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Investigation of Effective Classification Method for Online Health Service Recommendation System

Saravanan Palani*, Sahithya Nalla, Secherla Supriya
School of Computing, SASTRA Deemed University, India
*Corresponding Author

ABSTRACT

Hospital Recommendation Services have been gaining popularity these days. There are many applications and systems that are recommending hospitals based on the user's requirements and to meet the patient satisfaction. These applications take the reviews of the patients and the users and based on these reviews, they recommend the hospitals. Also if a person is new to the location that he is currently residing, when the speciality is given as input by him, then these applications recommend the hospitals. But the problem is that everyone is not aware of the medical terms like specialities. For those people, "Health Service Recommendation System" comes handy. "Health Service Recommendation System" is an Android Application for finding hospitals within a specified range of distance and requirements provided by the client using the Naïve Bayes classification algorithm. Naïve Bayes algorithm classifies the speciality and thus helps in achieving the maximum accuracy compared to the other algorithms used. This application is helpful even for the people who are not aware of the specialities of the hospitals.

Keywords: Android, Classification, Decision Tree algorithm, Support Vector Machine Algorithm, Naïve Bayes Algorithm, DBbrowser, SQLite, Specialties, Symptoms.

1. INTRODUCTION

People are not aware of the hospitals that provide better quality health service. Patient satisfaction is the main criteria for recommending the hospitals. Browsing online and spending hours together in the search for hospitals that provide better quality health service is a time-consuming process and does not provide relevant results. In case of emergency situations such as accidents, the patient has to be taken to the nearby hospital despite the other features such as ratings of the hospital. In that situation, our application comes into picture recommending the hospitals within the range specified by the user using recommender system. Recommender system is the software product which recommends most suitable item or place or product based point of interest [1].

When people move to the new places, they will not be aware of the hospitals around their current location. In that case, our application will use the GPS to find the current location coordinates of the client and recommends the hospitals based on the requirements. Not everyone is aware of the medical terms like specialities. They know only the symptoms of their diseases. In that

case, "Health Service Recommendation System" makes it easy to them where they select the symptoms of their diseases and its pain severity ranging from high to low. Then the application takes in these symptoms and finds out the speciality that comes with those symptoms of the disease [18-28]. As the user knows the speciality now, he can proceed with the process [29-39].

Android application for Health Service Recommendation system has been designed to make it convenient for clients to find the hospitals nearby their location. For finding a good hospital, there may be parameters like specialities or services, ratings of the hospitals [40-42]. In this application, location preference is the primary attribute which recommends the hospitals nearby. The significant features of the application are maintainability, where data regarding the hospitals is maintained in the database and is also responsive, reliable and user-friendly.

The manuscript is organized as follows. The next section of this manuscript discusses the existing related works. Section 3 explains Proposed Methodology Section 4 explains the Results and Section 5 consummates the research work.

2. RELATED WORK

The application of clinical decision support systems (CDSS) in [2] is integrated with health information system (HIS) to read the electronic health records directly for analysis for effective clinical diagnosis and treatment. Clinical decision treatment system (CDTS) helps the patients in choosing the hospitals according to their requirements. For disease detection in CDTS, the system uses voted ensemble multi-classification algorithm that creates decision trees for decision tree based stream mining. It reads more information at a time for analysis and also dynamically updates the database. This system shows the increase in the accuracy of the diagnosis.

Due to the lack of tools, diagnosis of asthma is difficult and challenging for primary care physicians. To help make it easy for the physicians to detect the asthma disease, Multivariate logistic regression analysis is used for the evaluation of responses from the asthma patients based on the questionnaire asked them. The asthma patients have shown higher total symptom score than non-asthma patients on the survey. Multivariate logistic regression analysis has increased the accuracy of diagnosing asthma in practice when the facilities required to find out the disease are unavailable. [3]

The emergency departments in the hospitals are always crowded and have negative consequences for the patients most of the times. To prevent this overflowing of the patients, three predictive models have been used in [4] to find out the model that reduces the risk of admissions into the emergency departments. They are a logistic regression, decision tree algorithm and gradient boosted machines. The gradient boosted machines model has performed better than the other two models with higher accuracy.

By integrating the data and the information obtained from the transformer insulating oils and a variety of chemicals, the health condition of the insulation system of an in-service transformer can be calculated.

According to [4], this data can be processed and the transformer insulating system health token can be determined using support vector machine algorithm. This improves the conditional assessment of the system and also attains higher classification accuracy.

Making proper decisions in diagnosing the patients' diseases is difficult and challenging. The clinician has to make proper decisions to diagnose the disease correctly. For this, Naïve Bayes algorithm is used in clinical decision support system which improves the accuracy of diagnosing the patients' diseases. Also, the patients' historical medical data is preserved privately. The query passes by the user is preprocessed by the Naïve Bayes classification standard with lightweight polynomial aggregation technique. [5]

Lung cancer cells are difficult to diagnose and also difficult to find out the survival time of those cells. They are treated with the help of computed tomography (CT) scans. According to [6], the CT images are taken as the input data and the cancer cells and their survival time are predicted using decision tree algorithm. The higher accuracy percentage of 77.5 has been noted in this implementation by the decision tree algorithm.

Job stress has become the common problem nowadays and if ignored causes long-term damages to the health. To predict the symptoms of the stress before it causes any damage, the data from the telephone and sensors are collected and the relevant attributes are identified through correlation analysis. In [7], the algorithms such as zeroR, Naïve Bayes, support vector machine, simple logistics, k-Nearest Neighbor, AdaBoost and random tree algorithms are implemented to find out the best-suited algorithm.

Finding tutors in nearby location based on the parents' requirements such as tutor qualification, the location where the tutor resides and gender of the tutor etc., Naïve Bayes classifier is used to classify the tutors into appropriate classes. This classifier helps to find the tutors with maximum accuracy. The Naïve Bayes algorithm outperformed the other algorithms used in this application with max.imum accuracy. [8]

Fraud causes serious damage to the health insurance system. It causes serious loss. To detect the fraud, data mining algorithms are applied to the dataset of health insurance system. Data mining techniques such as supervised and unsupervised algorithms are applied to find the best technique that detects the fraud in health insurance system. [9]

In general, many data mining techniques are applied for diagnosing medical data. But as the medical data is large, it will complicate the diagnosis process. In [10], WEKA, TANAGRA and MATLAB are the data mining tools that are used for comparative study of different data mining classification techniques. The results show that in TANAGRA, Naïve Bayes algorithm shows the accuracy of 100% and training time of 0.001 seconds. Naïve Bayes algorithm is good at handling large datasets and requires less data for training. The disadvantage is that misclassification cost is not considered explicitly.

In [11], for decision support, different data mining techniques are applied to the standardized electronic health records. It identifies the need of applying the data mining techniques to the health records for a decision support system. It considers various attributes and issues to be resolved by providing an efficient decision support system. These techniques can be applied to various data in various fields such as banking, marketing, sports, education, agriculture etc.

The selection of the correct data mining technique is very important and it also depends on the goal of the application. Different types of data mining methods such as Time Series Analysis, Clustering, Sequential Patterns, Prediction, Association Rule Mining and Classification are explained in [12]. Classification techniques such as Decision tree, neural networks and Naïve Bayes algorithms are explained. Comparative analysis of these data mining techniques is made.

The efficiency of Support vector machine, Naïve Bayes, Decision tree, C4.5, k-Nearest Neighbor, Linear regression, Linear classifier algorithms were investigated and the area under the curve (AUC) for these methods have been compared with each other considering the types of the attributes, size of the datasets and the number of continuous and discrete attributes. The algorithms Decision Tree, k-Nearest Neighbor, Support Vector Machine and C4.5 obtained the higher area under the curve than the algorithms, LogR, Naïve Bayes and Linear Classifier. Out of those four algorithms, C4.5 has obtained higher AUC. [13]

Authors of [14] and [15] had proposed the product recommendations based on items' relationship demographic information of uses. Further, fuzzy based support vector machine [16] is used to determine the health index.

3. PROPOSED METHODOLOGY

To recommend the hospitals with better quality health service, this application is introduced. This application runs on Android Platform. This application development requires the tasks such as data collection, database creation, information retrieval and implementation of classification algorithm in order to find the recommended hospital.

3.1. Data Collection:

For implementing the application, sample data is collected from Tanjavur and Trichy districts in Tamil Nadu. The hospital dataset for Health Service Recommendation System has been collected from the hospitals in Thanjavur and Trichy. This hospital dataset consists of attributes such as hospital name, speciality, address, pin code, phone number, service time, rating, latitude and longitude coordinates. These attributes are considered as the key fields for recommending the preferred hospitals. The dataset collected is in .csv format. This hospital dataset is used in the case where the user selects the speciality.

Another dataset is used by the application which is Symptoms dataset in order to predict the speciality using classification

algorithm. This symptoms dataset consists of the attributes such as symptoms like heart_pain, kid-ney_problem, bone_problem, urinary system, ear_nose_throat, etc. The values for these attributes are high, medium, low and nil. These values explain the pain severity of the disease symptoms. Another attribute is the specialty_classifier. The values for this attribute are the specialities of the hospitals.

3.2. Database creation and Data retrieval:

The collected dataset is stored in the SQLite database with .db extension using DBbrowser. SQLite is an in-process library that implements a self-sufficient, serverless, zero-configuration, transactional SQLite database. It has better performance, reduced application cost. It is portable, reliable and easily accessible. DBbrowser (Database Browser) is a tool which allows the user to connect to any database, browse and modify data, run SQL scripts, export, import and print data. This .db file is then loaded into Android Studio. In Android Studio, we create an assets folder to store the SQLite database. Assets allow inserting arbitrary files like text, XML, fonts, a database into the application.

3.3. Implementation of the proposed system:

The implementation of the proposed work is shown in figure 1, the preliminary work that has done is a selection of symptoms, specialities, hospitals and collecting relevant data from Trichy and Thanjavur hospitals. Using the collected data, SQLite database is created with hospital details and the Relational database is created using symptoms dataset which consists of symptoms and specialities.

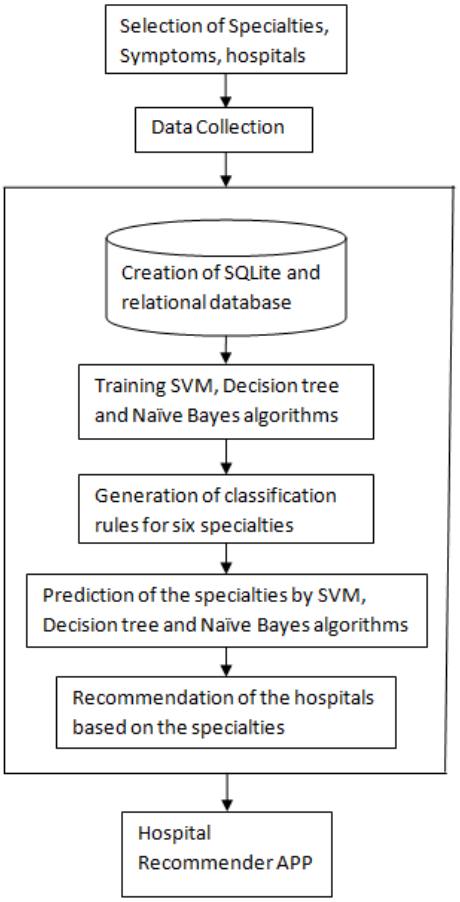

Fig 1. The architecture of the Health Service Recommendation System

The symptoms dataset is used for training Support Vector Machine algorithm, Decision Tree algorithm and Naïve Bayes algorithm. These algorithms generate classification rules for six specialities. Based on the symptoms the algorithms classify into 6 different specialities that are Cardiology, Gynecology, Orthopedics, Nephrology, ENT and Obstetrics and finally predict the appropriate speciality under which those symptoms can be treated. Based on the speciality predicted by algorithms, the

hospitals with that speciality are recommended to the patient. The user can interact with Health service recommendation system using Health Recommender Android Application.

Health Recommender App helps the user to give symptoms he is suffering from and know under which speciality he has to be treated. The Hospital details which contain that speciality is also displayed using Health Recommender App.

4. RESULTS

Experiments have been conducted in major hospitals in Thanjavur and Trichy districts, Tamil Nadu state, India. Health Service Recommendation System has used two datasets. One is Hospital dataset and the other is Symptoms dataset. The hospital dataset consists of attributes such as hospital name, speciality, address, pin code, phone number, service time, rating, latitude and longitude coordinates. These attributes are considered as the key fields for recommending the preferred hospitals. The symptoms dataset consists of the attributes such as symptoms like heart_pain, kidney_problem, bone_problem, urinary_system, ear_nose_throat, etc. The values for these attributes are high, medium, low and nil. These values explain the pain severity of the disease symptoms. Another attribute is the specialty_classifier. The values for this attribute are the specialities of the hospital.

Table 1, represents the sample test cases used for the calculation of accuracy and the prediction of the classifiers by the three algorithms. We have passed 20 sample test data as input to all the three algorithms. In the table, s1-s20 represents the patient_id. The SVM, Decision tree and Naïve Bayes algorithms have classified six specialities named Cardiology, Gynecology, Nephrology, Obstetrics, Orthopedics, ENT.

These classifiers are predicted based on the symptoms heart_pain, kidney_problem, bone_problem, urinary_system and ear_nose_throat with pain severity ranging from high to low. The pain severity is taken with the values ranging from high to low and is represented as high-103, medium-102, low-101 and nil-100.

They are taken in the form of a tuple as input. For example, consider this tuple [103,102,101,102,100]. It tells the heart_pain is high, kidney_problem is medium, bone_problem is low, the urinary_system problem is a medium and ear_nose_throat problem is nil. The green colour says that the classifier is predicted correctly by the algorithm whereas the red colour says that the classifier is predicted wrongly by the algorithm.

For example, s2 is passed as a sample test case to the three algorithms with the pain severity of bone_problem as high, heart_pain as medium, ear_nose_throat as medium and kidney_problem as low. the Support vector machine and Decision tree algorithms predicted the classifier as cardiology which is inappropriate whereas Naïve Bayes algorithm predicted the classifier as orthopedics which is correct.

Table 1. Classifiers predicted by the Algorithms

Patient_id	Symptoms (Symptom levels set)	Specialities classified		
		SVM	Decision Tree	Naïve Bayes
s1	[103,102,101,102,100]	Cardiology	Cardiology	Cardiology
s2	[102,101,103,100,102]	Cardiology	Cardiology	Orthopedics
s3	[100,103,101,100,100]	Nephrology	Gynecology	Nephrology
s4	[103,103,100,100,102]	Cardiology	Cardiology	Cardiology
s5	[100,100,103,100,102]	Orthopedics	Ent	orthopedics
s6	[100,103,101,103,102]	Gynecology	Gynecology	Gynecology
s7	[100,100,103,103,103]	Cardiology	Obstetrics	Cardiology
s8	[100,100,100,100,103]	Ent	Ent	Ent
s9	[102,100,103,100,100]	Cardiology	Cardiology	orthopedics
s10	[103,100,102,102,103]	Cardiology	Cardiology	Cardiology
s11	[100,102,102,100,102]	Nephrology	Nephrology	Nephrology
s12	[100,100,102,103,100]	Obstetrics	Obstetrics	Obstetrics
s13	[103,102,103,102,103]	Cardiology	Cardiology	Cardiology
s14	[100,100,103,102,102]	Gynecology	Gynecology	Obstetrics
s15	[100,103,100,103,100]	Obstetrics	Obstetrics	Gynecology
s16	[100,100,102,102,100]	Orthopedics	Orthopedics	Obstetrics
s17	[100,100,103,100,100]	Ent	Ent	orthopedics
s18	[100,100,100,100,103]	Ent	Ent	Ent
s19	[100,100,100,102,103]	Cardiology	Cardiology	Cardiology
s20	[102,101,100,103,101]	Gynecology	Cardiology	Gynecology

Also, when s9 is passed to the algorithms, Naïve Bayes has predicted the correct classifier and so goes in most of the cases. But only in the cases of s7 and s14, Naïve Bayes algorithm has predicted the wrong classifier which states that Naïve Bayes is more accurate when compared to the other two algorithms.

Decision tree algorithm, Support vector algorithm and Naïve Bayes algorithm are implemented and tested in terms of accuracy. Naïve Bayes algorithm came out to be highest in case of accuracy compared to the other two algorithms. Here, accuracy is the percentage of correct predictions of classifiers i.e., specialities. Accuracy can be calculated over n samples using the formula,

$$\boldsymbol{accuracy}(\boldsymbol{x}, \hat{\boldsymbol{x}}) = \frac{\mathbf{1}}{\boldsymbol{n_{samples}}} \sum_{\boldsymbol{i=0}}^{\boldsymbol{n_{samples}-1}} \mathbf{1}(\hat{\boldsymbol{x}}_{\boldsymbol{i}} = \boldsymbol{x}_{\boldsymbol{i}}) \quad \ldots\ldots (1)$$

As per the equation (1),

$\hat{x}_i$ is a predicted value of i^{th} sample.

x_i is the corresponding true value.

Figure 2 shows the bar graph of 20 number of patients classified in the specialities Cardiology, Gynecology, Orthopedics, Nephrology, ENT and Obstetrics by Support Vector Machine algorithm, Decision Tree algorithm and Naïve Bayes algorithm.

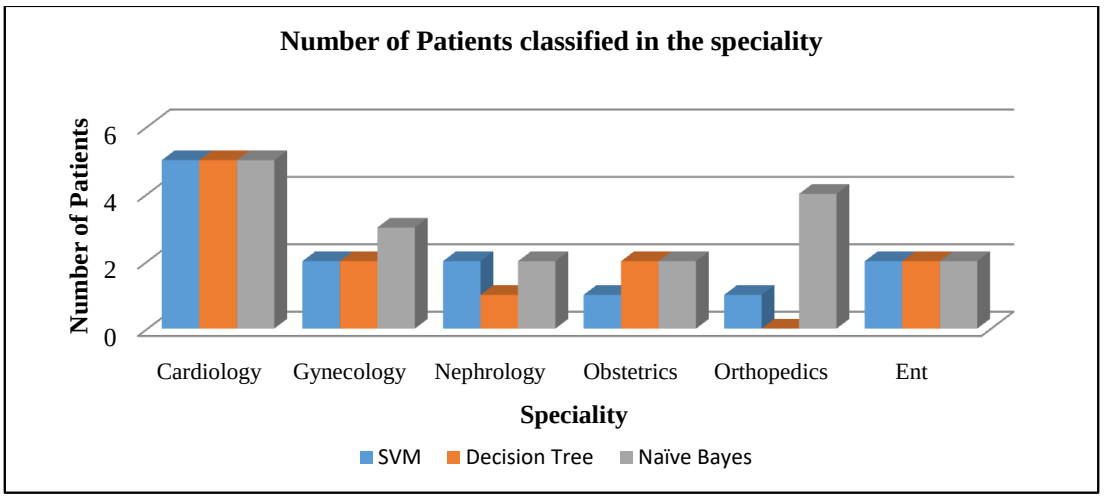

Fig 2: Number of patients classified in the Specialty

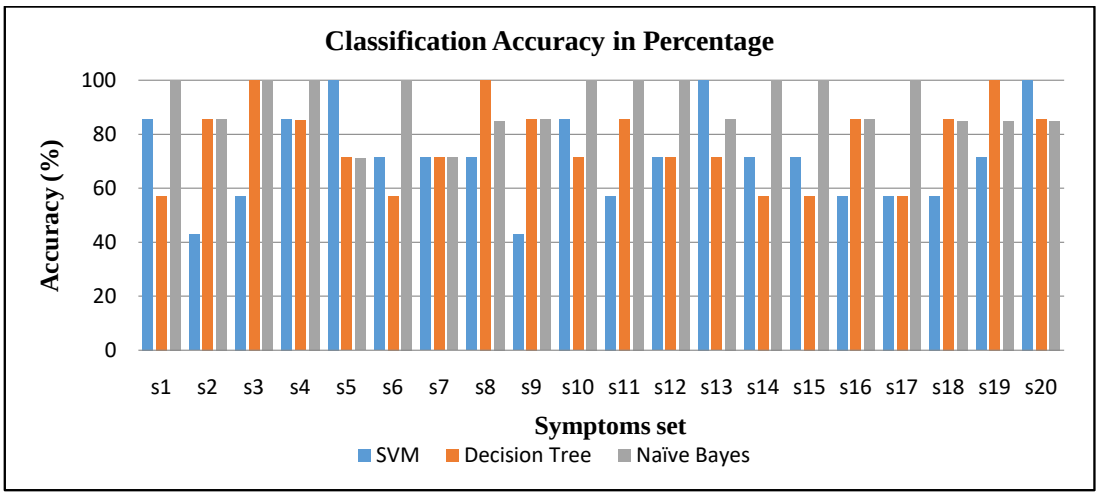

Fig 3: Classification accuracy in percentage

Figure 3 shows the bar graph of classification accuracy in the percentage of Support Vector Machine algorithm, Decision Tree algorithm and Naïve Bayes algorithm when sample test data of 20 cases are passed. As a result, we found that Naïve Bayes algorithm shows the highest average accuracy.

We found that the average accuracy for Support vector machine algorithm is 71.48 %, for Decision tree algorithm, it is 77.10%

and for Naïve Bayes algorithm, it is 91.25%. As a result, we found that Naïve Bayes algorithm is 20% more accurate compared to Support vector machine algorithm and 14% more accurate compared to Decision tree algorithm.

5. CONCLUSION

Recommending the hospitals based on the patient requirements and to meet his satisfaction is important criteria. In order to recommend the hospitals, the patient has to be aware of the specialities under which he should be treated. But unfortunately, not everyone is aware of the specialities. So, the proposed system not only recommends the hospitals based on the specialities but also helps those who are not aware of the specialities by taking the symptoms of the patients' disease and predicts the speciality. Based on this speciality, hospitals are recommended to the patients. Sample test data set of 20 patients, 6 specialities and 5 symptoms with pain severity ranging from low to high are passed to SVM, Decision tree and Naïve Bayes algorithms to compare the accuracy of the speciality prediction. The results showed that Naïve Bayes outperforms the other two algorithms with a higher average accuracy percentage of speciality prediction. Recommending the hospitals that are near to the location of patients has also been implemented to help the patients in case of emergency situations. In future, the research work will be extended to improve the recommendation of the hospitals more accurately considering other requirements of the patients.

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