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2014

IMPROVING THE MATCHING PROCESS OF DENTAL CARE RECOMMENDATION SYSTEMS BY USING SUBJECTIVE CRITERIA FOR BOTH PATIENTS AND DENTISTS

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Abstract

Nowadays, healthcare recommendation systems are matching health professionals with patients based on preferences such as location, type of treatments, price, availability or other information including their type of health insurance. In the health social network domain, subjective criteria such as attitude, personality and behaviour have not been considered for matching of patients and health professionals. In this research, we focus on dental care recommendation systems and we aim at introducing subjective criteria in the matching process. Patients are profiled in terms of attitudes, personalities and behaviours through a set of questionnaires, derived from the popular methods such as DISC (Dominant, Influencer, Steady, and Compliant) personality test. In addition, we use crowdsourcing to extract feedback from patients and to profile dentists according to their qualities (e.g.: friendly, caring, rude, etc.). These qualities are then used in the matching process. A thorough investigation on how to improve the matching process of a patient's subjective profile with a dentist's qualities is done through online questionnaires and focus group. The research aims at deriving a dynamic set of matching rules to improve the process of recommendation that includes subjective aspects so that in the future, patients can be better matched with the 'right' dentist for them.

Keywords: Health social networks, Dental care, Crowdsourcing, Recommendation systems, User profiling, matching.

1 INTRODUCTION

Healthcare is not immune to the spread of popularity of social media and recommendation systems. The trend of searching for health related information and sharing through social networking sites (SNSs) have been increasing (Luo and Smith 2011). Thus, the information is readily available online through reviews and ratings for health professionals from crowdsources, such as health social networks (HSNs). The HSNs have been used by both health professionals and patients, transforming the way they connect, search and communicate. These platforms allow the members to create, retrieve and share information and experiences. Examples include MedHelp, WebMD, PatientsLikeMe, DailyStrenth, CureTogether, Tudiabetes, Asthmapolis etc. (Swan 2012).

Pew Research Center (Lee 2012) reported a rising number of e-patients stating that 80% Internet users in the US get health information online. It is the third most popular online activity after email and search (Gallant et al. 2011). The Internet has become a better source of information in some cases than physical healthcare providers for users (Hou & Shim 2010). A survey indicated 81% of adult users have used the Internet for health information and acknowledged that the Internet is the most widely used source for health information instead of doctors, friends and families (Moturu and Liu 2010). It has gradually changed the patients' behaviour and been noticed a shift from passive and uninformed patients to empowered patients (Moick and Terlutter 2012).

One of the most popular features of the Internet world is 'peer reviews' and 'ratings'. These reviews and ratings are not only shaping and influencing public views on health issues but also have a great role on finding a health professional. Generally, healthcare recommendation systems allow patients to search for the health professionals based on location, type of treatments, price, and insurance covers. An aggregated rating from patients have been utilised to rank health professionals, which helps new patient to choose a health professional. For example, RateMDs[1] and HealthGrades[2] allow patients to provide feedback on their experience with their health professionals. Although subjective criteria have not yet been considered for matching a patient with a doctor or dentist, the ratings are often based on some criteria related to a level of satisfaction which is resulted from subjective characteristics such as punctuality, helpfulness, level of trust etc. (Pradhan et al. 2013). Our prime focus in this research is to match a patient with health professional based on attitudes and behaviours.

This research focuses on dental care recommendation system. Reviews and ratings sites have been popular in the dental care area as well. A website dedicated to dentist reviews quoted, "About 60% of population has some fear … the best way to find a dentist is through unbiased patient reviews of dentists." (DentistReviews 2013). There are rating sites such as DentalCenter[3], DentalFearCentral[4], DentistDig[5], DentistReviewsOnline[6] and DrOogle[7]. In addition, a general business review site, Yelp[8] has been gaining popularity in the US for dentist reviews, which allows patients to post reviews. These sites are referred as dental crowdsources in this paper. Amongst all, DrOogle is one of the most dedicated sites for dental professionals in the US, which provides rankings on dentists based on patients' positive reviews (Dr.Oogle 2014). However, the problem is not only there are many different sites available but also the different measuring criteria amongst the sites, making it harder to choose the right dentist (Pradhan et al. 2013). Nonetheless, dentists' behaviours and characteristics can be analysed from the reviews and ratings available through the dental crowdsources.

[1] www.ratemds.com
[2] www.healthgrades.com
[3] www.dentalcenter.com
[4] www.dentalfearcentral.com
[5] www.dentistdig.com
[6] www.dentistsreviewonline.com
[7] www.doctoroogle.com
[8] www.yelp.com

Once joined as a member with HSNs, the trend of sharing, creating and searching health related information are stored in user profiles. However, subjective characteristics such as attitude, behaviour or perception at the time of interaction are challenging to retrieve. Privacy provision and anonymity adds even more complexity to the process of retrieving subjective characteristics of the patient.

In this research, we designed dynamic dental care recommendation system which matches patients with dentists based on their subjective characteristics. This paper highlights the process of integrating subjective characteristics of both patients and dentists in the system. In section 2, a brief summary of matching process is explained. Section 3 then elaborates how patients are classified based on attitudes and behaviours to improve the effectiveness of matching process. The classification of dentists is explained in section 4. In section 5, the set up for empirical study is discussed to derive matching rules between patients and dentists. Finally, a conclusion is drawn.

2 MATCHING PROCESS WITH SUBJECTIVE CRITERIA

Subjective characteristics such as fearful, friendly, talkative, perfectionist, ambitious and so on are important in any interaction between two people. It has been reported that 'meeting of minds' between two individuals are important for effective communication (Clack et al 2004). The differences in personality between patients and health professionals may cause miscommunication (difficult encounters) between them. Moreover, Breen and Greenberg (2010) mentioned that understanding patients and knowing own limitations, strengths and weaknesses are major contributions in any patient-doctor interactions. Some health professionals seem to be able to manage difficult encounters but not others, why? It is due to difference in subjective characteristics of individuals, the communication could turn into fiasco. There has been increasing demand, to find ways to understand and appreciate the contributions health professionals make from their personality and style in their interactions with patients (Breen and Greenberg 2010). Therefore, it is critical to incorporate subjective characteristics while matching between individuals through a recommendation system.

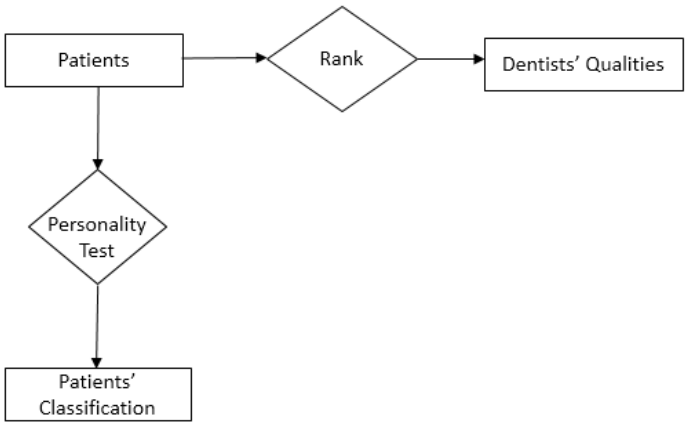

Figure 1. Matching Process of dynamic dental care recommendation system.

Subjective characteristics of both patients and dentists have been focussed for the matching process, in this study. As shown in the Figure 1 above, patients are requested to determine their personality type by taking one of the personality tests available. However, the dentists' subjective qualities are extracted from the crowdsourcing information such as dental reviews and ratings sites, readily available online.

In order to make an efficient and effective matching process for recommendation system, online questionnaires and focus group is set up for a number of patients to take the personality test and then rank the dentists' qualities. Based on the result from this study, comprehensive and dynamic set of matching rules will be prepared, which will be an engine for a dynamic dental care recommendation system.

3 PATIENTS SEGMENTATION BASED ON PERSONALITY

Alexander Osterwalder and Yves Pigneur (2010) developed a business model canvas which assimilates all aspects of a business by drawing 9 building blocks. Kevin Riley (2013) replicated the model for healthcare and created open-source business model canvas, named modelH. 'Customer segmentation' is one of the building blocks used in the original model. However, in modelH, customers are accustomed, and classified as patients by Archetype, Life Stage, Life Condition and Life Style, as shown in the Figure 2 below. Out of four types of classifications, we are focussing on Archetype (behaviours) of patients to match them with the most suitable dentist available at any given time and location. Therefore, we look at personality of a patient, which affects his or her emotions, attitude, perception, behaviours in various situations related to dental treatments uniquely. Other types of classifications are based on Life Stages (demography) such as babies, children, adolescents, adults, seniors; Life Conditions (health status) such as diabetic, blood pressure, cancer, etc.; and Life Styles (types of treatments to do) such as scaling, whitening teeth, dental implants, dental surgery, etc.

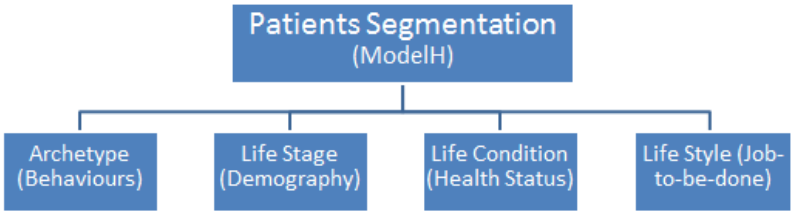

Figure 2. Patients' segmentation of ModelH (Riley, 2013).

Behaviour usually is just an expression of personality in that given circumstance. People's attitudes, behaviours and perceptions have been studied from a very long time, in the area of Psychology. There are many ways to measure a person's personality and behaviours. In this research, we use one of the most popular personality tests, called DISC (Dominant, Influential, Steady and Compliant) model. In 1928, Professor W. Marston stated that people, in general, shows their emotions through attitudes and behaviour using mainly four types of behaviour: Dominant (D), Influential (I), Steady (S), and Conscientious (C). DISC characteristics of emotions and behaviours are widely used for personality tests. Extensive lists of behaviours which qualify into the categories of DISC are available such as ambitious, outspoken and decisive as D, friendly, expressive and people-oriented as I, good listener, consistent and family-oriented as S and organised, perfectionist and detail-oriented as C (DISCInsights 2014). There are other personality models available such as descriptive model of personality traits, which focuses on five dimensions, and called Big Five traits (McCrae & John, 1991).

As mentioned above, in the context of the dental treatment, we use personality test to classify the patients. Once the personality is determined, matching the patient with a dentist who is suitable and experienced in dealing with that particular type of patient would be the most useful outcome for the dental care recommendation system.

4 DENTISTS CLASSIFICATION BASED ON BEHAVIOURS THROUGH CROWDSOURCES

In our research, the classification of dentists is extracted by analysing subjective characteristics or dentists' qualities. We chose popular dental crowdsources: DrOogle and Yelp in the US. These two sites are chosen for this study because the numbers of dental reviews are significant enough to analyse dentists' qualities. Since the word 'crowdsources' or 'wisdom of crowds' pertains many sources of the information, dentists from the popular cities of the US are selected. In comparison to other places in the world, the dentists from the US have the most reviews per dentist. The number of reviews has reached over 1,000 for some dentists as shown in the Figure 3 below. In addition, there are a higher number of dentists with reviews in the main cities of the US than any other cities in the world.

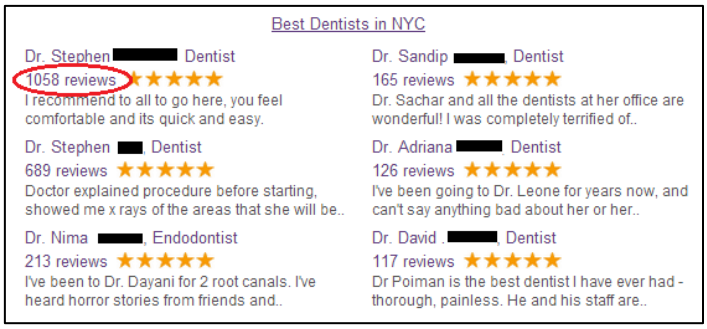

Figure 3. Extract of a list of dentist reviews in New York (DrOogle 2014).

Amongst many sources, DrOogle site is a dedicated dentist guide which allows dental patients to write reviews and personal feedback on their dentists. Based on positive reviews, the dentists are rated within a particular location in US. This site provides a paid service (US$18 to become a member) and is regulated so that the users can only post one review per dentist. It is also dedicated to avoid shilling attacks and dental rankings manipulations (DrOogle 2014). Another popular site, Yelp is also analysed and used in this research to classify dentists based on their subjective qualities.

Research in dental care has been exploring important subjective characteristics as well. Sbaraini et al. (2012) stated that dental patients' expectations are related to dentists' friendliness, caring attitudes, confidence and communication. Caring, compassion, thoughtful and supportive dentists are valued high by patients (Yarascavitch et al. 2009). Merijohn et al. (2008) and Mettes et al. (2008) pointed out the importance of expertise, knowledge sharing from dentists in the treatments. The terms (friendly, caring, experts, confident, good communicator) are also used to describe dentists in the reviews. The terminologies used by patients to describe their dentists, are subjective characteristics or behaviours of the dentists, and they are referred as dentists' qualities in this paper.

We analysed the frequencies of the terms used by patients to describe a particular dentist in the reviews, thus the dentist's qualities are derived. Based on the number of terms which qualifies the subjective characteristics of dentists, we have selected the list which is shown in Table1. We used the method called, term frequency-inverse document frequency (tf-idf) for text mining (Salton and Buckley 1988) the review data. For example, if a word 'friendly' is used by many patients to describe a specific dentist in an average, the dentist's behaviour can be depicted as 'friendly'. Similarly, other dentists' qualities are extracted by analysing the review data. The Figure 4 below shows an example on how the terms are extracted from 4 random reviews of a dentist. The example shows how the term 'friendly' is mentioned 4 times, 'explained' is repeated 2 times and 'professional' and 'rushed' once. The same process is applied for all the reviews of the dentists to describe the dentists' qualities.

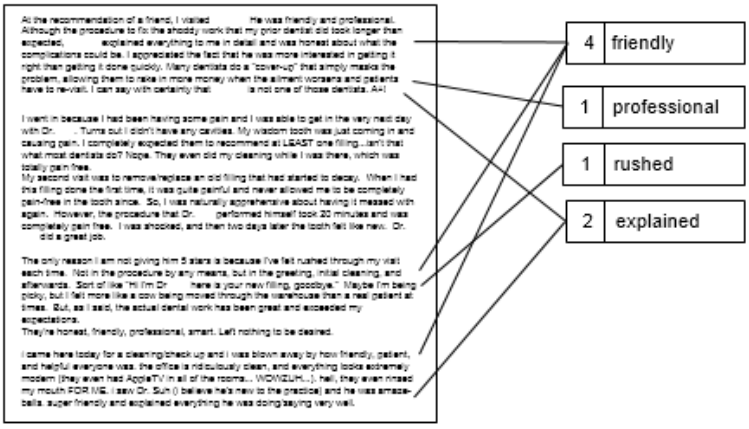

Figure 4. Example of how text mining is done from reviews.

However, there are not only synonyms for a word but the word can also be expressed in many different ways. We have selected the terms and created lexicon of the terms before analysing the review data by using tf-idf, text mining method.

4.1 Lexicon of terms used for Dentists' qualities

Mohammad (2011) prepared a 'National Research Council Emotion Lexicon' for 8 emotive words (anger, fear, anticipation, trust, surprise, sadness, joy, and disgust). There are over 1,000 words for each emotions. Only anger and trust are relevant for describing dentist in the context of interaction with a dentist, and we have referred to the lexicon for these terms. Another word 'fear' is much related in the dental treatment but it is for patients' emotions. Out of over 1,000 words, we have selected some words manually from the lexicon, which are related to the dental treatment and can be used to describe a dentist. There are many other words within the lexicon which can have wrong understanding in the context of dental treatment and hence not included. An extract of synonyms or other words used to describe dentists' qualities for the analysis is shown in the table 1 below.

Dentists' Qualities	Keywords							
Trust	trust	share	good	understand	recommend	fact	confide	decent
Friendly	friendly	amiable	amicable	attentive	cordia	favor	nice	help
Caring	caring	look after	loving	kind	nice	polite	affection	pay attention
Explains well	explain	describ*	points	clarify	justify			
Reliable	punctual	reliable	rely	accura*				
Professional	professional	qualified	efficient	Expert	competent			
Rude	rude	abus*	impolit	insult*	abrupt	coarse		
Rushed	rush*	haste	pressur*	quick	fast			
Aggressive	aggress	anger	angry	annoy	argue	awful	bad	brutal

Table 1. Extract of terms used to describe Dentists' Qualities and synonyms.

The reviews are written by patients to express their feelings and feedback on the treatment by their dentist. Therefore, the most of the subjective words used in the reviews are to describe their dentists.

4.2 Dentists' Qualities based on terminologies used by patients

We are extracting the terminologies used to describe dentists' qualities from dental crowdsources: DrOogle and Yelp in US. The terms used are extracted and shown in the table 2 below.

Positive terms		**Negative terms**
Friendly	Professional	Rude
Caring	Good personality	Rushed
Careful handling	Trusted	Poor manner
Experienced	Comfortable	Aggressive
Knowledgeable	Reliable	
Explains well		

Table 2. Dentists' qualities

Since the reviews are sourced from 2 sources: DrOogle and Yelp, and from the same location and the country (US), terms used in the reviews are similar in both sites. However, the numbers of reviews per dentist are relatively different. The dentist who has the most reviews in DrOogle site does not necessarily have more numbers of reviews in Yelp site and vice versa. This trend applies for many dentists in the US. It shows that the user base of these sites is different. Nonetheless, the patterns of use of terms are similar in both sites.

As an illustration, we selected a dentist from New York who has a significant number of reviews in both sites. There are 556 reviews for this dentist in DrOogle site and 65 reviews in Yelp site. We have

used the method, tf-idf to count dentists' qualities related terms used in all those reviews, as described earlier. The result is shown in the Figure 5. The numbers of terms used are shown as percentage based on total number of reviews for the dentist in the first graph. In the second graph, the numbers of terms are shown as percentage based on total number of terms to describe dentist's qualities, 1,247 and 246 in DrOogle and Yelp respectively.

The graphs show that the way patients describe their dentists are similar, although sourced from two different sites (DrOogle and Yelp). In addition, even when actual numbers of reviews are significantly different (556 versus 65) the proportions of actual terms used in the reviews, are almost evenly distributed in both sites, as shown in the graphs. This shows that the dentists' qualities are well recognised and noticed by the patients in general.

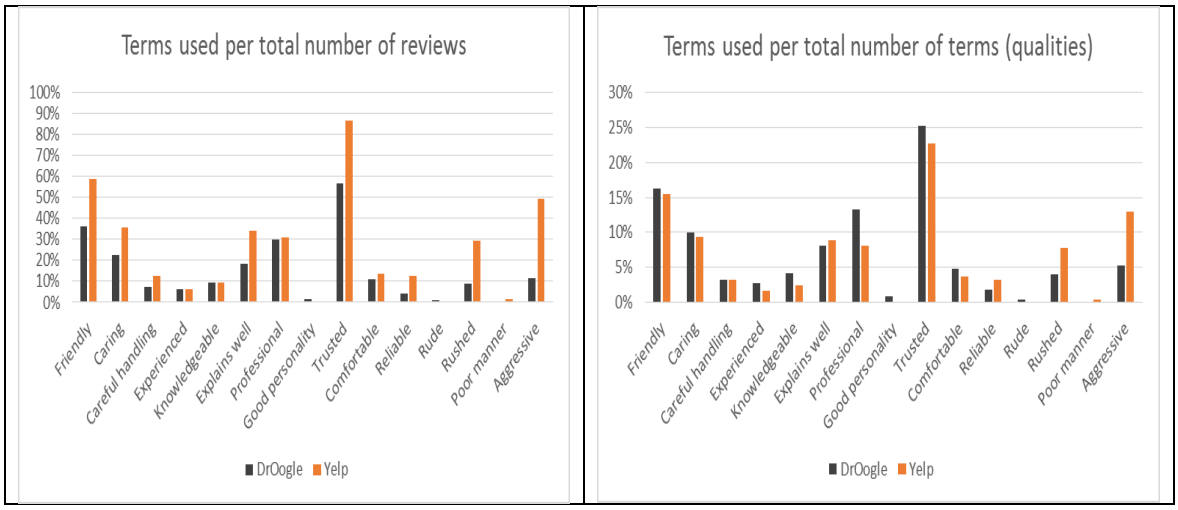

Figure 5. Comparison of terms used in different sites (DrOogle vs Yelp)

Y-axis: Percentage of terms used.

Dentists' qualities are thus extracted and used as subjective criteria for matching dentists for patients, based on matching rules described in the next section.

5 FUTURE WORK: SETTING UP AN EXPERIMENT FOR DERIVING MATCHING RULES

For this research, an empirical study is set up with online questionnaires and focus groups. The study has three major parts. The first part of this study is to conduct further literature reviews to confirm the methods used to match patients' personalities with dentists' qualities. Second part of this study encompasses conducting interviews and surveys to confirm the classification of patients and dentists. The third part is to involve dental patients to complete online questionnaires and focus groups.

Dental patients are asked to undertake a personality test available online through discpersonalitytesting[9]. As mentioned in Section 2, other personality tests are also considered. The chosen personality test has a set of 12 questions with 4 multiple choice answers (corresponding to D, I, S and C) to each questions. The questions are presented in such a way that the patients answer to a question with 'Most' likely and 'Least' likely. Once the personality test is conducted, it gives a report with patient's classification. An example is shown below in Figure 6 with two graphs.

[9] www.discpersonalitytesting.com

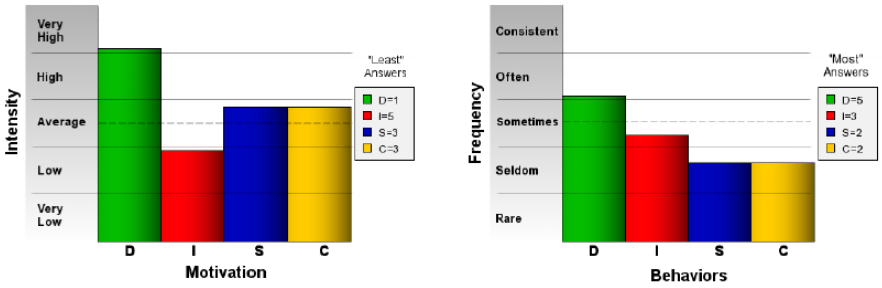

Figure 6. Example of patient in terms of their motivation and behaviour from Personality test

The graph on the left shows the internal motivation that drives the patient, derived from the set of questions with 'Least' likely. It is about how this patient feels in any given situation rather than how they will act or behave. The graph on the right shows how this patient can adapt or adjust in a given environment with their own behaviour. Based on the result from the personality tests, the dental patients will be classified into a specific type of patients. With combination of four types of personalities (DISC), we have 15 types of patients from this DISC personality test. It is listed in the Table 3 below.

Classification of Patients

Types of Patients						No. of types
D	I	S	C			4
DC	CS	SI	DI	DS	CI	6
DCS	CSI	DIS	DCI			4
DISC						1
Total number of types of patients						15

Table 3. Patients group based on personality test

The dentists' qualities have been derived from popular dental crowdsources: DrOogle and Yelp as explained in Section 4 earlier. Both positive and negative terms used to describe the dentists' qualities are listed in the Table 2. The patients will rank the dentists' qualities.

In order to devise matching rules for each type of patients from Table 3, the result from the questionnaires and focus groups will be analysed and compiled. Patients who belong to the same type, may have different rankings and vice versa. The system will be designed in a way that can analyse and update the matching rules dynamically. Weighted average of the ranks will be calculated to make the matching rules from all the participants. The Table 4 below shows some examples of matching rules.

Rules	Type of patients	Ranks of Dentists' qualities
1.	D	1. Experienced 2. Qualified 3.Reliable 4. ……
2.	I	1. Friendly 2. Caring 3. Explains well …….
3.	DC	1. Caring 2. Reliable ……..
3.	CI	1. Professional 2. ……..
..	…	…….

Table 4. Examples of matching rules that we will confirm with an experiment.

The matching rules formulated from the empirical study will be used as matching engine behind the dynamic dental recommendation system. The system will provide list of suitable dentists based on personality of patients and behaviours of dentists. Once the patient visits the recommended dentist from the system, the patient will be encouraged to provide feedback and rate the interaction with the dentists. The feedback and rating will be fed into the system so that the dentists' profiles based on the ratings and dentists' qualities will be updated instantaneously. Thus the matching rules also will be updated to provide a dynamism to the system.

6 CONCLUSION

Subjective characteristics such as personality, attitudes and behaviours of people are crucial when matching with another individual, whether it is for professional service or intimate relationships such as dating. Explosion of social media and crowdsources have significant impacts on the way people choose their health professionals. Attitudes, personality and behaviours of patients have not been yet considered while matching a patient with a health professional. In this research, we included personality and behaviours of patients while matching with a potential dentists for their treatments. Patients' classification is carried out from the popular personality test (DISC model). Profiling of dentists is done from the dentists' qualities extracted from the crowdsources (dental reviews). These qualities are used to match a dentist with a patient. A novel dynamic matching process is determined by derivation of matching rules from patients' personalities and dentists' qualities from crowdsources. This set up can be used in other healthcare as well as other professional services recommendation systems once it is formulated and tested.

References

Breen, K.J. and Greenberg, P.B. (2010). Ethics in Medicine – A clinical perspective, difficult physician-patient encounters, Internal Medicine Journal, 40, pp. 682-688.

Clack, G.B., Allen, J., Cooper, D. and O'Head, J. (2004). Personality difference between doctors and their patients: Implications for the teaching of communication skills. Medical Education, 38, pp. 177-186.

Gallant, L.M., Irizarry, C., Boone, G., and Kreps, G.L. (2011). Promoting participatory medicine with social media: New media applications on hospital websites that enhance health education and e-patients voices. Journal of Participatory Medicine, Vol.3

Hou, J. and Shim, M. (2010). The role of provider–patient communication and trust in online sources in internet use for health-related activities," Journal of Health Communication. Vol. 15, No. S3, pp. 186-99.

Lee, R. (2012). The rise of the e-patient, understanding social networks and online health information seeking. Pew Internet Project, Pew Research Center.

Luo, J.S. and Smith, B.N. (2011). Social Networking, Health 2.0, and Beyond. Information Technology Essentials for Behavioral Health Clinicians, pp. 119-131.

McCrae, R. R. and John, O.P. (1991). An introduction to the Five-Factor Model and its applications. Journal of Personality, 60: pp. 175-215

Merijohn, G.K., Bader, J.D., Frantsve-Hawley, J. and Aravamudhan, K. (2008). Clinical decision support chairside tools for evidence-based dental practice, Journal Evid Base Dent Pract, vol. 8, pp. 119-132.

Mettes, T. G., van der Sanden, W.J.M., Mokkink, H.G., Wensing, M., Grol, R.P.T.M. and Plasschaert, A.J.M. (2008). Routine oral examinations in primary care: Which predictors determine what is done? A prospective clinical case recording study, Journal of Dentistry, vol. 36, pp.435-443.

Mohammad, S.M and Turney. P. D. (2011) Crowdsourcing a Word-Emotion Association Lexicon, Computational Intelligence, Wiley Blackwell Publishing Ltd.

Moick, M. and Terlutter, R. (2012). Physicians' motives for professional Internet use and differences in attitudes toward the Internet-informed patient, Physician-Patient communication, and prescribing behaviour, Medicine 2.0, vol. 1, issue 2.

Moturu, S. and Liu H (2010). Quantifying the trustworthiness of social media content: content analysis for the social web, LAP Lambert Academic Publishing.

Osterwalder, A. and Pigneur, Y. (2010). Business model generation: A handbook of visionaries, game changers, and challengers, John Wiley and Sons, New Jersey

Pradhan, S., Gay, V. and Nepal, S. (2013). Social Networking and Dental Care: State of the Art and Analysis of the Impact on Dentists, Dental Practices and their Patients. 26th Bled eConference,

eInnovations:Challenges and Impacts for Individuals, Organizations and Society, June 9 - 13, pp. 178-187
Riley, K. (2013). Business model innovation for healthcare, modelH update: Healthcare customer segmentation – Users, buyers and intermediaries, available http://www.innovationexcellence.com/
Salton, G. and Buckley, C (1988). Term-weighting approaches in automatic text retrieval. Available on < http://www.cs.odu.edu/~jbollen/IR04/readings/article1-29-03.pdf>
Sbaraini, A., Carter, S.M. and Evans, R.W. (2012). Experiences of dental care: What do patients value? BMC Health Services Research. 12:177
Swan, M. (2009). Emerging patient-driven health care models: an examination of health social networks, consumer personalized medicine and quantified self-tracking. International journal of environmental research and public health, vol. 6, no. 2, pp. 492-525 (2009).
Swan, M. (2012). Crowdsourced health research studies: an important emerging complement to clinical trials in the public health research ecosystem. Journal of Medical Internet Research, Vol 14, No.2
Yarascavitch, C., Regehr, G., Hodges, B. and Haas, D.A.: Changes in Dental Student Empathy During Training. Journal of Dental Education. Vol. 73. No. 4. pp. 509-517. (2009).
Dentist reviews: http://www.dentistreviews.com
DISCInsights: https://www.discinsights.com
Doctoroogle: http://www.doctoroogle.com
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