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Mobidoc: Mobile Application for Predicting Doctor's based on Symptoms Using Naïve Bayes Classifier

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Abstract: - **In the present scenario, whenever any patient needs to visit a specialist doctor for treatment, availability of the doctor on time becomes a major issue. The patient needs to call in the clinic or go personally to the clinic to book the doctor's appointment. This consumes lot of time and energy of the patient. Sometimes patients have a difficulty in deciding which specialist doctor to meet for a particular problem that they are suffering from. This paper proposes an Android application called as "MobiDoc" that will ease out the process of booking doctor's appointment, predict the specialist doctor based on patient's symptoms using Naive Bayesian classifier and also find out which is the nearest doctor/pharmacy in patient vicinity using Ranking algorithm, at any point of time or place. It is also useful for the doctors as they get to keep track of their patients on a system without the help of an assistant.**

Index Terms:— **patient, doctor, Android , Naïve Bayes classification, Ranking algorithm.**

I. INTRODUCTION

In today's worlds human life is growing busy with the work schedule. This keeps oneself busy to get medical appointments in person and to maintain a good health. To find specialist doctor with an available appointment in case of medical emergency can be a little difficult in more ways than one. The distance gap between the doctors and patients can be reduced by taking the benefits of mobile web, which will in turn provide quick and adequate medical facilities [5].

In the present scenario, there is lot of upcoming diseases, for which there is a specialties appointment. A normal person may not be aware the availability of these specialist doctor.

Mobi Doc application discussed in this paper, allows the patient to specify the symptoms of his/her illness and using Naïve Bayesian classifier predicts the specialist doctor. The most effective and efficient classification algorithm is the Naive Bayes classifier, or simply naïve bayes (NB)[2]. It is a simple probabilistic classifier based on applying Bayes' theorem with strong (naïve) independence assumptions.

MobiDoc application also helps in searching for doctors in your vicinity and book appointments so that the patient can get medical care at earliest. Ranking algorithm is used to find the most closet or nearby doctors ie top-k relevant doctor locations for a query issued by a patient at a known location.

Mobi Doc is Android based application. Android[5] is a Linux based open source operating system giving an excellent performance. This application aims to be the one stop destination for patients to find their doctors, research about them and book online appointments. It also provides the doctors with a better technology to keep track of patient appointments and make doctor-patient interaction easier and better.

II. LITERATURE SURVEY

Patient Appointment System (PAS) an android application is discussed in paper [1]. Using this application the patient can book an appointment with the doctor. The patient can interact and communicate with doctors without making any physical appointments with them. The patient can also make an appointment to visit the doctor in clinic. The system of QR code is used in this system wherein the QR code will maintain all the details of the patient and details that the doctor has prescribed or mentioned with respect to the treatment the patient is undergoing. This application can help the doctors to keep track of the number of patients per day, schedule the time of patient appointment, allow the doctor to share the

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patient reports with the other doctor. So, in this paper, the PAS system will save patients as well as doctors time and it will also reduce paper work

In [3], a mobile based application scheduling system is presented for managing patient appointments. The application facilitates by providing the time slots to patients when they make appointments and the higher precedence patients are prioritize. If patients forgets appointments he/she can receive reminder alert messages on the upcoming appointment. The doctor can keep a track of the patient appointments and also a record of the patient health.

In paper [4], a detailed study of online appointment scheduling system with architecture and merits is discussed. The popularity of online appointment scheduling is increasing day by day as it helps the patient to book an appointment with their doctor, clinic or hospital at an ease. Instead of visiting the hospital, wait ing in the queue for long hours just to get an doctor appointment can be reduced through the computer, just access a website or software and book an appointment and also through this, patients can also involve in the health decisions that they have to make.

K.M. Al-Aidaroos, A.A. Bakar and Z. Othman have presented a paper on Medical Data Classification by Naïve Bayes approach in which they have presented overview of medical data mining from different perspective including characteristics of medical data, requirement of systems dealing with such data and the different techniques used for medical data mining. They have shown the comparison of Naïve bayes with 5 different popular classifiers on 15 medical data set proving that Naïve bayes is well suited for medical application and has high performance in most of the examined medical problems [6].

III. NAÏVE BAYES CLASSIFIER

One of the simplest and one of the most effective method for classification is the Naive Bayes Classifiers. The main idea on which this method works is on the Bayesian Networks which is a probabilistic graphical model signifying a set of random variables and their conditional independencies. In the Bayesian Networks, there are several efficient algorithms that perform inference and learning. In basic requirement for this method to be applied is that the features of the dataset should be different. On considering dataset features different, the classification is done based on the Naïve bayes method. Naïve Bayes classifier is a simple probabilistic classifier based on applying Bayes' theorem with strong independence assumption [2].

The algorithm for Naïve Bayes classification is as follows:

Step 1: The data set has to be first converted into a frequency table

Step 2: Find the probabilities in order to obtain the likelihood table.

Step 3: Then use the Naive Bayesian equation to calculate the posterior probability for each class. The class with the highest posterior probability is the outcome of prediction.

Naïve Bayes Algorithm Example

Problem Statement: Assume that and an adult patient who is a male and has symptoms: cough, chest pain that is often worse with deep breath and weight loss wants to predict the doctor for consultation.

Data Set

Type of doctor	Disease	Symptoms
General physician	Fever	01.sweating 02.chills 03.headache 04.weakness 05.fatigue 06.cough 07.sore throat
	Cold	08.runny nose 07.sore throat 06.cough 09.congestion 03.headache 10.sneezing 11.watery eyes
oncologist	cancer	06.cough 12.chest pain that is often worse with deep breath 13.weight loss 14.loss of appetite 15.shortness of breath 04.weakness
cardiologist	Heart problem	16.discomfort,pressure,heaviness,pain in chest, arm or below the elbow bone 17.discomfort radiating to the back, jaw, throat or arm 18.fullness 19.choking feeling 01.sweating 20.nausea 21.vomiting 22.dizziness

Fig 1: Data Set

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TRAINING DATA:

Age	Gender	Symptoms																					type of doctor
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
11	male	N	N	Y	N	N	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	Pediatrician
15	female	N	N	Y	N	N	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	Genereal Physician
30	female	N	N	N	Y	N	Y	N	N	N	N	N	Y	Y	Y	Y	N	N	N	N	N	N	N	Oncologist
60	male	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Geriadrician, Cardiologist
25	male	N	N	N	Y	N	Y	N	N	N	N	N	Y	Y	Y	Y	N	N	N	N	N	N	N	Oncologist
10	male	N	N	Y	N	N	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	Pediatrician
72	female	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Geriadrician
17	male	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Genereal Physician
19	female	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Genereal Physician
45	female	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Cardiologist

Fig 2: Training data set

Attributes	Value	Count					Probabilities				
		I	II	III	IV	V	I	II	III	IV	V
Gender	M	2	1	1	1	1	2/2	1/3	1/2	1/2	1/2
	F	0	2	1	1	1	0	2/3	1/2	1/2	1/2
Age	C	2	2	0	0	0	2/2	2/3	0	0	0
	A	0	1	2	2	2	0	1/3	2/2	2/2	2/2
Symptoms	1	0	2	0	2	2	0	2/23	0	1/8	1/8
	2	0	2	0	0	1	0	2/23	0	0	1/16
	3	2	3	0	0	1	1/7	3/23	0	0	1/16
	4	0	2	2	0	1	0	2/23	1/5	0	1/16
	5	0	2	0	0	1	0	2/23	0	0	1/16
	6	2	3	2	0	1	1/7	3/23	1/5	0	1/16
	7	2	3	0	0	1	1/7	3/23	0	0	1/16
	8	2	3	0	0	1	1/7	3/23	0	0	1/16
	9	2	1	0	0	0	1/7	1/23	0	0	0
	10	2	1	0	0	0	1/7	1/23	0	0	0
	11	2	1	0	0	0	1/7	0	0	0	0
	12	0	0	2	0	0	0	0	1/5	0	0
	13	0	0	2	0	0	0	0	1/5	0	0
	14	0	0	2	0	0	0	0	1/5	0	0
	15	0	0	0	0	0	0	0	0	0	0
	16	0	0	0	2	1	0	0	0	1/8	1/16
	17	0	0	0	2	1	0	0	0	1/8	1/16
	18	0	0	0	2	1	0	0	0	1/8	1/16
	19	0	0	0	2	1	0	0	0	1/8	1/16
	20	0	0	0	2	1	0	0	0	1/8	1/16
	21	0	0	0	2	1	0	0	0	1/8	1/16
	22	0	0	0	2	1	0	0	0	1/8	1/16

Fig 3: Training data set

Prior Probability

P(I)=2/11 =0.1818 -------- Pediatrician
P(II)=3/11 = 0.2727 -------- General Physician
P(III)=2/11=0.1818 -------- Oncologist
P(IV)=2/11=0.1818 --------- Cardiologist
P(V)=2/11=0.1818 --------- Geriatrician

To classify new tuple (M;A;6,12,13)

P(t/I)=2/2 x 0 x 1/7 x 0 x0 =0
P(t/II)= 1/3 x 1/3x3/23 x0 x0 = 0
P(t/III)=1/2 x 2/2 x 1/5 x 1/5 x 1/5= 0.04
P(t/IV)=1/2 x 2/2 x 0 x 0 x 0= 0
P(t/V)=1/2 x 2/2 x 1/16 x 0x0=0

Combining the two we get likelihood as follows:

Likelihood of I [Pediatrician] = 0 x 0.1818 = 0
Likelihood of II [General Physician] = 0x0.2727=0
Likelihood of III [Oncologist] = 0.004x0.1818=0.0007272
Likelihood of IV [Cardiologist] = 0x0.1818=0
Likelihood of V [Geriatrician] = 0x0.1818=0

We estimate P(t) by summing up these individual values since t will be either one of the 5 categories= 0+0+0.0007272+0+0=0.0007272

Finally we obtain the actual probabilities of each event using

$$P(x/t) = \frac{P(t/x) * P(x)}{P(t)}$$

P(t/I)= (0 x 0.1818)/ 0.0007272 =0
P(t/II)= (0 x 0.2727)/ 0.0007272=0
P(t/III)= (0.004 x 0.1818)/ 0.0007272 =1
P(t/IV)= (0 x 0.1818)/ 0.0007272=0
P(t/V)= (0 x 0.1818)/ 0.0007272=0

Hence (M;A;6,12,13) should visit an Oncologist for the entered Symptoms.

Ranking Algorithm

Ranking algorithm is used to find the most closet or nearby places for a query issued by a user at a known location. There are two ranking algorithms:

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Table-Based Algorithm (Baseline)

The table-based algorithm takes in subset of the tuples as input wherein the input is in the range the user is wants to travel. A standard spatial index is used to find such tuples/places. Using this subset of tuples, the algorithm computes a place ranking by sorting the result tuples according to their distance-weighted scores

Threshold Based Algorithm

The threshold algorithm is capable of handling a very large number of places. This algorithm mixes well with current search engines that use space filling curves to index their geo content

Location	Name	Type	Category
53...	Veterinary clinic	Veterinary	clinic
51...	Tar Dental clining	Dental	clinic
51...	Dr Reshma Clinic	Dental	clinic
52...	Modern Clinic	General Physician	clinic
52...	Mother Care clinic	Dental	clinic
53...	Get well soon clinic	General Physician	clinic
54...	Neogi Clinic	ENT	clinic
54...	Dr swati clinic	Ayurveda	clinic
55...	Dr Usha Clinic	General Physician	clinic
53...	Margao Clinic	General Physician	clinic

Fig. 4: Data set

Let us assume that the output assumed after Prediction is "general physician". Now, a new table is formed with Type= General Physician

Location	Name	Type	Category
52...	Modern Clinic	General Physician	clinic
53...	Get well soon clinic	General Physician	clinic
55...	Dr Usha Clinic	General Physician	clinic
53...	Margao Clinic	General Physician	clinic

Fig. 5: List of General Physician

Let us assume that the user wishes to travel a maximum distance of 500m
D=500

Weight $q_D(d)=1-(d/D)$

D=distance the user wishes to travel
d=distance of destination from user's current location

Modern Clinic:Score= [1-(364/500)]=0.272
Get well soon clinic:Score= [1-(340/500)]=0.32
Dr Usha Clinic:Score= [1-(300/500)]=0.4
Margao Clinic:Score= [1-(233/500)]=0.534

Hence the doctors will be ranked based on the score:

1] Margao Clinic

2] Dr Usha Clinic

3] Get well soon clinic

4] Modern Clinic

IV. PROPOSED WORK

In order to save time and energy, and break the constraints of time, a mobile as well as a web based application based on Android was proposed and realized in the paper.

Currently the patient has to visit the clinic/hospital, wait in the queue in order to get the doctor's appointment. The patient might sometimes find it difficult to decide on a specialist doctor for a particular problem. With the help of this application, a user can book a doctor's appointment, predict specialist doctor for

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a medical problem and find out which is the nearest doctor/pharmacy etc.

V. PROPOSED METHOD

The application has the following design process:

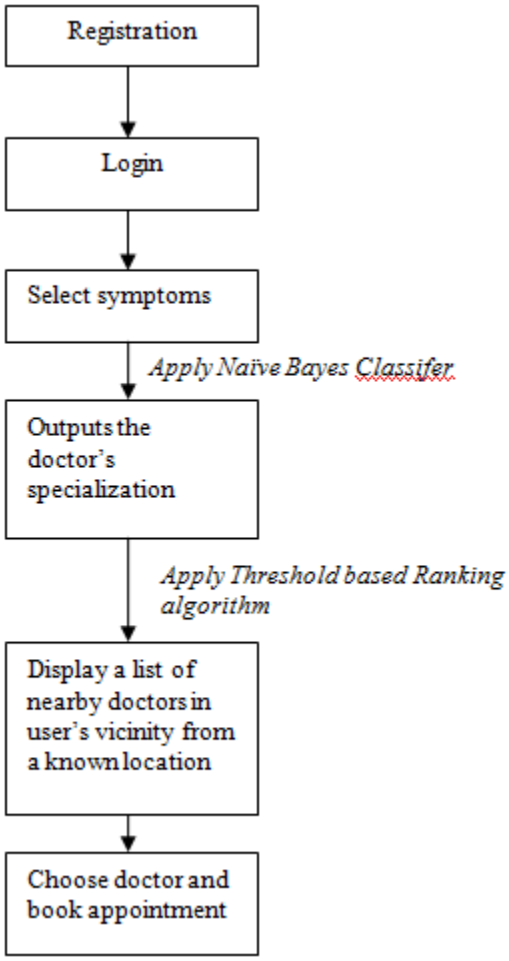

Fig. 6: Flow diagram

VI. RESULT AND DISCUSSION

The minimum requirements for Mobidoc application to work on Android smart phones are as follows: 512 Mb Ram, 150 Mb Storage space and Play store.

Once the Mobidoc application is downloaded by the user, he needs to follow the steps as given below and as also shown in the snapshot(Refer Fig 7):

a) Register as a patient or a doctor

When user is using the app for the first time he needs register as a doctor or a patient. Depending on this, he will be provided with a variety of services.

b) Login

If user has already signed up, he needs to login to avail the facilities of the Mobidoc application.

c) Patient functionalities:

- A person with a patient account can search for hospitals, clinics, pharmacies based on location i.e. the person can find the nearest hospital, clinic, pharmacy using the location based services of this software.
- He/she can also search for doctors by selecting the symptoms from the list provided; Depending on nearby doctor in user's vicinity from a known location , the user can select the doctor and book an appointment.

d) Functionalities for doctors.

- The doctors can view the appointment details online and they can accept /deny it;
- The doctor can update their schedule for patients so that they can book the appointment online.

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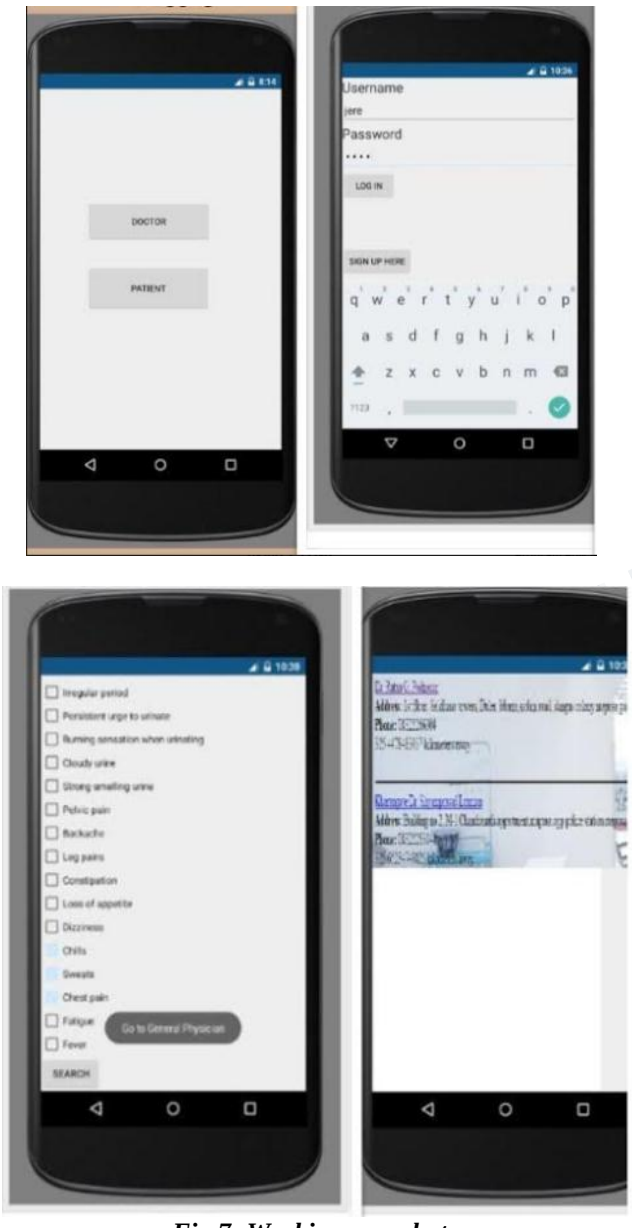

Fig 7: Working snapshot

VII. CONCLUSION AND FUTURE SCOPE

The Mobidoc application presented in the paper targets to reduce the efforts of the patient and the doctor. As the patient will not have to wait in the queue for booking an doctor's appointment and also book an appointment according to their choice in a more convenient way. It also helps the doctor to manage their appointment. The Mobidoc application is particularly effective and helpful as it can provide information, assist and guide regarding medical healthcare and doctors to anyone with basic internet access. The use of Naive Bayes classifier in predicting the doctor based on symptoms simplifies the task of selecting the specialized doctor in the users vicinity. The experimental result shows that it gives more accurate result. The future scope of the this work would be to predict the disease based on the symptom selected.

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