarding to their billing invoices. Because high quality healthcare data is useful for providing better medical services only to the patients but also to the healthcare organizations or any other organizations who are involved in healthcare industry.

Takes all necessary steps in order to minimize the semantic gap in data sharing between distributed healthcare databases environment so that meaningful patterns can be obtained. These patterns can be very useful in order to improve the treatment effectiveness services, to better detection of fraud and abuse, improved customer relationship management across the world.

REFERENCES

[1] D. Hand, H. Mannila and P. Smyth, "Principles of data mining", MIT, **(2001)**.
[2] H. C. Koh and G. Tan, "Data Mining Application in Healthcare", Journal of Healthcare Information Management, vol. 19, no. 2, **(2005)**
[3] U. Fayyad, G. Piatetsky-Shapiro and P. Smyth, "The KDD process of extracting useful knowledge form volumes of data.commun.", ACM, vol. 39, no. 11, **(1996)**, pp. 27-34.
[4] J. Han and M. Kamber, "Data mining: concepts and techniques", 2nd ed. The Morgan Kaufmann Series, **(2006)**.
[5] U. Fayyad, G. Piatetsky-Shapiro and P. Smyth, "From data mining to knowledge discovery in databases", Commun. ACM, vol. 39, no. 11, **(1996)**, pp. 24-26.
[6] C. McGregor, C. Christina and J. Andrew, "A process mining driven framework for clinical guideline improvement in critical care", Learning from Medical Data Streams 13th Conference on Artificial Intelligence in Medicine (LEMEDS). http://ceur-ws. org, vol. 765, **(2012)**.
[7] P. R. Harper, "A review and comparison of classification algorithms for medical decision making", Health Policy, vol. 71, **(2005)**, pp. 315-331.
[8] V. S. Stel, S. M. Pluijm, D. J. Deeg, J. H. Smit, L. M. Bouter and P. Lips, "A classification tree for predicting recurrent falling in community-dwelling older persons", J. Am. Geriatr. Soc., vol. 51, **(2003)**, pp. 1356-1364.
[9] R. Bellazzi and B. Zupan, "Predictive data mining in clinical medicine: current issues and guidelines", Int. J. Med. Inform., vol. 77, **(2008)**, pp. 81-97.
[10] R. D. Canlas Jr., "Data Mining in Healthcare:Current Applications and Issues", **(2009)**.
[11] F. Hosseinkhah, H. Ashktorab, R. Veen, M. M. Owrang O., "Challenges in Data Mining on Medical Databases", IGI Global, **(2009)**, pp. 502-511.
[12] M. Kumari and S. Godara, "Comparative Study of Data Mining Classification Methods in Cardiovascular Disease Prediction", IJCST ISSN: 2229- 4333, vol. 2, no. 2, **(2011)** June.

[13] J. Soni, U. Ansari, D. Sharma and S. Soni, "Predictive Data Mining for Medical Diagnosis: An Overview of Heart Disease Prediction", **(2011)**.

[14] C. S. Dangare and S. S. Apte, "Improved Study of Heart Disease Prediction System Using Data Mining Classification Techniques", **(2012)**.

[15] K. Srinivas, B. Kavihta Rani and Dr. A.Govrdhan, "Applications of Data Mining Techniques in Healthcare and Prediction of Heart Attacks", International Journal on Computer Science and Engineering, vol. 02, no. 02, **(2010)**, pp. 250-255.

[16] A. Aljumah, M. G.Ahamad and M. K. Siddiqui, "Predictive Analysis on Hypertension Treatment Using Data Mining Approach in Saudi Arabia", Intelligent Information Management, vol. 3, **(2011)**, pp. 252-261.

[17] D. Delen, "Analysis of cancer data: a data mining approach", **(2009)**.

[18] O. Osofisan, O. O. Adeyemo, B. A. Sawyerr and O. Eweje, "Prediction of Kidney Failure Using Artificial Neural Networks", **(2011)**.

[19] S. Floyd, "Data Mining Techniques for Prognosis in Pancreatic Cancer", **(2007)**.

[20] M.-J. Huang, M.-Y. Chen and S.-C. Lee, "Integrating data mining with case-based reasoning for chronic diseases prognosis and diagnosis", Expert Systems with Applications, vol. 32, **(2007)**, pp. 856-867.

[21] S. Gupta, D. Kumar and A. Sharma, "Data Mining Classification Techniques Applied For Breast Cancer Diagnosis And Prognosis", **(2011)**.

[22] K. S. Kavitha, K. V. Ramakrishnan and M. K. Singh, "Modeling and design of evolutionary neural network for heart disease detection", IJCSI International Journal of Computer Science Issues, ISSN (Online): 1694-0814, vol. 7, no. 5, **(2010)** September, pp. 272-283.

[23] S. H. Ha and S. H. Joo, "A Hybrid Data Mining Method for the Medical Classification of Chest Pain", International Journal of Computer and Information Engineering, vol. 4, no. 1, **(2010)**, pp. 33-38.

[24] R. Parvathi and S. Palaniammalì, "An Improved Medical Diagnosing Technique Using Spatial Association Rules", European Journal of Scientific Research ISSN 1450-216X, vol. 61, no. 1, **(2011)**, pp. 49-59.

[25] S. Chao and F. Wong, "An Incremental Decision Tree Learning Methodology Regarding Attributes in Medical Data Mining", **(2009)**.

[26] Habrard, M. Bernard and F. Jacquenet, "Multi-Relational Data Mining in Medical Databases", Springer-Verlag, **(2003)**.

[27] S. B. Patil and Y. S. Kumaraswamy, "Intelligent and Effective Heart Attack Prediction System Using Data Mining and Artificial Neural Network", European Journal of Scientific Research ISSN 1450-216X, © EuroJournals Publishing, Inc., vol. 31, no. 4, **(2009)**, pp. 642-656.

[28] A.Shukla, R. Tiwari, P. Kaur, Knowledge Based Approach for Diagnosis of Breast Cancer, IEEE International Advance Computing Conference,IACC 2009.

[29] L. Duan, W. N. Street & E. Xu, Healthcare information systems: data mining methods in the creation of a clinical recommender system, Enterprise Information Systems, 5:2, pp169-181 , 2011.

[30] D. S. Kumar, G. Sathyadevi and S. Sivanesh, "Decision Support System for Medical Diagnosis Using Data Mining", **(2011)**.

[31] S. Palaniappan and R. Awang, "Intelligent Heart Disease Prediction System Using Data Mining Techniques", **(2008)**.

[32] Alpaydin, E. (1997), Voting over Multiple Condensed Nearest Neighbors. Artificial Intelligence Review, p. 115–132.

[33] Bramer, M., (2007) Principles of data mining: Springer.

[34] Goharian & Grossman, Data Mining Classification, Illinois Institute of Technology, http://ir.iit.edu/~nazli/cs422/CS422-Slides/DM-Classification.pdf, **(2003)**.

[35] Apte & S.M. Weiss, Data Mining with Decision Trees and Decision Rules, T.J. Watson Research Center, http://www.research.ibm.com/dar/papers/pdf/fgcsaptewe issue_with_cover.pdf, **(1997)**.

[36] Pagallo, G. and Huassler, D., Boolean feature discovery in empirical learning, Machine Learning, 5(1): 71-99, 1990.

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

[38] V. Vapnik, "Statistical Learning Theory", Wiley, **(1998)**.

[39] V. Vapnik, "The support vector method of function estimation", **(1998)**.

[40] N. Chistianini and J. Shawe-Taylor, "An Introduction to Support Vector Machines, and other kernel-based learning methods", Cambridge University Press, **(2000)**.

[41] N. Cristianini and J. Shawe-Taylor, "An Introduction to Support Vector Machines", Cambridge University Press, **(2000)**.

[42] Anderson, J. A., and Davis, J., An introduction to neural networks. MIT, Cambride, 1995.

[43] Obenshain, M. K., Application of data mining techniques to healthcare data. Infect. Control Hosp. Epidemiol. 25(8):690–695, 2004.

[44] Bellazzi, R., and Zupan, B., Predictive data mining in clinical medicine: current issues and guidelines. Int. J. Med. Inform. 77:81–97, 2008.

[45] Übeyli, E. D., Comparison of different classification algorithms in clinical decision making. Expert syst 24(1):17–31, 2007.

[46] Kaur, H., and Wasan, S. K., Empirical study on applications of data mining techniques in healthcare. J. Comput. Sci. 2(2):194–200 2006.

[47] Romeo, M., Burden, F., Quinn, M., Wood, B., and McNaughton, D., Infrared microspectroscopy and artificial neural networks in the diagnosis of cervical cancer. Cell. Mol. Biol. (Noisy-le-Grand, France) 44(1):179, 1998.

[48] Ball, G., Mian, S., Holding, F., Allibone, R., Lowe, J., Ali, S., et al., An integrated approach utilizing artificial neural networks and SELDI mass spectrometry for the classification of human tumours and rapid identification of potential biomarkers. Bioinformatics 18(3):395–404, 2002.

[49] Aleynikov, S., and Micheli-Tzanakou, E., Classification of retinal damage by a neural network based system. J. Med. Syst. 22(3):129–136, 1998.

[50] Potter, R., Comparison of classification algorithms applied to breast cancer diagnosis and prognosis, advances in data mining,7th Industrial Conference, ICDM 2007, Leipzig, Germany, July 2007, pp.40–49.

[51] Kononenko, I., Bratko, I., and Kukar, M., Application of machine learning to medical diagnosis. Machine Learning and Data Mining: Methods and Applications 389:408, 1997.

[52] Sharma, A., and Roy, R. J., Design of a recognition system to predict movement during anesthesia. IEEE Trans. Biomed. Eng.44(6):505–511, 1997.

[53] Einstein, A. J., Wu, H. S., Sanchez, M., and Gil, J., Fractal characterization of chromatin appearance for diagnosis in breast cytology. J. Pathol. 185(4):366–381, 1998.

[54] Brickley, M., Shepherd, J. P., and Armstrong, R. A., Neural networks: a new technique for development of decision support systems in dentistry. J. Dent. 26(4):305– 309, 1998.

[55] M. H. Dunham, "Data mining introductory and advanced topics", Upper Saddle River, NJ: Pearson Education, Inc., **(2003)**.

[56] Schwarzer, G., Vach, W., and Schumacher, M., On the misuses of artificial neural networks for prognostic and diagnostic classification in oncology. Stat. Med. 19:541– 561, 2000.

[57] H. Hu, J. Li, A. Plank, H. Wang and G. Daggard, "A Comparative Study of Classification Methods For Microarray Data Analysis", Proc. Fifth Australasian Data Mining Conference (AusDM2006), Sydney, Australia. CRPIT, ACS, vol. 61, **(2006)**, pp. 33-37.

[58] R. Potter, "Comparison of classification algorithms applied to breast cancer diagnosis and prognosis", advances in data mining, 7th Industrial Conference, ICDM 2007, Leipzig, Germany, **(2007)** July, pp. 40-49.

[59] L. Huang, H. C. Liao and M. C. Chen, "Prediction model building and feature selection with support vector machines in breast cancer diagnosis", Expert Systems with Applications, vol. 34, **(2008)**, pp. 578-587.

[60] G. Beller, "The rising cost of health care in the United States: is it making the United States globally noncompetitive?", J. Nucl. Cardiol., vol. 15, no. 4, **(2008)**, pp. 481-482.

[61] M. U. Khan, J. P. Choi, H. Shin and M. Kim, "Predicting Breast Cancer Survivability Using Fuzzy Decision Trees for Personalized Healthcare", 30th Annual International IEEE EMBS Conference Vancouver, British Columbia, Canada, **(2008)** August 20-24.

[62] L. Chang and C. H. Chen, "Applying decision tree and neural network to increase quality of dermatologic diagnosis", Expert Systems with Applications, Elsevier, vol. 36, **(2009)**, pp. 4035-4041.

[63] R. Das, I. Turkoglub and A. Sengur, "Effective diagnosis of heart disease through neural networks ensembles", Expert Systems with Applications, vol. 36, **(2009)**, pp. 7675-7680.

[64] I. Curiac, G. Vasile, O. Banias, C. Volosencu and A. Albu, "Bayesian Network Model for Diagnosis of Psychiatric Diseases", Proceedings of the ITI 2009 31st Int. Conf. on Information Technology Interfaces, Cavtat, Croatia, **(2009)** June 22-25.

[65] K. F. R. Liu and C. F. Lu, "BBN-Based Decision Support for Health Risk Analysis", Fifth International Joint Conference on INC, IMS and IDC, **(2009)**.

[66] Avci, "A new intelligent diagnosis system for the heart valve diseases by using genetic-SVM classifier", Expert Systems with Applications, Elsevier, vol. 36, **(2009)**, pp. 10618-10626.

[67] S. Gunasundari and S. Baskar, "Application of Artificial Neural Network in identification of Lung Diseases", Nature & Biologically Inspired Computing, 2009. NaBIC 2009. World Congress on. IEEE, **(2009)**.

[68] S. Soni and O. P. Vyas, "Using Associative Classifiers for Predictive Analysis in Health Care Data Mining", International Journal of Computer Applications (0975 – 8887), vol. 4, no. 5, **(2010)** July.

[69] S. W. Fei, "Diagnostic study on arrhythmia cordis based on particle swarm optimization-based support vector machine", Expert Systems with Applications, Elsevier, vol. 37, **(2010)**, pp. 6748-6752.

[70] O. Er, N. Yumusakc and F. Temurtas, "Chest diseases diagnosis using artificial neural networks", Expert Systems with Applications, vol. 37, **(2010)**, pp. 7648-7655.

[71] Chuang, L.Y., Wu, K.C., Chang, H.W. and Yang, C.H. (2011) "Support Vector Machine-Based Prediction for Oral Cancer Using Four SNPs in DNA Repair Genes". Proceedings of the International Multi Conference of Engineers and Computer Scientists, Hong Kong,16-18 March 2011, 16-18.

[72] A. Bakar, Z. Kefli, S. Abdullah and M. Sahani, "Predictive Models for Dengue Outbreak Using Multiple Rulebase Classifiers", 2011 International Conference on Electrical Engineering and Informatics, Bandung, Indonesia, **(2011)** July 17-19.

[73] S. S. Moon, S. Y. Kang, W. Jitpitaklert and S. B. Kim, "Decision tree models for characterizing smoking patterns of older adults", Expert Systems with Applications, Elsevier, vol. 39, **(2012)**, pp. 445-451.

[74] H. Jena, C. C. Wang, B. C. Jiangc, Y. H. Chub and M. S. Chen, "Application of classification techniques on development an early-warning systemfor chronic illnesses", Expert Systems with Applications, vol. 39, **(2012)**, pp. 8852-8858.

[75] Chien and G. J. Pottie, "A Universal Hybrid Decision Tree Classifier Design for Human Activity Classification", 34th Annual International Conference of the IEEE EMBS San Diego, California USA, **(2012)** August 28-September 1.

[76] M. Shouman, T. Turner and R. Stocker, "Applying K-Nearest Neighbour in Diagnosing Heart Disease Patients", International Conference on Knowledge Discovery (ICKD-2012), **(2012)**.

[77] Y. Liu, H. L. Chen, B. Yang, X. E. Lv, N. L. Li and J. Liu, "Design of an Enhanced Fuzzy k-nearest Neighbor Classifier Based Computer Aided Diagnostic System for Thyroid Disease", Journal of Medical System, Springer, **(2012)**.

[78] Hattice and K. Metin, "A Diagnostic Software tool for Skin Diseases with Basic and Weighted K-NN", Innovations in Intelligent Systems and Applications (INISTA), **(2012)**.

[79] M. J. Abdi and D. Giveki, "Automatic detection of erythemato-squamous diseases using PSO–SVM based on association rules", Engineering Applications of Artificial Intelligence, vol. 26, **(2013)**, pp. 603-608.

[80] W. L. Zuoa, Z. Y. Wanga, T. Liua and H. L. Chenc, "Effective detection of Parkinson's disease using an adaptive fuzzy k-nearest neighbor approach", Biomedical Signal Processing and Control, Elsevier, **(2013)**, pp. 364-373.

[81] Rusdah and Edi Winarko, "Review on Data Mining Methods for Tuberculosis Diagnosis" Information Systems International Conference (ISICO), 2 – 4 December 2013.

[82] Marina Evrim Johnson and Nagen Nagarur, "Multi-stage methodology to detect health insurance claim fraud", Health Care Management Science, DOI 10.1007/s10729-015-9317-3, Springer, 20 January 2015.

[83] Johannes Arthuur Govaert, Anne Charlotte Madeline van Bommel, Wouter Antonie van Dijk, Nicoline Johanneke van Leersum, Robertus Alexandre Eduard Mattheus Tollenaar and Michael Wilhemus Jacobus Maria Wouters, "Reducing Healthcare Costs Facilitated by Surgical Auditing: A Systematic Review", Worls J Surg, DOI 10.1007/s00268-015-3005-9, Springer, 18 February 2015.

[84] Peng Z *et al.,* "An expression signature at diagnosis to estimate prostate cancer patients' overall survival", Prostate Cancer and Prostatic Disease (2014) 17, 81-90, doi 10.1038/pcan.2013.57; January 2014, Nature.

[85] J. Fox, "Applied Regression Analysis, Linear Models, and Related Methods", **(1997)**.

[86] Gennings, R. Ellis and J. K. Ritter, "Linking empirical estimates of body burden of environmental chemicals and wellness using NHANES data", http://dx.doi.org/10.1016/j.envint.2011.09.002,2011.

[87] P. A. Gutiérrez, C. Hervás-Martínez and F. J. Martínez- Estudillo, "Logistic Regression by Means of Evolutionary Radial Basis Function Neural Networks", IEEE Transactions on Neural Networks, vol. 22, no. 2, **(2011)**, pp. 246-263.

[88] Divya and S. Agarwal, "Weighted Support Vector Regression approach for Remote Healthcare monitoring", IEEE-International Conference on Recent Trends in Information Technology, ICRTIT 2011, 978-1-4577-0590-8/11/\$26.00 ©2011 IEEE MIT, Anna University, Chennai, **(2011)** June 3-5.

[89] Gennings, R. Ellis and J. K. Ritter, "Linking empirical estimates of body burden of environmental chemicals and wellness using NHANES data", http://dx.doi.org/10.1016/j.envint.2011.09.002,2011.

[90] Xie *et al., "*Predicting Days in Hospital Using Health Insurance Claims", IEEE Journal of Biomedical and Health Informatics, DOI 10.1109/JBHI.2015.2402692,ISSN 2168-291, IEEE Transactions, 2015.

[91] J. Alapont, A. Bella-Sanjuán, C. Ferri, J. Hernández-Orallo, J. D. Llopis-Llopis and M. J. Ramírez-Quintana, "Specialised Tools for Automating Data Mining for Hospital Management", http://www.dsic.upv.es/~abella/papers/HIS_DM.pdf, **(2005)**.

[92] K. Jain, M. N. Murty and P. J. Flynn, "Data Clustering: a review", ACM Compute, Surveys, vol. 31, **(1996)**.

[93] Hamerly and C. Elkan, "Learning the K in K-means", Proceedings of the 17th Annual Conference on Neural Information Processing Systems, British Columbia, Canada, **(2003)**.

[94] L. Lenert, A. Lin, R. Olshen and C. Sugar, "Clustering in the Service of the Public's Health", http://www-stat.stanford.edu/~olshen/manuscripts/helsinki.PDF.

[95] S. Belciug, F. Gorunescu, A. Salem and M. Gorunescu, "Clustering-based approach for detecting breast cancer recurrence", 10th International Conference on Intelligent Systems Design and Applications, (2010).

[96] J. Escudero, J. P. Zajicek and E. Ifeachor, "Early Detection and Characterization of Alzheimer's Disease in Clinical Scenarios Using Bioprofile Concepts and K- Means", 33rd Annual International Conference of the IEEE EMBS Boston, Massachusetts USA, (2011) August 30-September 3.

[97] Yoo, I., and Hu, X., A comprehensive comparison study of document clustering for a biomedical digital library MDELINE. ACM/IEEE Joint Conference on Digital Libraries 11–15:220–229, 2006. Chapel Hill, NC, June 11–15, 2006.

[98] Yoo, I., Hu, X., and Song, I.-Y., Biomedical ontology improves biomedical literature clustering performance: a comparison study. Int. J. Bioinform. Res. Appl. 3(3):414–428, 2007.

[99] M. E. Celebi, Y. A. Aslandogan and R. P. Bergstresser, "Mining Biomedical Images with Density-based Clustering", Proceedings of the International Conference on Information Technology: Coding and Computing (ITCC'05), (2005).

[100] T. S. Chen, T. H. Tsai, Y. T. Chen, C. C. Lin, R. C. Chen, S. Y. Li and H. Y. Chen, "A Combined K-Means and Hierarchical Clustering Method for improving the Clustering Efficiency of Microarray", Proceedings of 2005 International Symposium on Intelligent Signal Processing and Communication Systems, (2005).

[101] Chipman and R. Tibshirani, "Hybrid hierarchical clustering with applications to microarray data", Biostatistics, vol. 7, no. 2, (2006), pp. 286-301.

[102] Bertsimas, M. V. Bjarnadóttir, M. A. Kane, J. C. Kryder, R. Pandey, S. Vempala and G. Wang, "Algorithmic prediction of health-care costs", Oper. Res., vol. 56, no. 6, (2008), pp. 1382-1392.

[103] S. Belciug, "Patients length of stay grouping using the hierarchical clustering algorithm", Annals of University of Craiova, Math. Comp. Sci. Ser., ISSN: 1223-6934, vol. 36, no. 2, (2009), pp. 79-84.

[104] J. J. Tapia, E. Morett and E. E. Vallejo, "A Clustering Genetic Algorithm for Genomic Data Mining", Foundations of Computational Intelligence, vol. 4 Studies in Computational Intelligence, vol. 204, (2009), pp. 249-275.

[105] T. H. A. Soliman, A. A. Sewissy and H. A. Latif, "A Gene Selection Approach for Classifying Diseases Based on Microarray Datasets", 2nd International Conference on Computer Technology and Development (lCCTD 2010), (2010).

[106] Schulam et al., "Clustering Longitudinal Clinical Marker Trajectories from Electronic Health Data: Applications to Phenotyping and Endotype Discovery", Associations for the Advancements of Artificial Intelligence, 2015.

[107] Fletcher Lu and J. Efrim Boritz, "Detection Fraud in Health Insurance Data: Learning to Model Incomplete Benford's Law Distributions", Machine Learning: EMCL 2005 16th European Conference on Machine Learning, Porto, Portugal,October 3-7, 2005 Volume 3720, pages 633-640, Springer.

[108] Peng Y, Kou G, Sabatka A, Chen Z, Khazanchil D and Shi Y," Application Of clustering methods to health insurance fraud detection", Int Conf Serv Syst Serv sManag 1:116-120, 2006.

[109] Piatetsky-Shapiro, G., Discovery, analysis, and presentation of strong rules. In: Piatetsky-Shapiro, G., (Ed.), Knowledge Discovery in Databases. AAAI/MIT Press, 1991, pp. 229–248.

[110]   Agrawal, R., Imielinski, T., and Swami, A., Mining association rules between sets of items in large databases, Proceedings of the ACM SIGMOD International Conference on the Management of Data. ACM, Washington DC, pp. 207–216, 1993.

[111]   Agrawal, R., and Srikant, R., Fast algorithms for mining association rules, Proceedings of the 20th International Conference on Very Large Data Bases (VLDB'94). Morgan Kaufmann, Santiago, pp. 487–499, 1994.

[112]   J. Yanqing, H. Ying, J. Tran, P. Dews, A. Mansour and R. Michael Massanari, "Mining Infrequent Causal Associations in Electronic Health Databases", 11th IEEE International Conference on Data Mining Workshops, (2011).

[113]   R. Agrawal and R. Srikant, "Fast Algorithms for Mining Association Rules", VLDB, Chile, ISBN 1-55860-153-8, (1994) September 12-15, pp. 487-99.

[114]   U. Abdullah, J. Ahmad and A. Ahmed, "Analysis of Effectiveness of Apriori Algorithm in Medical Billing Mining", 2008 International Conference on Emerging Technologies, IEEE-ICET 2008, Rawalpindi, Pakistan, (2008) October 18-19.

[115]   M. Patil, R. C. Joshi and D. Toshniwal, "Association rule for classification of type -2 diabetic patients", Second International Conference on Machine Learning and Computing, (2010).

[116]   J. Yanqing, H. Ying, J. Tran, P. Dews, A. Mansour and R. Michael Massanari, "Mining Infrequent Causal Associations in Electronic Health Databases", 11th IEEE International Conference on Data Mining Workshops, (2011).

[117]   M. Ilayaraja and T. Meyyappan, "Mining Medical Data to Identify Frequent Diseases using Apriori Algorithm", Proceedings of the 2013 International Conference on Pattern Recognition, Informatics and Mobile Engineering, (2013) February 21-22.

[118]   J. Nahar, T. Imam, K. S. Tickle and Y. P. Chen, "Association rule mining to detect factors which contribute to heart disease in males and females", Expert Systems with Applications, vol. 40, pp. 1086-1093, (2013).

[119]   Eiko Kai et al., "Enpowering the healthcare worker using the Portable Health Clinic", IEEE Transactions, DOI 10.1109/AINA.2014.108, 2014.

[120]   Divya et al.," A Survey on Data Mining Approaches for Healthcare", International Journal Of Bio-Science and Bio-Technology Vol.5, No.5 (2013),pp.241-266 http://dx.doi.org/10.14257/ijbsbt.2013.5.5.25.

[121]   EliasLemuye,tatus Predictive―Hiv ModelingS Using Data Mining Technology‖