

Trust Evaluation in Health Information on the World Wide Web

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Abstract—The impact of health information on the web is mounting and with the Health 2.0 revolution around the corner, online health promotion and management is becoming a reality. User-generated content is at the core of this revolution and brings to the fore the essential question of trust evaluation, a pertinent problem for health applications in particular. Evolving Web 2.0 health applications provide abundant opportunities for research. We identify these applications, discuss the challenges for trust assessment, characterize conceivable variables, list potential techniques for analysis, and provide a vision for future research.

I. INTRODUCTION

HEALTH information on the World Wide Web has surged ahead in recent years. Though the availability of this information and its use by patients has affected certain aspects of healthcare delivery [1], this wealth of information has not been fully exploited. Digital and demographic factors discriminate the users seeking health information online [2]. However, these distinctions could be blurred with the impending emergence of online Personal Health Records (PHRs). Chief web players like Google and Microsoft are entering the fray [3] in collaboration with strategic health partners, signifying that online PHRs and web-based care management will soon become commonplace.

This provides ample scope for change. With users regularly turning to the web for health information and the possibility of online PHR providers directing them to relevant information, we are going to see a major transformation in how patients manage their health [4]. Health management and promotion through cyberspace by the patients themselves or by their family and friends would form an integral part of healthcare. This would drastically improve the use of health information sources and the frequency of such use. Like the Web 2.0 revolution changed the user from a passive consumer to an active contributor, a similar metamorphosis being termed as Health 2.0 or Medicine 2.0 [5] would extend the role of information seeking users to include dissemination of experiences and

acquired knowledge [6]. The realization that information sharing could help patients or physicians and promote research possibilities will drive user contributions. The term healthcare will acquire a new meaning online with more informed patients, some of whom will pass on their empirical and acquired knowledge back to the community.

As these changes occur, the success of such information seeking and supplemental health promotion activities will be questioned. The web is going to have its share of useful health information in combination with marketing and vandalistic activities as well as incorrect information and false beliefs. The question of trusting a doctor versus trusting a quack will resurface. Books, friends and other sources will gradually be replaced by similar online entities in the quest for knowledge. Since the scope for qualified professionals disseminating health information in cyberspace is limited, there is a need to evaluate the trustworthiness of information.

Trust examination holds much more importance for healthcare than many other web domains. In this paper, we discuss the various issues and challenges for research in this area in anticipation that it will grow in leaps and bounds in the approaching years.

II. ONLINE HEALTH INFORMATION

Health portals catalog health information that also includes content developed for patient education. Sources like WebMD (www.webmd.com) are well respected and readers tend to trust their content, developed in part by medical experts. These websites, in general, follow the basic web model and are not a part of the Web 2.0 revolution that stresses on user interaction. As a result, trust appraisal is for the health portal instead of individual content. Herein, we identify Health 2.0 information sources [6] and assess the need for evaluating the trustworthiness of their content.

A. Social Networks

While social networks have become an intrinsic part of the lives of the young, web-savvy generation, health social networks verge upon becoming an integral part of the lives of the middle-aged and elderly. Though they are built on the premise of connecting patients and eliminating logistic barriers, the focus is then to manage health data, gain knowledge about other patients' experiences, provide and receive support and much more. Active participation in these networks could make patients more health conscious. Though health social networks have evolved only recently, sites like PatientsLikeMe (www.patientslikeme.com) and DailyStrength (www.dailystrength.org) show promise.

One major distinction with health social networks is that most contacts would be established online. As shared data

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could include information about treatments, drugs and effects, trust needs to be established. Trustworthiness of a user is of utmost importance in establishing the trustworthiness of shared information in this application.

B. Collaborative Information Sharing

The user-generated content revolution has gained a considerable boost through the wiki technology that allows users to collaboratively edit and develop content. Aside from the immensely popular Wikipedia (www.wikipedia.org), numerous health wikis have sprung up including restricted ones like AskDrWiki (www.askdrwiki.com) and Ganfyd (www.ganfyd.org) where only physicians and medical experts can contribute [7]. These wikis cater to the patients as well as the medical community. Trust assessment in this domain is necessitated by the numerous users with various levels of trustworthiness contributing information of differing quality. Collaborative information development allows content to evolve while collaborators monitor changes. The constant evolution alters trustworthiness continually and presents a challenge.

C. Blogosphere

The blogosphere, unlike wikis, does not allow for content evolution. Without any peer monitoring, trust can be a bigger issue unless the blogger is a medical professional or a popular blogger with significant reputation. Blogging has gained considerable popularity in recent years and health specific blogs as well as community health blogs are emerging. Since the blogosphere has no restrictions, the content in this domain could include information available from other Web 2.0 applications. Content ranging from patient experiences to shared news articles and original content makes trust assessment more complex.

D. Other forms of user-generated content

There are numerous other avenues where users can share health information on the web [6]. Groups, discussion boards, and forums are some examples. Various portals also depend considerably on user contributions. Users can answer questions or provide advice on Taumed (www.taumed.com) and rate doctors on RateMDs (www.ratemds.com) among other things. All these sources have the commonality that users physically unknown to each other share the content and the trustworthiness of that content is therefore questionable.

E. Multimedia

The multimedia revolution is another area where trust might come into play. The success of video sharing and the developing ubiquity of podcasts signify that users are getting accustomed to gathering information in different forms. This is spreading to health as well with sites like ICYou (www.icyou.com). While we do not focus on this area, it is an important consideration for trust evaluation in the future.

III. UNDERSTANDING TRUST

Trust is a concept involving in a transaction between two entities, the trustor and the trustee. Trust can be defined as

the perception of the trustor about the degree to which the trustee would satisfy an expectation about a transaction constituting risk. Trustworthiness can be defined from the perspective of both these entities. In this paper, we will only consider the perspective of the trustor, which defines this term to be the amount of trust associated with the trustee [8].

The trustworthiness of health portals [9] and the quality of health information on the web [10] has been studied in the past but not in the Health 2.0 context. Trust and quality have also been studied in the Web 2.0 context [11], [12] and are sometimes used interchangeably by researchers but there is a significant difference between the two [13].

Trustworthiness and quality might often complement each other but this is not always true, especially in the Health 2.0 domain. A trustworthy article might not be of high quality and a high quality article need not necessarily be trustworthy. Trust can no longer be assessed from a health portal perspective. Placing trust on a community blog or wiki or a social network portal is simply unacceptable. As a result, trust assessments must evaluate each individual piece of information making it an exacting endeavor.

General public may not be well versed with health or scientific knowledge. The words of experts and the trust associated with them are used to make a judgment about risks and benefits when personal knowledge is missing [14]. In addition, levels of trust can vary [15]. One would not mind trusting certain information from those whose expertise may be varied but for cases that are considered risky, it is preferable to consult certified experts. Therefore, trust is not the ultimate goal. Instead, it is a facilitator for patients to make risk-benefit assessments while assimilating health information that when accepted and followed might affect their health for better or for worse. Hence, it is a necessary aspect of online information seeking.

Trust and trustworthiness in cyberspace differ from those in the real world [15]. People trust experts who share similar values [14]. However, with limited personal knowledge and relationships built on virtual interactions, trust is hard to assess in cyberspace. To evaluate trust, we need to consider information provenance and may have to separate facts from opinion and fiction to assimilate the content accurately. Such challenges in the virtual world make this a hard task.

A careful analysis is necessary to assess trust. However, an individual might not be willing to spend the time and instead make a naïve assessment to arrive at the decision. This decision might also be affected by how trusting a person is [16]. It also might be easier to trust the written word online because of an egalitarian atmosphere in cyberspace [15]. This problem necessitates the creation of a trust score or a similar indicator to provide a relative measure that the patient can use to make an informed decision. In this paper, we endeavor to delineate the areas that need to be considered for trust assessment of online health information.

IV. ASSESSING TRUST

Assessing trust for the various Health 2.0 applications is not a simple task. The examination would need to be

different in every situation and devising an automated trust evaluation strategy for any application would be extremely challenging. Nevertheless, the basic underlying principles would be similar. In this section, we list the various categories of information that might together be useful in trust evaluation.

A. *Trustworthiness of contributor(s)*

This is probably the most important factor for trust evaluation, as it is pertinent to every Web 2.0 domain. There can be many different contributors ranging from patients and their friends to doctors or professionals employed for providing such content and even fraudsters. In this situation, trust can be studied in many ways:

1) *Expertise*: With contributors from all areas of life, contributor expertise in the area of his/her contribution might be a useful indicator of trust. Expertise could be education or profession but experience could also be considered. While, the words of a medical professional will be taken seriously, the words of a patient sharing first-hand experiences might also be considered important. There is also the issue of the user credentials being validated so that we can believe someone who claims to be a medical professional.

2) *History*: Contributor trustworthiness can be accessed through historical information like contributions and activity/participation. This is similar to a real world scenario where a person's past is used to assess his credibility.

3) *Peer evaluation*: Peer evaluation from readers, other users or experts can help evaluate the trustworthiness of a contributor. If the evaluation were for the contributor, it would be a direct indicator for credibility and even if it is for contributed content, it can still be an indirect indicator with evaluations for multiple contributions being more useful.

4) *Social connections and interactions*: There is a higher chance of trusting the word of someone who is a friend or at least connected in the social circle through one. Information about social connections and the trustworthiness of these connections can be used to assess the credibility of a user. This may not be the best way to lend credence to a user but is used by many in a real world situation.

B. *Citations or References*

Aside from personal experiences and opinions, citations and references are important aspects of establishing credibility for factual information. The types of references can also be used for evaluation by assigning them relative importance. For example, peer-reviewed publications may be considered more reliable than web articles.

C. *Objectivity, completeness and pluralism*

These qualities are considered the hallmark of good information [11]. They help assess quality of the information more than its trustworthiness and could be useful in evaluating factual information like the content of Wikipedia articles [11]. Information shared from personal experiences like the effects of a treatment would lack all three qualities but the information could still be useful and trustworthy.

D. *Other indicators*

Numerous other indicators useful in evaluating trust could be extracted from a contribution. The time at which the article was created or last updated could provide an indication whether it might be obsolete or lacking in current information. Frequency of updates of a wiki article might provide indications about its maintenance. Frequency of user contributions on a blog might indicate how seriously the user takes his role as a contributor. The length of a contribution might indicate the earnestness of a user's intent. These are some examples of the varied nature of features that can be considered while assessing trust [17].

E. *Time*

On occasion, time can play an important role in assessing reliability in a variety of ways. One needs to consider that health information has to include current knowledge. An old blog post about a drug would not reflect recent developments about its withdrawal and would not be credible enough.

When historical information is used for evaluation, recent events could be more relevant. A social network user might not have been active the first year of his membership but might be extremely active in the last two months. This recent history might have to be considered more useful than the overall history when evaluating the user's trustworthiness.

Further, with content that evolves or changes with time, it becomes a necessity to consider the temporal aspect of the changes along with the changes themselves while evaluating trust. A health article on a wiki evolves over time and recent changes are more important than those from a year ago.

F. *Peer evaluation*

Evaluation by peers can be a direct indicator of the quality of information. A piece with significantly more evaluations might be more trustworthy. Evaluation can be of many types. The simplest evaluation can be a binary indicator whether the content was useful or not. A rating system can also be used. Such evaluation is particularly useful to evaluate contributed opinions or experiences. In situations where contradicting views are presented, these evaluations can help decide upon which view to trust.

V. CHALLENGES AND TECHNIQUES

In this section, we describe major challenges that are pertinent to trust evaluation and related problems. We also briefly list the broad analytical approaches that are relevant for solving Health 2.0 problems.

A. *Challenges*

The biggest challenge for Health 2.0 research might be posed by the lack of standards among websites in the same application domain. These portals would differ in aspects like the amount of data, types of variables and data model. The dynamic and brisk evolution of information, varied navigational structures and user personalization would complicate matters further for both data collection and analysis. Integrating, processing and selecting appropriate data for analysis can be a tough task. Since distinct sources

might have differing amounts of data, data analysis techniques would have to be designed with great flexibility to allow for such heterogeneity.

Data collection is an arduous endeavor without even considering the aforementioned issues. Since shared health information in applications like social networks might be subject to privacy issues, it might not be available for use unless provided in a de-identified form by the data owners. If the data is available for use from applications like wikis, it still needs to be extracted from relevant sources. This can be particularly strenuous in applications like blogs when data is to be located and extracted from multiple sources.

The perception of trust itself can be highly subjective and context dependent [18], posing another major challenge. In many cases, finding a suitable ground truth might be a formidable pursuit. Lacking such a baseline, novel procedures would need to be designed for evaluation. One conceivable direction is the use of existing data sources to compare and build cross-validation models to resolve trust issues. For example, comparing a user claim about a treatment against a database with outcomes for a hundred patients on that treatment would help validate the claim.

The challenges discussed here are limited to a high-level perspective but a closer look at each application could uncover concerns that are more demanding. Solving these would be a key to furthering research in this developing area.

B. Techniques

One can consider various approaches for analysis of problems in the Health 2.0 domain. Given the complexity of trust evaluation, a combination of different techniques might be ultimately necessary to provide adequate solutions. Since considerable text data would be involved, text mining and natural language processing techniques might be necessary for tasks like semantic analysis, sentiment detection and word sense disambiguation [19]. Traditional data mining approaches like classification and clustering are also pertinent when relevant feature selection and appropriate data preprocessing is performed [20]. Intuitive mathematical models [17] as well as newer statistical and machine learning approaches in areas such as link mining, social network analysis, community detection and evolution, graph mining and multi-relational learning could also prove useful [21].

VI. CONCLUSIONS

The emergence of Health 2.0 web technologies will have an inevitable effect on patient health management and promotion, forming an integral part of patients' lives. As user-generated content is at the heart of this revolution, the credibility of this content needs to be carefully examined and tangibly presented. In this paper, we have tried to highlight the importance of such trust assessment.

Our main contribution is to provide a vision for research opportunities in the Health 2.0 domain with respect to trust evaluation. With diverse applications in this domain and more that will develop in the future, there are tremendous opportunities for research. We have identified various applications and delineated the possible

variables that might be useful for analysis across these sub domains. We have also discussed the challenges and the possible approaches that can be used to devise novel solutions. While actively pursuing trust evaluation research in the health domain, we are extending our work to other pertinent applications where trust evaluation is a fundamental issue. This work emphasizes the importance of trust evaluation for Health 2.0, defines and illustrates the various key issues in this high impact area.

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