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MHCQ: A Tool for Measuring Health Care Quality-Using Sentimental Analysis

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Abstract: Sentimental Analysis (SA) is a text mining or Opinion Mining (OM) approach in which the opinion and an emotion of human beings related to an entity is analyzed. Sentic computing is a multi-disciplinary approach to sentiment analysis that exploits both computer and society to better recognize, interpret and process opinions and sentiments that are available online. Sentic computing is mainly used to detect the emotions of the users and analyze free text opinions of unstructured data. Measuring the quality of health care is helpful in knowing the performance of the health care system and provides the way for improvement. This study has proposed an easy-to-use tool to monitor and analyze patient opinion on a regular basis and calculates the quality of health care systems that are available in the hospitals. Usually the patients are willing to express their opinions and feelings in free text, rather than simply filling in a questionnaire, speaking out their satisfaction. This proposed tool, MHCQ allows the patients to enter their health status using an android app and evaluates their health status by means of sentic computing. The performance parameters such as precision, recall and F-measure are used to measure the mood and feeling of the patients regarding the health care system provided.

Key words: Sentic computing, sentimental analysis, natural language processing, semantic parser, affective space

INTRODUCTION

The term sentic computing is derived from the Latin words sentire and sensus. Sentire means sentiment where as sensus is intended as common sense. Sentic computing uses a common sense reasoning approach together with a novel emotion categorization model. It enables the analysis of documents not only at page level or paragraph level but also at sentence level. Sentic computing uses artificial intelligence and semantic web techniques, mathematics, linguistics, psychology and ethics. Knowledge representation and inference, graph mining and multi-dimensionality reduction, discourse analysis and pragmatics, cognitive and affective modeling, understanding social network dynamics and social influence analyzing the nature of mind are some of the application areas of sentic computing (Cambria *et al*., 2012a).

In sentic computing, the common sense knowledge contained in conceptnet (Cambria *et al*., 2012b) is usually exploited to spread affective information from selected affect seeds to other concepts. This research exploits the emotional content of the open mind corpus by collecting new affective common sense knowledge through label rules and a purpose technique. Figure 1 shows an example of concept net. In particular, developing open mind common sentics serves as a platform for affective common sense acquisition and as a publicly available natural language processing tool for extracting the cognitive and affective information associated with short texts. Emotions are often the product of human thoughts as well as reflections is often the product of affective states. Emotions in fact are intrinsically part of human mental activity and play a key role in decision-making processes such as special states, shaped by natural selection to adjust various aspects of our organism to make it better to face particular situations (Pang and Lee, 2008).

Part-of-Speech (PoS) is the important process in sentiment analysis and opinion mining. Part-of-speech tagging is considered to be a basic form of word sense disambiguation. Adjectives have been employed as features by a number of researchers. One of the earliest proposals for the data-driven prediction of the semantic orientation of words was developed for adjectives. Subsequent work on subjectivity detection revealed a high correlation between the presence of adjectives and sentence subjectivity. Adjectives are good indicators of sentiment and sometimes have been used to guide feature

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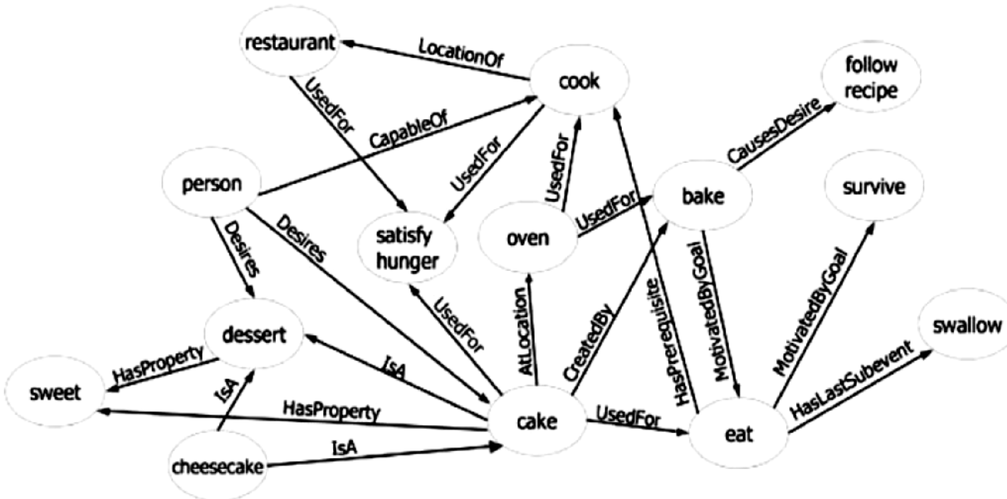

Fig. 1: A sketch of concept net (Cambria *et al*., 2012b)

selection for sentiment classification (Cambria *et al*., 2012c). Sentic computing allows measuring the health care quality in unstructured way. There are tools such as howRu (Benson *et al*., 2010) are used to monitor patient experience and outcomes in structured way. But, the patients are interested to express their positive or negative opinions in free text or speech rather than structured way. Usually, patients are happy to share their experience on health care systems. Sometimes they are benefited from others and also giving back their opinions to the society. The proposed tool, MHCQ, provides the health care quality of the patients in better way.

Literature review: This study presents the existing methodologies used for opinion mining and sentiment analysis. Medhat *et al*. (2014) have a detailed survey on Sentimental Analysis (SA). SA is the computational treatment of opinions, sentiments and subjectivity of text and also, it is the study of people's opinion and emotions on an entity. Sentiment analysis identifies the sentiment expressed in a text then analyzes it. The three main classification levels in SA are document-level SA, sentence-level SA and aspect-level SA. Document-level SA aims to classify an opinion document as expressing a positive or negative opinion or sentiment. Sentence-level SA aims to classify sentiment expressed in each sentence. The first step in sentiment analysis is to identify whether the sentence is subjective or objective. If the sentence is subjective, Sentence-level SA is determined to check whether the sentence expresses positive or negative opinions. Aspect-level SA aims to classify the sentiment with respect to the specific aspects of entities (Medhat *et al*., 2014). A detailed classification on various techniques used for sentiment analysis is analyzed and summarized by Medhat *et al*. (2014).

Cambria *et al*. (2012a) have proposed sentic PROMs to evaluate patient's health status and experience in a semi-structured way and aggregate input data by means of sentic computing. PROMs can provide a new category of real-time health information which enables every level of the health service to focus on continuously improving those things that really matter to patients. The advantage of routine measurement of Health Related Quality of Life (HRQoL) includes helping to screen for problems, promoting patient-centric care, aiding patients and doctors to take decisions. The final aim of sentic PROMs is to format the unstructured input and accordingly aggregate, it with the structured data. The patient's health status is measured with the help of the parameters such as precision, recall and F-measure. Using these parameters the polarity is calculated to measure HRQoL.

Cambria *et al*. (2012b) have proposed Social Media Marketing (SMM) using sentic computing. It involves the use of artificial intelligence and semantic web technique. ConceptNet represents the information in the open mind corpus as a directed graph in which the nodes are concepts and the labeled edges are assertions of common sense that interconnect them. The SMM tool was developed to address both marketers and end-users for the management of social media information relative to the products. Human Emotion Ontology (HEO) is developed using OWL description logic to model emotional description. The information relative to multimedia resources are represented by the descriptors provided by

OMR (Ontology for Media Resources) and FOAF (Friend of A Friend ontology) (Cambria *et al*., 2012b). The proposed tool displays the results in interactive web page developed using SIMILE Exhibit API, Java Script and Java Script Object Notation (JSON).

To overcome the disadvantages in existing coarse grained and context-free social analytics approaches a new social analytics methodology fuzzy based ontology mining algorithm is proposed by Lau *et al*. (2014). The main contributions of the proposed research are designed a social analytics methodology to extract collective social intelligence from consumer comments posted to social media web sites developed a fuzzy product ontology mining algorithm to capture the associated sentiments to support sentiment analysis designed a statistical learning method to automatically extract sentiments from online consumer comments developed based on Ontology Based Product Review Miner (OBPRM). The proposed OBPRM (Lau *et al*., 2014) is compared with text-to-onto for product ontology mining in terms of precision, recall, accuracy and F-measure and proves better.

Hai *et al*. (2014 have introduced intrinsic and extrinsic domain relevance (IEDR) criterion for identifying features in opinion mining from the reviews. It finds the difference between domain-specific corpus and domain-independent corpus, i.e., given review corpus and contrasting corpus. The list of terms relevant to the text collection is called the measure Domain Relevance (DR). The Extrinsic-Domain Relevance (EDR) and Intrinsic-Domain Relevance (IDR) scores are calculated for each selected opinion feature. The features which are having EDR score less than a threshold and IDR score greater than another threshold are confirmed as opinion features. IEDR is compared with traditional methods in the literature and proved to be better.

Deng *et al*. (2014) have proposed a supervised term weighting scheme based on the factors Importance of a Term in a Document (ITD) and Importance of a Term for expressing Sentiment (ITS). To calculate ITD, three definitions are defined based on frequency and to learn the ITS, seven statistical functions are used. Three benchmarked data sets are used for the evaluation of the proposed system by Deng *et al*. (2014). The Support Vector Machine (SVM) classifier is used in the proposed system. From the experimental results the proposed system provides better accuracy on two of the three data sets.

Cambria (2016) has explained the importance of affective computing and sentiment analysis. Usually emotions are having important role in human to human communication. Both affective computing and sentiment analysis are the enhancement in Artificial Intelligence (AI). Sentiment-mining techniques are used to mine opinions from reviews of text and videos. The affective computing and sentiment analysis approaches are classified into knowledge based techniques, statistical methods and hybrid approaches (Cambria, 2016). The tools which are used for research in affective computing and sentiment analysis are WordNet, ConceptNet, SenticNet and SentiWordNet.

MATERIALS AND METHODS

Measuring Health Care Quality tool (MHCQ): The architecture of the proposed tool, MHCQT is shown in Fig. 2. It consists of the components such as database, Natural Language Processing (NLP) module, semantic parser, affective space and statistic module. The proposed tool, MHCQT provides health care quality of a health system based on patient opinion. In this proposed tool patient enters the status and feedback using either mobile app or Graphical User Interface (GUI) and the doctor can review the status and feedback for each patient. MHCQT allows patients to evaluate their health status and experience in a semi-structured way and accordingly aggregate input data by means of sentic computing, while tracking patient's physic-emotional sensitivity.

The Android app has questions and their corresponding answers to check the health status of the patient. Question and answer systems with feedback is an unstructured collection of natural language documents. The patient entered their health status with the help of smiley's and feedback is also entered by the patient. They are stored in a database separately. Natural language processing tool, stanford NLP is used for parts-of-speech tagging, parsing and sentence breaking. The part-of Speech tagging is used to identify noun, verb and adjective. Parsing is used to determine grammatical analysis of a given sentence. Sentence breaking is used to split the sentence which is given in feedback by the patient.

The input to the WordNet tool is the output of the NLP module. WordNet tool is used as semantic parser. It is a semantic dictionary that was designed as a network following the idea that representing words and concepts as an interrelated system is consistent with evidence for the way speakers organize their own mental lexicons. WordNet tool is used to give the synonyms of the status, feedback and PoS tag words. Affective space calculates resulting sentic vector for each retrieved concept which is the relative affective information in terms of pleasantness, attention, sensitivity and aptitude which is ultimately exploited to infer moods and polarity. The affective space consists of two parts and consists of positive sentence at the top and negative sentence at the

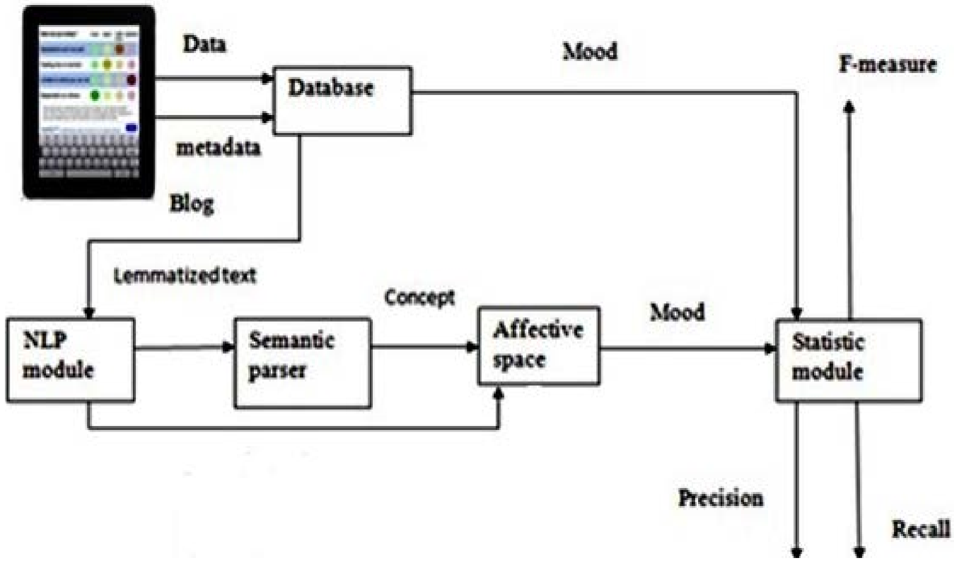

Fig. 2: The architecture of the proposed MHCQ tool

Fig. 3: The processing flow of the proposed MHCQ tool

bottom. Affective space is used to deconstruct the text and give the scores positive or negative both for the status and feedback. The performance measures used in the proposed tool are precision, recall and F-measure. The precision is the less false positive and recall is the large false positives. The processing flow of the proposed MHCQ Tool is shown in Fig. 3. Precision value is calculated based on the retrieval of information at true

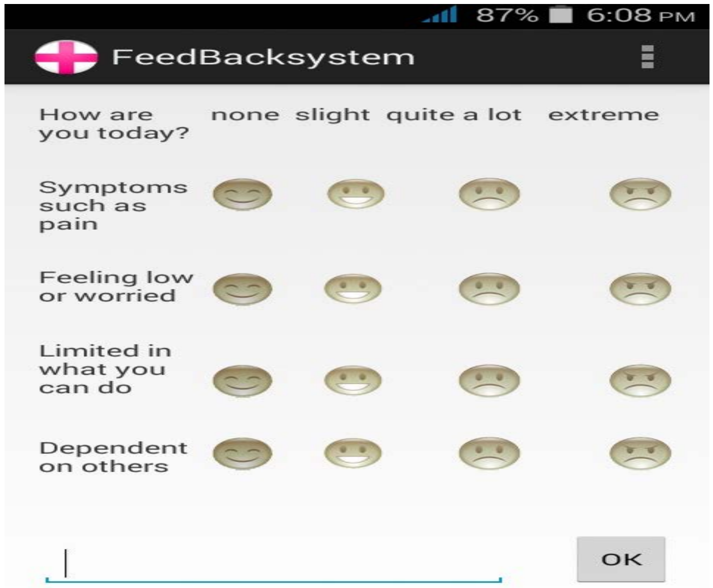

Fig. 4: Android app GUI for patient feedback

positive prediction, false positive. In healthcare data precision is calculated the percentage of positive results returned that are relevant. Equation 1 is used to calculate the precision. Recall value is calculated is based on the retrieval of information at true positive prediction, false negative. In healthcare data precision is calculated the percentage of positive results returned that is recall in this context is also referred to as the true positive rate. Recall is the fraction of relevant instances that are retrieved. Equation 2 is used to calculate recall. A measure that combines precision and recall is the harmonic mean of precision and recall, the traditional F-measure or balanced F-score. Equation 3 is used to calculate F-measure:

$$\text{Precision} = \text{True positive}/(\text{True positive}+\text{False positive}) \quad (1)$$

$$\text{Recall} = \text{True positive}/(\text{True positive}+\text{False negative}) \quad (2)$$

$$\text{F-Measure} = (2\times\text{Precision}\times\text{Recall})/(\text{Precision}+\text{Recall}) \quad (3)$$

RESULTS AND DISCUSSION

This study provides the performance measures of the proposed tool MHCQ. The proposed tool is evaluated with 200 patients. The patient entered their health status with the help of smiley's and feedback is entered as free text. The status and feedback are stored in a database separately which is taken for the NLP process in MHCQ. Figure 4 shows the GUI for patient feedback system in the proposed tool MHCQ. The output from the natural language processing will consist of the process, part-of speech tagging, parsing and sentence breaking. The part of-speech tagging is used to identify noun, verb and adjective. Parsing is used to determine grammatical analysis of a given sentence. Sentence breaking is used to split the sentence which is given in feedback by the patient.

Table 1: Precision, recall and F-measure rates of the ten selected moods

Moods	Precision (%)	Recall (%)	F-measure (%)
Ecstatic	73	61	66
Happy	89	76	82
Pensive	69	52	59
Surprised	81	65	72
Enlarged	68	51	58
Sad	81	68	74
Angry	81	53	64
Annoyed	77	58	66
Scared	82	63	71
Bores	70	55	62

The semantic parser, word net is a semantic dictionary. It is designed as a network that representing words and concepts as an interrelated system and is consistent with evidence for the way speakers organize their own mental lexicons. The input given to word net will show the synonyms and hyponyms of the words parsed by NLP. Precision, recall and F-measure are calculated for the 200 patient's feedback. F-measure is obtained by calculating the mean of precision and recall values. Table 1, represents precision, recall and F-measure rates of the ten selected moods.

CONCLUSION

Measuring Health Care Quality (MHCQ) of the patient is important task in modern health care system. The proposed tool, MHCQ is clinically useful and built using standard procedures. It is flexible and adaptable and user friendly. It also meets the requirements of continuous quality improvement. It exploits both the semantics and sentics associated with opinions of patients and aggregates data to evaluate patient's health status in a semi-structured way. MHCQ is used to track patient's emotional sensitivity. The system also measures the mood of patient in terms of precision, recall and F-measure. With the measured performance of the proposed tool, MHCQ, it is easy to conclude the health care quality of the patient in a particular health system. The proposed MHCQ can be further extended and improved to research with voice recognition and multilingual options.

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