

Social Media Canonicalization in Healthcare: Smart CDSS as an Exemplary Application

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Abstract—Social media is a mean to connect people through information sharing. It has been helping to use in various domains like education, business and human resource management. Healthcare domain however can be considered as one of the most potential domain to benefit from the social media participation in its different sub-domains like clinical observation, medications, professional training, patient education, home care and personalize care. However, there has always been a debate about contents' trust worthiness. Nevertheless, social media is totally discouraged to be considered in healthcare due to fear of open and unauthenticated contents. With all these reservations, the importance of information shared through social networks can never be ignored. This paper investigates the role of social media in patient centric healthcare. It highlights the special and active contribution of the social technologies in the domain of Decision Support System (DSS). The outcomes of this work will results in improved architecture for Smart CDSS system which is under development at UC Lab (Ubiquitous Computing Research Lab Kyung Hee University, South Korea).

I. INTRODUCTION

Social media is becoming part of our daily routine. Only Twitter attracted 105 million users [1] to post news, announcements and up to date information on some issues. Facebook established community of more than 400 million users ¹. Likewise over 800 million unique users visit YouTube each month ². Social networks hold potential to be utilized in various sub-domains of healthcare like disease management, maintaining health wellness, patient education, professional training and many more. Paul Keckley enlisted many of such applications of social networks in the domain of healthcare [2].

The use of social media in healthcare requires in depth analysis of dual sides; social media side and healthcare side. The most general categorization of social media can be based on the parameters like nature of social media, type of people using it and the kind of sharing contents. Healthcare side can be alienated as; what is the context for social media to use? This paper provides the foundation for social media

meaningful utilization in the area of healthcare especially in the area of decision support system. Clinical Decision Support System (CDSS) is one of the focused arenas that is considered for social media canonicalization in healthcare.

Very recently, UC Lab proposed the initial design of comprehensive architecture for Smart CDSS where one of the important inputs mentioned for decision making is social media. Smart CDSS is envisioned to help physician at the time of diagnosis and medication with three types of diverse inputs including clinical data, sensory data and social media generated data [3]. Social Media input to CDSS on one hand assist the physician in decision making at time of observation and medication. On the other hand, it helps the patients to get guidelines on their current health status. Other than DSS, social media can provide interesting stories regarding some specific disease like cancer which will help professionals to learn experience from and the users interested to find information on the same lines. Users will get response in the form of guidelines to the social network they are using.

This paper covers different social networks with their potential role in decision making by CDSS system to assist the clinicians at time of patient diagnosis and medication. Also it provides the case study of how twitter input can be converted to a standardized format in order to be used for decisions making. This work will lay down the foundation to mature social media input for Smart CDSS currently under development. Also it will open new horizons of research for new in-takers in the area of social mediated healthcare. This work has several challenges like contents trustworthiness, data interoperability as mentioned in one of my papers [4], but this is the right time to harness the meaningful use of this highly potential area in healthcare for improved patient care.

II. PROBLEM AND STATE OF THE ART

Social mediated healthcare can results in manifold advantages for both patients and clinicians. But the issue is that social media generated contents are not usable for decision making easily due to the diverse nature of social networks. Taking input from social networks need normalization before it can be used in any decision making process. So the

¹<http://www.zdnet.com/blog/facebook/facebook-has-over-845-million-users/8332>

²http://www.youtube.com/t/press_statistics

problem of how to make this input usable can be seen from two perspectives; patient and clinician. As a patient, the internet users need a platform where they can get guideline about their health issues in order to educate themselves for the next step avoiding a physical visit to a physician every time. Clinicians face numerous information needs during patient care activities and most of these needs are not met [5].

Lacking of social aspects in decision making process creates thirst for social and behavioral knowledge regarding patients. Clinicians too, spend much time to dig out the required information with respect to social interactions, activities and behavior by asking a series of questions from the patient. This lacking also leads towards depriving many-fold benefits afterward. The data generated as a result of user interactions can be transformed into a well-structured format which can be utilized to help in clinical decision making. To explain the problem in one sentence; social media exists but is not canonicalized properly in healthcare to benefit for improved patient care.

Health Level Seven (HL7) Context Aware Knowledge Retrieval (Infobutton) [6], [7], [8] is one of the initiatives to help from online knowledge resources in clinical decision making. Infobutton is one of the popular techniques to connect clinicians using health systems like Electronic Health Record (EHR) with knowledge resources. Infobutton supports identified knowledge resources to connect via HL7 standard. It doesn't mention anything about social media input assistance in decision making which is important for a clinician to know about social interaction and behavior of a patient. Infobuttons for CPRS³ is a project initiated with the aim to use an Infobutton Manager customizing the way resources, applications, and clinical context provide decision support. Novice Computer Decision Support (N-CODES) Project [9] provides approach to guide novice nurses while making clinical judgments. The approach has the worth of its own but we are focusing to come up with enhanced knowledge base to assist physicians in decision making process. Author of [10] highlighted the effects of computer based CDSS system on physician performance and patient outcomes. They mentioned that CDSS is less effective in diagnosis. In our work we are trying to achieve good results in diagnosis and recommendation which will result in better patient outcomes. The statistics given in [11] encourage us to harness the valuable potential of social media in healthcare.

III. PROPOSED APPROACH

DSS can utilize social media at two levels; fetching useful information for clinician to assist in decision making and generating guidelines based on existing knowledge stored in the Knowledge Base. These guidelines are sent to the respective social network from where the input was taken

in order to guide the user accordingly. Fig 1 depicts this approach as integration with Smart CDSS. The components of Smart CDSS are not explained here as they are elaborated in [3].

A. Fetching useful information from social media

Getting information from social media is the first step to consider for decision making. There are many sub-steps to achieve this task as the nature of social media interactions is different from each other. Selection of social network determines the nature of data to be fetched but the data needs many investigations to reach to the pertinent contents. First of all, what should be the request format to interact with target social network? HL7 Infobuttons connect with clinical knowledge resources via standard request mechanism (HL7 Messaging). In case of social networks, this approach will not work as the services/applications/APIs available to get data from social networks are not necessary to be HL7 compliant. However, sending request in non-standard way to get the unformatted data requires transformation techniques to convert into some standard format. In our approach, we are following the latter i.e. transforming the fetched data into virtual Medical Record (vMR) [12] and send to the Smart CDSS [3].

B. Generating guidelines using Knowledge Base

Generating guidelines for fetched data using knowledge in the KB is only possible if the KB has enough information to match this new data. In case when there is no matched rule in the KB then we will help from machine learning techniques. Naive Bayes technique [13], [14], [15] is one of the possible candidate approaches to consider predicting the required guideline. The most important aspect of the proposed approach is the transformation of mined text from social media into some standard format so that Smart CDSS can accept for decision making. HL7 vMR is the proposed format to convert the input data after identifying the patterns by Natural Language Processing techniques into clinical statements.

IV. METHODOLOGY

Social Media is a vast domain in itself. We will select some specific social networks in order to analyze their basic

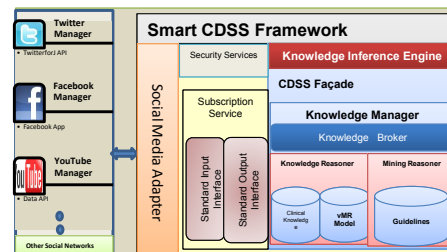


Figure 1. Social Media Input to Smart CDSS

³<http://www.openinfobutton.org/project-definition#TOC-Objectives>

theme, nature of data and features to be used in decision making process. Generically it will compose of the following steps.

- Selection of Social Media categorizing as social networking, media sharing, blogs, wikis etc. that can add value to use in healthcare.
- Fetching data using services/apps/APIs as per corresponding social media. Among the possible approaches of getting data; Twitter, Facebook and YouTube are discussed in next sub-section.
- Filtration of information gathered from various sources based on the parameters chosen for decision making.
- Transformation of filtered data into a standard format (HL7 vMR).
- Combining social media vMR with sensory input and local database clinical input in order to make a complete vMR input for Smart CDSS.
- Check with the existing rules in KB of Smart CDSS, if found then generate the guidelines, otherwise apply the technique of envisioning some trained values for prediction using Naive Bayes or some other useful machine learning techniques.

A. Data Fetching Approaches from Social Networks; Twitter, Facebook and YouTube

This section provides possible approaches of how to fetch data from Twitter, Facebook and YouTube. Also it discusses about the nature of target social network.

1) *Twitter*: Tweets are short messages limited to 140 characters. This information can be used for effectively monitoring person's social activities. Also it can be used to extract some important information to be used as knowledge for clinicians especially when a tweet refers to some clinical web resource in it. Some API like Twiiter4J ⁴ is used to fetch data from user tweets. Twiiter4J returns data is in JSON format so it needs processing before using for the decision. HL7 vMR is the proposed format to communicate with Smart CDSS. So there are two types of interaction with Twitter. First; extract information from the tweets of a particular patient into Smart CDSS generating guidelines to monitor him/her health status. Second; extract information from the tweets by clinical experts generating knowledge in order to enhance the KB further. Fig 2 shows the interaction diagram of Smart CDSS with Twitter.

2) *Facebook*: People use Facebook to stay connected with friends and family, to discover what's going on in the world, and to share and express what matters to them. In addition to interaction, Facebook can play an important role to add to the KB of Smart CDSS. There are specialized groups and communities established on Facebook that share information regarding a specific health issue like cancer. On one hand, we can determine the user's behaviour

from Facebook data, on the other hand we can build new knowledge to KB using special groups created for specific health issues. One of the possible ways to approach to such groups/communities is to develop Facebook applications. Customized application will fetch the data from the group provided that it has the open access. The interaction pattern of Smart CDSS with Facebook will look like Twitter shown in Fig 2 except that here we will use Facebook application instead of API like TwitterforJ and also Twitter Manager will be replaced with Facebook Manager.

3) *YouTube*: YouTube is another potential social media input to consider for Smart CDSS. According to [16], 32% of 180 million viewers watch health videos. There are a number of YouTube channels created around the world. For example, American hospitals created more than 500 channels on YouTube containing thousands of videos ⁵. Similarly, National Health Service (NHS) ⁶ has published more than 500 videos on YouTube. These channels can be used to assist not only clinicians in decision making but also can enhance the KB of Smart CDSS. In this case analysis can only be performed if videos converted to textual format using transcription techniques. Videos from YouTube can be fetched with the help of some APIs like Google Data API ⁷.

V. DISCUSSION ON SIGNIFICANCE, CHALLENGES AND LIMITATION OF THE WORK

Similar to other tools and techniques Social Media can play an important role in healthcare industry. Statistics show that 60% percent of surveyed physicians are interested in using social networks for professional purposes [11], which means that they can be empowered in decision making during treatment of patients on some chronic diseases. In other words, physicians can benefit from experience of other physicians for some chronic disease diagnosis. The outputs of collaborated efforts of practitioners can be input to CDSS

⁵<http://ebennett.org/hsnl/>

⁶<http://www.youtube.com/user/NHSChoices>

⁷<https://developers.google.com/youtube>

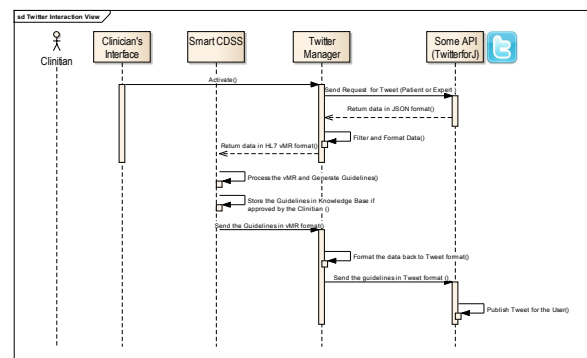


Figure 2. Twitter Interaction with Smart CDSS

⁴<http://twitter4j.org/en/index.html>

for certain diseases. So systems like Smart CDSS can play a prominent role to fill the gaps of decision making process as it has enriched with social media input along with other inputs like sensory data and local clinical database data.

However, there are many more challenges still on the way to be seen. First of all contents trustworthiness; social networks are meant to create for sharing data in a free style without taking into account the contents verification. Although in our work we are dealing with this challenge "keeping the contents coming from social media as unpublished knowledge until it is approved by the clinician or panel of clinicians". However, at the surface level, it helps the clinician to decide better for a patient knowing his/her social interactions. These issues are well discussed in [17] where the authors gave the concept of Health Trust which basically checks the trustworthiness of the contents as per maximum before using in the healthcare applications. Such issues lead towards limitation of our work. Another big challenge is the interoperability. Smart CDSS accepts data only in vMR format while the data fetched from social networks are in unstructured and free narrative style format. The input needs close attention to identify patterns in it before transformation into vMR. There are many other challenges and requirements associated to our work either one way or the other as discussed in our paper [4].

VI. CONCLUSION

The global emphasis on interoperable EMR/EHR systems has increased in recent years. At the same time, use of social media among the internet users is also increased. Health 2.0 main focus is also the innovations in healthcare domain through the use of social media participation. The proposed idea in this paper focuses on meaningful integration of social media with healthcare information systems more specifically with decision support system. The work can be considered as an extension of Smart CDSS focusing on social media input exploration and normalization. The idea is envisioned to facilitate both physicians and patients to get into more informed healthcare. We are unable to present a coherent view of the overall infrastructure, however, it will lay down the foundation for further work on the same lines. In future work, we will look into the challenges discussed in Section V and will put efforts to investigate nature of each social network and usefulness in decision making process. Also we will see how to align Infobuttons Standards with our solution in meaningful way.

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