Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 12, Issue 6, July, 2021: 7935-7947

Research Article

Android App Solutions to Aid ClinicalDecision-Making

[1]Akanksha Srivastava, [2]Akash Ranjan Das, [3]Rakshitha B, [4]Shruthi K

Abstract

One of the key challenges today faced by the healthcare system is the retrieval and analysis of huge quantities of varying data for various use cases such as clinical care, screening test, administration, and research. With the concept of learning the healthcare system cycle, clinical research and practice both can become a distinctive and cooperative process. Clinical decision support systems need to aid entailment within events by updating and modeling accordingly the various details of clinical care. Well-designed and precise models of clinical regulations and care pathways can be a successful tool to distinguish the analytic results from anticipated behaviors. In this paper, we are introducing an android app for clinical decision-making for nursing students, nursing practitioners, and patients in order to make the diagnosis more accurate, easy, and cost-effective. The app gives two separate UI for patients and nursing practitioners. It uses the symptoms of potential patients as inputs, gives the diagnostic results to the nursing practitioner, and suggests local doctors to the patients, using machine learning algorithms. This could permit constructive revision of continuously collected data, to acquire a new understanding of patients' results, and to give reasons for their clinical patterns. All these measures are the solutions of a Learning Health Care System that we implement as an Android Application.

***Keywords*—**Clinical decision support system, Machine Learning, Android Application, Naive Bayes, Decision Tree, Random Forest.

I. INTRODUCTION

Traditional ways of clinical decision-making are filled with human errors and inherent bias. Nursing practitioners and doctors fail to perform the correct testing for diagnosis in the lack of correct questions which would have led to it, or even worse, fail a specific diagnosis entirely. Clinical decision-making is a very tedious and critical process. It consists of three kinds of decisions i.e., the analysis of symptoms to prescribe a diagnosis, determination of tests to be done to confirm a diagnosis, and the treatment to be prescribed. A practitioner has to go through this process every time they see a new patient and sometimes has to do it many times with the same patient. Every time a new symptom is found, the practitioner has to analyze new information, go through the medical history again, and decide for the patient. According to a study from Colombia University, nursing students who had a questionnaire provided by decision-making software were able to diagnose the patients more accurately than they were able to do without it. Also, patients find it hard to analyze their symptoms and visit a specialized

[1,2,3,4]UG Student,Computer Science and Engineering, Siddaganga Institute of Technology Tumkur, India
[4]Assistant Professor, Computer Science and Engineering, Siddaganga Institute of Technology Tumkur, India
E-Mail: akankshabsrivastava@gmail.com

doctor. We see all these problems throughout the world but we have got no effective solution to them. In this paper, we propose the use of a mobile application for a clinical decision support system in order to remove human error from the process of clinical decision-making.

Clinical decision-making refers to collecting a huge variety of relevant clinical data to predict which tests to order, which treatment is to be given, etc. in order to reduce diagnostic uncertainty, risks to patients, and cost. Clinical decision support, on the other hand, is any tool that provides clinicians, medical practitioners, patients, and other members of the care team with details and information that is analyzed and aimed at a specific person or situation. To make clinical decision support widely available, in this paper an android app has been used for the deployment of a clinical decision support system, as it is an applied science almost used by everyone in the current era.

Clinical decision support systems such as mobile applications, or software, are aimed to increase the results of delivery in healthcare by improving medical decisions with specific clinical, patient and other health related information. This software is designed to be of direct help in making clinical decisions, where the characteristics of a specific patient is linked to a database. The recommendations for that patient are then produced to the medical specialist in order to make a decision.

Clinical Decision support system makes use of machine learning algorithms to predict the desired results. Machine learning is the advancing field of artificial intelligence that helps to identify the pattern and help in decision making with increased accuracy in various fields. We can use these patterns to provide greater benefit to nursing practitioners and patients. Well-designed and precise models of clinical regulations and care pathways can be a successful tool to distinguish the analytic results from anticipated behaviors. This could permit constructive revision of continuously collected data, to acquire a new understanding of patients' results, and to give reasons for their clinical patterns.

Today clinicians combine their knowledge with suggestions or information provided by these machine learning tools. To facilitate this support system Naive Bayes/Random Forest algorithm is used. This paper aims at providing an interface that utilizes machine learning algorithms for higher accuracy and an android application to listen to patients' chief complaints along with recommending an appropriate medical specialist.

II. LITERATURE SURVEY

Clinical decision-making is a very tedious and critical process. It consists of three kinds of decisions i.e., the assessment of signs and symptoms to prescribe a diagnosis, decisions regarding the requirement for additional assessments to clarify a diagnosis, and the selection of the treatment. A practitioner has to go through this process every time they see a new patient and sometimes has to do it many times with the same patient. Every time a new symptom is found, the practitioner has to analyze new information, go through the medical history again, and decide for the patient.

A clinical decision support system is an active knowledge system, which uses variables of patient data to produce advice regarding health care. This implies that a CDSS is simply a decision support system that is focused on using knowledge management in such a way so as to achieve clinical advice for patient care based on multiple items of patient data. CDSSs which do not use a knowledge base, use a form of artificial intelligence called machine learning, which

allows computers to learn from past experiences and/or find patterns in clinical data. [1]

Machine learning (ML) is the study of computer algorithms that improve automatically through experience data. It is seen as a part of artificial intelligence. Machine learning algorithms build a model based on sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed to do so. Machine learning algorithms are used in a wide variety of applications, such as in medicine, email filtering, and computer vision, where it is difficult or unfeasible to developconventional algorithms to perform the needed tasks. [2]

To understand the responses and perception of the implementation of clinical decision support system in the field of Prosthodontics, a research "Mobile learning App: A Novel Method To Teach Clinical Decision Making in Prosthodontics" by Saee Deshpande et al. [3] aims to resolve the issue of how the difficult decision-making process in prosthodontics. It includes restoring lost dentofacial structures using artificial replacements, which could be simplified by the use of CDSS applications. Due to the abundance of substance and methods, the decision-making of a medical specialist, concerning the pertinent options of the prosthesis, needs reasoning capabilities. During the training period of the nursing practitioners of the graduation years of the students, students do not get exposure to different kinds of situations, therefore their clinical thinking capabilities have not evolved appropriately. Thus, with the shift of including technological advancement in the traditional education system, this paper showcases a developed, mobile learning application for this specific reason. The focus of this research was to gauge the perception of nursing students towards the applications' usage and effect on their methodology in making clinical decisions. Making clinical decisions in the field of prosthodontics using a mobile application is an efficient and constructive method to upgrade clinical analysis and reasoning skills for laying the groundwork for prosthodontic recovery. The study shows that almost 94% of students who were under study suggested that this kind of app should be in regular use as it increases the learning efficiency and accuracy of the prediction.

Another work on a similar domain "Medical Instructed Real-Time Assistant for Patients with Glaucoma and Diabetic Conditions" by Ubaid Ur Rehman et al. [4] makes use of the overwhelming usage of virtual assistants in our day to day activities. Due to this service they provide, the healthcare sector uses virtual medical assistants to give all appropriate diseases that are supposed to align with a specific symptom. But these results from the virtual assistants may lead to distrust due to inaccuracy and unpredictability and could lead to hypochondriasis. This paper proposes a Medical Instructed Real-time Assistant (MIRA) that works in listening to patients' issues and gives aspecific disease as a result. This result will be used to inform the user of a nearby doctor instead of the medical condition. The architectural design of MIRA takes into consideration the drawbacks of the virtual assistant, such as lack of understanding, uncertain recommendation, and weak input. The collection of patients' data is through speech corpora. It is then manually verified under a specialist's care. The data is then further used for giving required responses, identifying diseases, and even understanding natural language. This paper took diabetes and glaucoma for the prototype of MIRA. The measure of performance of this was evaluated as accuracy, sensitivity, precision, specificity, and F-measure. The final work conclusion was ultimately devised utilizing Cohen's kappa which indicated this virtual assistant as almost perfect. It also identifies users from voice-based authentication to prevent any outsider attacks. The experiences with users also indicated almost satisfying outcomes in every aspect according to the benchmark data of the User Experience Questionnaire (UEQ). Ultimately, the outcomes indicated MIRA effectively foresees users' issues and helps in making decisions.

Similar literature, "Mobile Clinical Decision Support Systems and Applications: A Literature and Commercial Review." by Martínez-Pérez et al. [5] shows the case study of different mobile apps available in the field of clinical decision making and also their comparison from the traditional way of cynical decision making. This paper was inspired by the tremendous growth of electronic health and mobile health which led to the rapid expansion of health caresystems on the mobile application. During the review process, applications from the play store and apple store were taken. In addition to these, a thesis on IEEE Xplore, Scopus, PubMed, and Web of Knowledge was also performed. This paper threw light on the fact that the applications designed in this field have some features in common in spite of the diversity in medical domain objectives. In the previous years, the involvement of patients in the clinical decision support system has significantly increased and hence has increased the number of clinical decision support system mobile applications.

III. METHODOLOGY

A. Data Description

We have taken a real-time dataset from Kaggle and applied algorithms like Naive Bayes, Decision tree, and Random forest. These output values were recorded considering their accuracies to compare the three algorithms as well as their performance.

Our Dataset contains 4920 rows and 133 columns. The columns consist of symptoms of different possible diseases. Fig.1 displays the dataset including its attributes i.e., symptoms and number of rows and columns. Fig.2 displays its attributes along with the target attribute i.e., prognosis.

	itching	skin_rash	nodal_skin_eruptions	continuous_sneezing	shivering
0	1	1	1	0	0
1	0	1	1	0	0
2	1	0	1	0	0
3	1	1	0	0	0
4	1	1	1	0	0
...	...	...	...	...	...
4285	0	0	0	0	0
4286	0	0	0	0	0
4287	0	0	0	0	0
4288	0	0	0	0	0
4289	0	0	0	0	0

4290 rows × 133 columns

Fig. 1: Dataset description - attributes

blister	red_sore_around_nose	yellow_crust_ooze	prognosis
0	0	0	Fungal infection
0	0	0	Fungal infection
0	0	0	Fungal infection
0	0	0	Fungal infection
0	0	0	Fungal infection
...	...	...	...
0	0	0	Hepatitis C
0	0	0	Hepatitis D
0	0	0	Hepatitis E
0	0	0	Alcoholic hepatitis
0	0	0	Tuberculosis

Fig. 2: Dataset description - target attribute

A detailed flow of the algorithms' application is described inthe flowchart shown in Fig.3.

Number of Instances: 4290

Number of prognoses (probable diseases): 41Number of symptoms: 133

B. Parameters for comparison

1) Accuracy**:**

Accuracy is an important term used to measure the performance of an algorithm model. Its definition is the ratio of correctly predicted values to the total number of values. Accuracy is the best measure of performance but only if datasets are of symmetrical values where false positives and false negatives are of almost similar values. Thus other parameters are necessary to evaluate the model performance.The equation is as follows:

Accuracy = TP+TN/TP+FP+FN+TN (1)

Fig. 3: Flowchart - Algorithms' application

2) Precision:

Among predicted observations, the ratio of correct positive values to the total positive values is the definition of precision. It measures the probability of the positives to the values that are actual positives. High precision indicates a rate of low false positives. The equation for precision is:

Precision = TP/TP+FP (2)

3) Recall:

The ratio of correctly predicted positive values to all the values in the true class can be the definition of recall as a performance measure. It is also the rate of true positives. Its equation is given as:

Recall = TP/TP+FN (3)

4) F1 score:

F1 score is a performance measure calculated as the weighted average of precision and recall. Thus it includes both false positives and false negatives while calculating. F1 score is more convenient than accuracy considering an irregular class distribution as in this case. Since the cost of false positives and false negatives are dissimilar, both precision and recall are preferred. For calculating the F1 score, the equation is as shown below:

F1 Score = 2*(Recall * Precision) / (Recall + Precision) (4)

branches are followed by those values and similarly move tothe next node.

4) Algorithm comparison

As shown in Fig.4, the comparison metrics give the same results for all the three algorithms that have been used. For the same reason to avoid these similarities and to attain optimum results, we have further used the k-fold validation metric to analyze the best algorithm.

C. Algorithm description and analysis

1) Random forest :

Random Forest is an ensemble machine learning algorithm used for classification problems. An ensemble algorithm is a combination of one or more algorithms put together for a stranger and stable prediction algorithm.

Random forest intuition suggests taking k points from the dataset on which prediction is to be performed and it builds the decision tree associated with those k data points. choose the number N tree of the tree and keep on repeating this for a different set of k points and take an average of all the predicted values. This will give a stable and accurate prediction as one of the trees will have the perfect fit and some change in the dataset cannot affect all the trees at once.

2) Naive Bayes

Naive Bayes is an algorithm that comes under supervised learning and is mostly used in classification-related problems. It is usually used for text classification and since our application deals with classifying symptoms in the form of textual inputs, this algorithm is well utilized.

The algorithm is called 'Naive' because it takes each value as an independent value of other occurrences and 'Bayes' because it follows the principle of Bayes' Theorem of probability.

3) Decision Tree

Decision Tree is a machine learning algorithm that comes under supervised learning, but it is one that can be used for both regression problems and classification problems. In a decision tree, analyzing the rules, inferences, and decisions from the training dataset, the value can be predicted of the target variable by referring to the training dataset.

The root of the tree is where the prediction algorithm begins and simultaneously then compares the values of the root with the records, and from then the corresponding

	precision	recall	f1-score	support
(vertigo) Paroymsal Positional Vertigo	1.00	1.00	1.00	37
AIDS	1.00	1.00	1.00	42
Acne	1.00	1.00	1.00	42
Alcoholic hepatitis	1.00	1.00	1.00	40
Allergy	1.00	1.00	1.00	36
Arthritis	1.00	1.00	1.00	42
Bronchial Asthma	1.00	1.00	1.00	48
Cervical spondylosis	1.00	1.00	1.00	37
Chicken pox	1.00	1.00	1.00	38
Chronic cholestasis	1.00	1.00	1.00	31
Common Cold	1.00	1.00	1.00	34
Dengue	1.00	1.00	1.00	46
Diabetes	1.00	1.00	1.00	35
Dimorphic hemmorhoids(piles)	1.00	1.00	1.00	50
Drug Reaction	1.00	1.00	1.00	38
Fungal infection	1.00	1.00	1.00	33
GERD	1.00	1.00	1.00	43
Gastroenteritis	1.00	1.00	1.00	43
Heart attack	1.00	1.00	1.00	42
Hepatitis B	1.00	1.00	1.00	47
Hepatitis C	1.00	1.00	1.00	40
Hepatitis D	1.00	1.00	1.00	38
Hepatitis E	1.00	1.00	1.00	50
Hypertension	1.00	1.00	1.00	37
Hyperthyroidism	1.00	1.00	1.00	42
Hypoglycemia	1.00	1.00	1.00	44
Hypothyroidism	1.00	1.00	1.00	38
Impetigo	1.00	1.00	1.00	36
Jaundice	1.00	1.00	1.00	37
Malaria	1.00	1.00	1.00	35
Migraine	1.00	1.00	1.00	39
Osteoarthristis	1.00	1.00	1.00	30
Paralysis (brain hemorrhage)	1.00	1.00	1.00	38
Peptic ulcer diseae	1.00	1.00	1.00	31
Pneumonia	1.00	1.00	1.00	46
Psoriasis	1.00	1.00	1.00	33
Tuberculosis	1.00	1.00	1.00	40
Typhoid	1.00	1.00	1.00	41
Urinary tract infection	1.00	1.00	1.00	41
Varicose veins	1.00	1.00	1.00	40
hepatitis A	1.00	1.00	1.00	44
accuracy			1.00	1624
macro avg	1.00	1.00	1.00	1624
weighted avg	1.00	1.00	1.00	1624

Fig. 4: Comparison parameters for Naive Bayes, Decision Tree, and Random Forest

After taking the value of k from 2 to 11 in K-Fold, the Decision tree was found to be the best fit, at k-value 2, forthe given dataset as all other algorithms seemed to overfit.

Table I shows the accuracy of all the algorithms at k-value 2 for both train and test datasets. Hence, the Decision tree algorithm was implemented in the clinical decision support system.

TABLE I.

ACCURACY SCORES FOR ALGORITHM AFTER K-FOLD VALIDATION, WITH K-VALUE = 2

Type of dataset	Algorithms	Accuracy
Training Dataset	Decision Tree	1.0
	Random Forest	1.0
	Naive Bayes	1.0
Testing Dataset	Decision Tree	0.869512195121951
	Random Forest	1.0
	Naive Bayes	1.0

D. UI description

The user interface of the clinical decision support system mobile application has two activities, one for the patients and another one for the nursing practitioners. Both the actors, patients, and nursing practitioners, have authentication functionalities like registration, login, logout, and profile. In the patient view, the user has a symptoms page where the user gets to choose the symptoms or conditions they have on which the prediction is to be done. The prediction is shown on the result page. The prediction includes the suggested doctor's name and address and not the disease in order to prevent self-diagnosis. Fig.5 shows the flow of the patient's view.

The nursing practitioner view has a symptom page where the nursing practitioner will choose the symptoms or conditions of the patient and a profile will be created to save the history of the patient for the convenience of the nursing practitioner. After the symptoms are entered, the prediction of probable disease is shown on the results page. Fig.6 shows the flow of the nursing practitioner's view.

To create this UI, XML is used and the development of the android application is done in Java. The Firebase database is used to store the profiles and records of patients.

IV. EXPECTED OUTCOME

A. Build a model for clinical decision making

Different machine learning algorithms could be used for clinical decision making but the one with maximum accuracy

is the best. In addition to accuracy, we also need to considerthe factor of overfitting.

Considering all these factors we get a machine learning algorithm that is efficient for the implementation of clinical decision making and hence we get a model for clinical decision making.

B. Making and deployment of android app

For the model to come into use for nursing practitioners or students and the patients, a UI is needed. The UI chosen isan android app with two interfaces, one for the patient and another one for the nursing practitioner or student. The deployment of this android application aims to ease the process of clinical decision-making and increase its accuracy. It also helps the nursing students in studies by improving their clinical decision-making skills, as they have a platform to explore and cross verify their analysis. The android application is designed to provide patients and nursing practitioners a safe and user-friendly environment for the prediction of their medical condition.

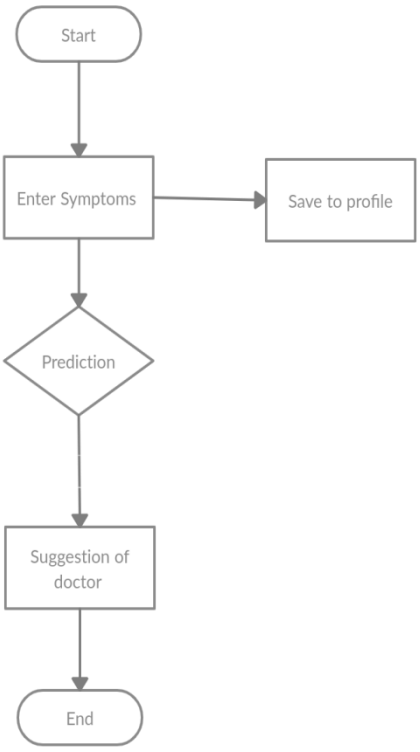

Fig. 5: Flow of the patient's view

V. CONCLUSION

Making clinical decisions manually has become a very tiring and long process. Every time a medical specialist sees a new patient, they have to evaluate signs and symptoms to make a diagnosis, evaluate the need for additional tests, and the choice of treatment. Thus to make the diagnosis more accurate, easy, and cost-effective, this paper provided a solution with an android

app. The number of clinical decision support systems as well as their applications in the medical field has increased to a huge extent in the last few years. The mobile learning app suggested from this paper is a practical teaching and learning

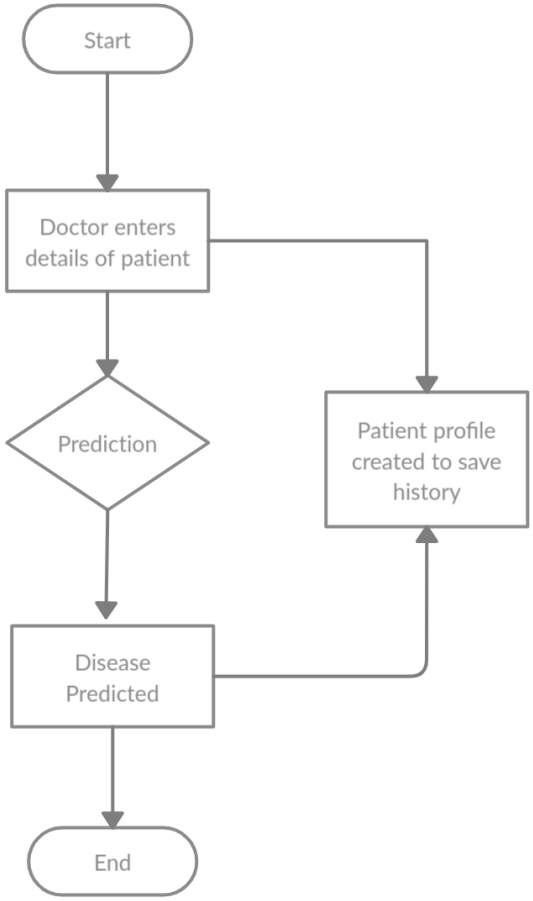

Figure 6: Flow of the nursing practitioner's view

This paper gives an insight with three algorithms of machine learning i.e., Naive Bayes, Decision tree, and Random forest for clinical decision making

technique to arrange training for medical interns and nursing practitioners. It allows the discovery of a huge range of clinical situations and an opportunity to improve clinical analysis in selecting the right diagnostics and treatments. These medical practitioners and patients will be able to save their time and get probable results in their respective fields using the app.These three algorithms are applied to a real-time dataset and their accuracies along with other performance measures have been recorded via graphs and values.

The Decision tree algorithm is giving the best results when applied to the dataset. This further is deployed as an android app and gives ease in the user interface for patients and nursing practitioners.

By using this clinical decision support system, we can further ensure the expected outcomes are properly met and provide as accurate results as possible for nursing practitioners and patients.

REFERENCES

[1] "Clinical decision support system", 18:05, 7 May 2021, Wikipedia [Online]. Available: https://en.wikipedia.org/wiki/Clinical_decision_support_system

[2] "Machine learning", 22:06, 31 May 2021, Wikipedia [Online]. Available: https://en.wikipedia.org/wiki/Machine_learning

[3] Deshpande S, Chahande J, Rathi A., "Mobile learning app: A novel method to teach clinical decision making in prosthodontics" Educ Health 2017, pp.30:31-4.

[4] Rehman UU, Chang DJ, Jung Y, Akhtar U, Razzaq MA, Lee S. "Medical instructed real-time assistant for patient with glaucoma and diabetic conditions" Applied Sciences. 2020; 10(7):2216

[5] Martínez-Pérez B, de la Torre-Díez I, López-Coronado M, Sainz-de-Abajo B, Robles M, García-Gómez JM, "Mobile clinical decision support systems and applications: a literature and commercial review", J Med Syst. 2014 Jan;38(1):4. doi: 10.1007/s10916-013-0004-y. Epub 2014 Jan 8. PMID: 24399281.