Med-Recommender System for Predictive Analysis of Hospitals and Doctors

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***Abstract*— A recommender system is proposed and developed to help users to find the best hospital for a particular treatment. Finding a best hospital that can cure one's ailment is of paramount importance. A good hospital is one in which there are always enough staff on duty with the right skills, knowledge and experience. Customer experience is how customers perceive their interactions with a company or an organization. A customer's experience is reflected in the comments that he makes about the organization through online public forums. Med–recommender system aims to provide accurate analysis of hospitals by taking into account the reviews by thousands of patients, which were written by the patients themselves in various online forums. Our recommendation system performs sentiment analysis on the reviews of various patients using Natural Language Processing techniques to classify them as positive and negative reviews. It weighs the ranking of hospitals on three different parameters namely polarity, subjectivity and intensity. The hospital with the best ranking for curing a particular disease is then given as result to the user asking for a recommendation. The system is evaluated using 300 online reviews about hospitals and specialties and found to yield 90% of accuracy. The proposed system also helps the users to understand the quality of a certain hospital by providing star ratings for the hospital when the user needs.**

Keywords*— Medical domain, Review, Comments, Natural Language Processing, Sentiment Analysis, Data Analysis

I. INTRODUCTION

The identification of hospitals that has the qualified staff to efficiently cure a disease involves a considerable amount of trust in the hospitals that are recommended by friends and family or painstakingly long hours of analysis done by the patient on the web among the various hospitals. The credility of recommendation is only through word of mouth in the former and credibility becomes subjective in the latter. Med–recommender aims to erase all these from the picture by providing accurate analysis of hospitals by taking into account the reviews of thousands of current and past patients, which were written by the patients themselves in various online forums.

Existing recommendation systems use many different approaches such as collaborative and content based approach. For example in [1], the system proposed tries to utilize the recommendations by friends and family (collaborative approach) and the content of the movie and purpose for watching it (content based approach) for recommendation of the movies. Other approaches at recommending a movie include a group affinity based social trust model for intelligent movie recommender systems as proposed in [2]. The proposed method evaluates sentimental similarities between users based on the ratings of movies and makes the results into abstract trust values. It also extracts user profiles and analyzes collective tendencies among the profiles. These two user tendencies are synthesized to form trust models and are applied to recommender systems. Other recommendation system approaches aimed at hospital recommendations such as in [4], the system aims to extract important information and encoded in free-text patient comments. The system determines the most common topics in patient comments, design automatic topic classifiers, identify comments' sentiment, and find new topics in negative comments. This system could be used by the hospital to make better their services unlike other recommendation systems aimed at helping the customers make informed purchases.

The drift towards utilizing the sentiments in the comments of customers is an evolving trend for building recommendation systems. In [5], the system proposed utilizes the analysis of comments to understand the expertise and nature of a particular doctor. In [6], the proposed system does the quality analysis using twitter comments written about the hospitals.

The above systems are designed to support the organisation's need and help them improve their customer's experience. A sentiment analysis based system for helping the layman make informed choices is very scarce. The existing systems which use sentiment analysis of comments use the comments written in a particular forum. This might result in an biased result and will produce less accurate results. Thus, a system which analyzes the large amount of user discussion comments and reviews from multiple user discussion websites is necessary. Med–recommender system is aimed to gathers the comments and reviews written by patients from numerous discussion forums and analyzes the sentiment of those comments and gives an informed and accurate result to the user.

Med-Recommender system acts as a bridge between the users and the healthcare providers. This product can be utilized by both the patients as well as the healthcare providers. The patients can use it to find a hospital which can best help them during their period of illness whereas the

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healthcare providers can harness this product as the definitive platform that helps them build their presence, grow establishments and engage patients more deeply than before.

Customer experience is a significant evaluator of how good a hospital is. Thus, the proposed system uses the comments and reviews of the patients to provide analyzed suggestions to people, and therefore the system ensures that, it will be of use to anyone using the system across the world to get an access to excellent healthcare facilities along with experienced staff.

The proposed Med-Recommender system meets the following objectives:

- Helps the user to analyze and identify the hospitals for a certain disease.
- Provide the user with the ratings of a particular hospital based on reviews written about it.
- Provide the most important portion of medical help at very low cost and minimal effort even to the layman.

II. PROPOSED WORK

Med–Recommender system provides the information about the best hospitals to the user based on public comments. This is achieved through natural language processing approach using sentiment analysis involving three factors namely, polarity, subjectivity and intensity. Polarity is used to determine the category (positive, negative, neutral) of emotion in a given word. Subjectivity refers to the personal feelings, views or beliefs. Intensity speaks the amount of impact a word has on the forthcoming words in a sentence.

A. PROPOSED SYSTEM DESIGN

The flow of the proposed recommender system is depicted in Figure 1. The proposed system involves the following steps:

1. It gathers the comments on various hospitals from numerous public discussion and review forums periodically.
2. Performs sentiment analysis of the comments collected.
3. Rates the various reviews based on the polarity and suggests the best hospital for curing a particular ailment.

Data collection from various websites

Information about hospitals is obtained from comments and reviews posted by people across the world in different public forums by web crawling through the various websites of the WorldWide Web. The data is then fed to the algorithm for further processing.

Natural Language Processing

The data collected from various comments and reviews are then processed using Natural language processing tool, Textblob. The Natural language processing involves the following stages: stemming, tokenization, part of speech tagging and parsing. Sentiment analysis is then performed on the processed reviews to give the classification of the review comments which is discussed in Section B of the Proposed work.

Ranking

The intelligence algorithm chooses the hospitals which co-relates and satisfies the need and interests of the user and displays an output to the user that summarizes the best possible choices.

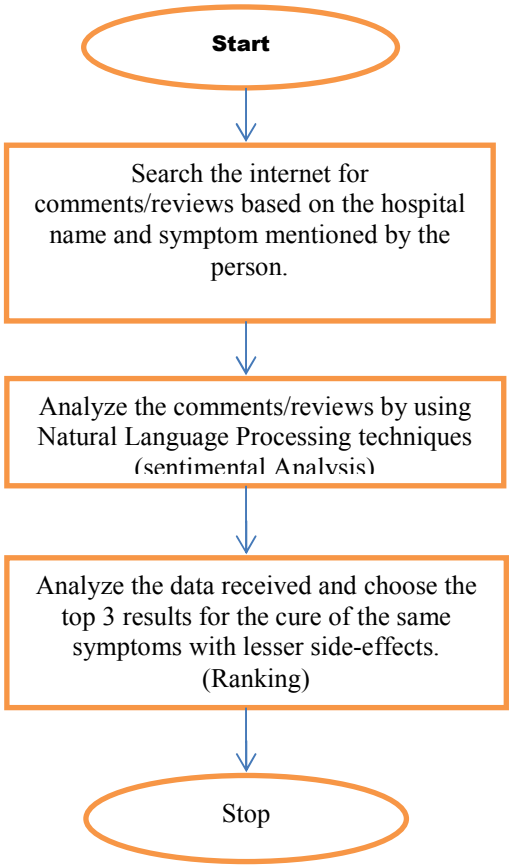

Figure 1. Flowchart of Med-Recommender System

B. SENTIMENT ANALYSIS

Polarity, subjectivity and intensity are the main factors estimated for sentiment analysis of the user's review and comments. The sentiment polarity is a verbal representation of the sentiment. It can be "negative", "neutral", or "positive". The sentiment score is a more precise numerical representation of the sentiment polarity. The average polarity of all the words in a sentence gives the polarity of a complete sentence. The subjectivity is determined by defining a subject and finding how relevant the sentence pertaining to that subject. Intensity just specifies how

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adversely the given word affects the forthcoming words. In textblob, each word in the sentence has predefined scores:

Polarity: negative vs. positive (-1.0 => +1.0)
Subjectivity: objective vs. subjective (+0.0 => +1.0)
Intensity: modifies next word? (x0.5 => x2.0)

Let us consider examples to see how med-recommender uses these three parameters to understand each sentence. Table 1 shows the polarity, subjectivity and intensity of the word great under various contexts of speech.

Table 1. The polarity, intensity and subjectivity values of words "great" and " very" in different parts of speech.

Word	Polarity	Subjectivity	Intensity
great	1.0	1.0	1.0
great	1.0	1.0	1.0
great	0.4	0.2	1.0
great	0.8	0.8	1.0
very	0.2	0.3	1.3

Case 1 : Only one word is analyzed

The polarity and subjectivity of the below code is returned as the average of the polarity and subjectivity values of the above table.

Textblob("great").sentiment
Sentiment(polarity = 0.8, subjectivity = 0.75)

Case 2 : A negative word is added

The polarity of the word succeeding the negative word is multiplied by -0.5, while the subjectivity remains unchanged. This is depicted below :

Textblob("not great").sentiment
Sentiment(polarity = 0.4, subjectivity = 0.75)

Case 3 : More supporting words are added

In this case Med- recommender ignores the polarity and subjectivity and uses the intensity of the preceding word to modify the polarity of the succeeding words. In the below example we multiply the polarity and subjectivity of the word "great" using the intensity of the word "very".

Textblob("very great").sentiment
Sentiment(polarity = 1.0, subjectivity = 0.97500001)

The above sample cases describes how a sentiment analysis is done on the comments retrieved from the forums. Similarly, the words in the review comments are processed and analyzed in all contexts.

III. IMPLEMENTATION AND RESULTS

A. Technical Background

The proposed Med–Recommender is developed using Textblob, an natural language processing tool which runs on top of Python Anaconda's NLTK package. It uses import.io which is a SaaS tool for scraping the reviews and comments written on various hospitals from numerous online review forums. It also uses Tkinter, a Python GUI package, for it's frontend.

Textblob is a hybrid sentiment analysis tool, which combine rule based and automatic approaches. In rule based approach, a sentiment analysis system performs analysis based on a set of manually crafted rules. Whereas, in an automatic approach, the system relies on machine learning to learn from data. Textblob, combines both these methods to give efficient outputs. Like any other sentiment analysis system, Textblob performs analysis through the following stages: stemming, tokenization, part of speech tagging and parsing. The default sentiment calculation is defined in _text.py of Textblob, which gives credit to the pattern library. The values of polarity, subjectivity and intensity are predefined in the en-sentiment xml file. This document considers all the different permutations in which each word can be used as well. Finally, rating is provided for the various reviews based on the polarity estimated to suggest the best hospital for curing a particular ailment.

B. Interfaces

The interface asks the user for the specialty in which they would like to find the best hospital. It also provides methods for the user to input a particular hospital, in which case the system will provide information about how good the hospital is based on ratings. Figure 2 shows Med–Recommender providing the ratings for a particular hospital and list of hospitals best suited for the inquired ailment in Figure 3.

Figure 2. Ratings of RJR Hospitals

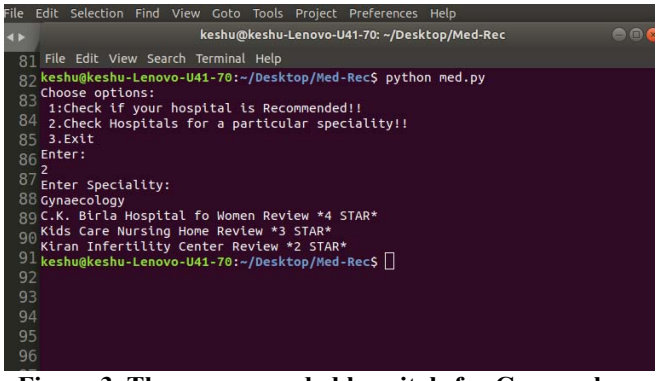

Figure 3. The recommended hospitals for Gynaecology

C. Performance Results and Discussion

The following metrics are used to analyze the performance of the proposed system.

1. Accuracy = (TP + TN) / Number of occurrences
2. Precision = TP/(TP+FP)
3. Recall = TP/(TP+FN)
4. F-Score = 2TP/(2TP+FP+FN)
5. False Positive Rate = FP/(FP+TN)

Where,

TP = No. of positive reviews classified correctly.
FP = No. of negative reviews classified incorrectly as a positive.
TN = No. of negative reviews classified correctly.
FN = No. of positive reviews classified incorrectly as a negative.

The proposed system is analyzed with different set of tuples containing the hospital name and reviews from the dataset collected. Table 2 explains the diversity of the data used in the system. Initially 150 tuples are considered and these 150 tuples have a varied range of 78 hospitals and 8 specialties. Then 300 tuples were fed into the algorithm, this dataset has 121 different hospitals which were reviewed and 11 different specialties across which these reviews vary.

Table 2. Dataset - Number of tuples in each vertical.

Number of tuples(reviews)	*Hospitals*	*Specialities*
150	***78***	***8***
300	***121***	***11***

Table 3 shows the results obtained for 150 tuples and the analysis outcome obtained for 300 tuples is given in Table 4.

Table 3. Accuracy measures of certain hospitals and specialty with 150 reviews

Item considered	Parameters observed	Precision	Recall	F-Score	FPR
C.K. Birla Hospital for women	TP = 10 FP = 0 TN = 0 FN = 1	1	0.9099	0.95	0
Medispa Hair Transplant Center	TP = 8 FN = 1 TN = 1 FP = 0	1	0.89	0.94	0
Gynaecology	TP = 16 FP = 0 TN = 2 FN = 2	1	0.88	0.94	0

Table 4. Accuracy measures of certain hospitals and specialty with 300 reviews

Item considered	Parameters observed	Precision	Recall	F-Score	FPR
C.K. Birla Hospital for women	TP = 20 FP = 0 TN = 0 FN = 1	1	0.952	0.975	0
Medispa Hair Transplant Center	TP = 8 FN = 1 TN = 1 FP = 0	1	0.89	0.94	0
Gynaecology	TP = 16 FP = 0 TN = 2 FN = 2	1	0.93	0.96	0

The first two rows of Table 3 and 4 shows the characteristics of the results obtained when the user searches if a particular hospital is recommended or not. The last row of table shows the accuracy of the list of hospitals recommended when the user searches for a list of hospitals capable of solving a particular ailment (in this case, Gynaecology). Table 5 states the performance of Med-recommender system obtained in terms of accuracy when 150 and 300 tuples are analyzed.

Table 5. Performance of Med-Recommender System

Number of tuples	Parameter measured	Accuracy
150	TP = 110 FP = 3 TN = 13 FN = 3	0.82
300	TP = 226 FP = 4 TN = 46 FN = 3	0.90

IV. CONCLUSION

This work demonstrates that sentiment analysis of patients' and user's comments and reviews stated about their experience of health care discussed in public forums. This system proves to be a quality measure of the healthcare providers. This measure shows promising results in fast evaluation of unstructured patient's feedback. This work adds to a growing body of literature opening up a new understanding of the patients' point of view of care from their postings given in online websites.

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