

Trust Evaluation Mechanisms for Wikipedia

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Abstract

Wikipedia is the well-nigh successful and most popular free encyclopedia developed by many editors in collaborative manner. It provides multitude of opportunities for online large scale knowledge sharing between virtual communities by letting the viewer to create and edit articles directly in the web browser. Information on Wikipedia is expanding largely, but the increase in quantity is not proportional to quality of the content. The cursory observer of Wikipedia may not be able to differentiate between the good and the bad quality of the content. Despite the success of Wikipedia, trust on Wikipedia content is still questioned because of its open editing model. In this paper primarily the challenges for trust evaluation mechanisms, caused by the significant characteristics of Wikipedia's knowledge base are discussed. Existing Wikipedia trust evaluation models are comprehensively surveyed and key issues related to these are highlighted. Finally based on this study new dimensions for effective trust evaluation mechanisms are proposed, which are aimed to set-up clear goals for future research in this area.

1 Introduction

Recently an average web user has been emerged from a consumer to a content creator after the advent of Web 2.0. So a large volume of content is generated on web that is driven by the open collaborative model and mutual contributions on the social media like Wikis, Blogs and Social Networks. The gateways to access these contents are well known search engines. But they don't provide guarantee about the trustworthiness of knowledge present at Web. So it has become very important to evaluate the trustworthiness of the content that is produced by unknown users.

Wikipedia ranks as one of the top ten most visited web sites (Javanmardi, Ganjisaffar, Lopes, and Baldi, 2011) on Web which is a most successful and well known User Generated Content (UGC) repository. Various studies have been constituted to evaluate the trust in Open Colla-

borative Authoring System (OCAS) e.g. Wikipedia. Trust of readers on the information presented in these open content knowledge bases is often wondered and questioned (Moturu and Liu, 2009) by researchers. The quality of Wikipedia contents is not guaranteed as vandalism and manipulation cannot completely be eradicated. Hence several researchers have focused to minimize vandalism through fostering readers trust on content through the analysis of Wikipedia editor's behavior and the text's quality (Adler, Alfaro, and Pye, 2010). Wikipedia is designed in such a way that it has fresh information content rather than existing encyclopedias, because the editors at Wikipedia are more active and many in numbers. This largest encyclopedia is based on crowd sourcing (Fuchs, 2008). It is a system in which there is an open call of outsourcing to large group of people for completion on a specific task.

Primary goal of this paper is to provide a comprehensive summary and a comparison of the features used in identification of trust evaluation mechanisms, presented in literature for Wikipedia contents. These features are grounded and have foundations in the domain of open collaborative systems (Waltinger, Breuing, and Wachsmuth, 2011). Another significant contribution of this work is the categorization of the trust evaluation methods in field of Wikipedia and the provision of a comprehensive coverage of the open problems in this domain. This list of the open problems provides an agenda for researchers in this area.

Residuum of this paper is coordinated as follows. Section II introduces important terminology and concepts, as well summarize the problem of trust in contrast with various systems, it also introduce enduring examples in domain. Section III highlights several areas and follow-ups in more detail to the logical fundament of the trust evaluation for Wikipedia knowledge base. Section IV reviews several trust evaluation mechanisms and propose the open challenges in this field. Finally section V concludes this paper.

2 Background

Wikipedia can be viewed as an electronic session for brain storming between the colleagues or likeminded individuals, but some others heavily criticized on the open editing natures of Wikipedia and found it as waste of time (Gorman, 2005). In (West, Weber, and Castillo, 2012) Wikipedians characteristics and their editing behavior in context of their online activities beyond the Wikipedia are studied. It is found that Wikipedia editors play more games, read more news, do more search and mostly indulge in pop culture. Wikipedia's article become good quality or feature article in a short time span, especially those in which editors take more participation (Nemoto, Gloor, and Laubacher, 2011). Talk pages at Wikipedia for article can be also be simulated to make the social network between editors and to do their mutual interaction. There are certain key findings about Wikipedians, the most important findings are that they start in intense manner, tail of little, and then they maintain relatively high activity in the rest of their career (Pancier, Halfaker, and Terveen, 2009).

Information risks associated with the Wikipedia articles determine that the articles may also contain information that is not reliable and readers can't trust on it. So there is a possibility that intentionally false information is added there (Denning, Horning, Parnas, and Weinstein, 2005). More precisely, risks associated with the Wikipedia articles are classified in (Denning, Horning, Parnas, and Weinstein, 2005). These risks are equally applicable on all the systems that are open and users generated contents.

To evaluate the reliability of the content of Wikipedia in this paper primary focus is on terms of "Trustworthiness" and "Trust". It is also well accepted that the most important concept during the transaction between two entities is the trust between trustor and trustee (B. Bailey, L. Gurak, and J. Konstan, n.d.). Trust is defined as a degree by which trustee is able to satisfy the anticipation about a risk involving in transaction for a trustor. In this paper focus is on the perspective of the trustor, which relies on the quantity of trust affiliated with the trustee.

2.1 Trust Management

Trust fostering in open content systems can only be done by an efficient Trust management for readers or users. Trust management is defined by (Grandison and Sloman, 2003) as follows,

"The activity of collecting, codifying, analyzing and presenting evidence relating to competence, honesty, security or depen-

dability with the purpose of making assessments and decisions regarding trust relationships for Internet applications".

The best practices for the trust management and to enhance the trust online is providing the feedback about the content (Shneiderman, 2000).

2.2 Parameters for Trust Evaluation

There are several factors that can be used to evaluate the trust of users on the content that is generated in a collaborative manner. The two most important parameters to evaluate the trust of users are quality and credibility of the content, explanation of these parameters is as follows:

1) *Quality*: One can define quality of the text as an essential character or inherent feature for trust. To evaluate the quality some predictors can also be used to derive quality from the content. There are many other aspects in the definition of quality e.g. expertise, correctness and credibility. In literature one of the primary approaches to measure the quality of the Wikipedia content is using survival and link ratio as presented in (Adler et al., 2008a). Sometime trust is also used interchangeably with quality but it is important to understand that these two issues are distinct (Lampe, Doupi, and Van den Hofen, 2003).

2) *Credibility*: Quality of the inspiring belief is defined as Credibility (Moturu and Liu, 2009). The most suitable property about credible content is its factual accuracy. In open editing models, metadata associated with the content is the best source to judge this attribute. In Wikipedia domain metadata information e.g. proportion of reverted edits, revision counts, edit length, mean time between successive edits and reverted edits can be used to measure this trust evaluation parameter.

3 Trust Evaluation Mechanisms in Wikipedia

To evaluate the trust on the text and its authors and/or editors, one needs to assess the material authenticity and the reputation of the authors and/or editors. In this section the methods for the trust evaluation are categorized and limitations of these categories are described briefly. A summary of the methods is also presented in Table 1.

3.1 Quantitative Evaluation

Quantitative analysis of the Wikipedia data and analyzing the trust using existing data of the Wikipedia can be performed through tracing the author's activity from database dumps. In (Ortega and Barahona, 2007) is found that editing be-

havior of authors change over time. It is also stated that the analysis of sysops (an administrator of a multi-user computer system) is not much effective to analyze the contribution because the policy at Wikipedia to elect them is also continuously evolving in collaborative manner. Automated computation of the trust (Zeng, Alhossaini, Ding, Fikes, and McGuinness, 2006a) is proposed with the help of revision history of an article that is basically developed through the help of Dynamic Bayesian Network (DBN) and its outcome is a trust evaluation model that evaluates trust on a Wikipedia article.

Another trust evaluation model (Zeng, Alhossaini, Fikes, and McGuinness, 2006) is presented that is also based on article revision history. This model uses article fragments to evaluate trust. It also explores the dynamic nature of revisions so that revision history can be best utilized. This model calculates the trust on the fragments of an article. In comparison to the citation-based model (McGuinness et al., 2006) to evaluate the trust this model performs far better.

Basic limitations in above described models are that if there are no edits on articles in long time by editor then these models assume that the great degree of personal belief exists in that particular article which is not universal true. Trust labeling by the techniques described above are also unable to consider the change in positioning of words during edits. They measure each edit at granularity of sentence hence inherently these techniques miss the important aspect of positioning and in that consequence may lead to calculate distrust by these methods. Text deletions edges for cut-and-paste are also not labeled for trust evaluation which means that when the text is removed and added again in an article then it is calculated as a new edit that is another limitation of models described above.

3.2 Qualitative Evaluation

There are always a large number of collaborative activities involved in an open editing model when used over the internet. To answer the trust assessment doubts about collaboratively generated content, quality of the content becomes a prime question. Statistical analysis of the Wikipedia (Wilkinson and Huberman, 2007) has shown that presumably high-quality featured articles can be distinguished on the basis of the number of edits and contributions made by various authors/editors. In (Stvilia, Twidale, Gasser, and Smith, 2005) information quality is measured using process-oriented pages (e.g. discussion pages about the editing process). According

to them it helps to understand the discussions at talk pages about edits, and other tradeoffs they make between these dimensions also enables one to assess the quality.

Evolution of content quality is modeled in (Javanmardi and Lopes, 2010) for the Wikipedia articles to evaluate the time fractions in which articles obtained and retained high quality condition. A trust evaluation system is designed in combination of link analysis method and text survival ratio (Suzuki and Yoshikawa, 2012). This system basically evaluates the quality of articles by mutually evaluating the parameters about text and editors. When text is able to survive within the multiple revisions of article then it is considered as good quality text by them.

Another trust model is proposed in (Moturu and Liu, 2009) that relies on author's information and revision history of content. Their method has three major steps for trust evaluation which are described as follow:

- Features are identified that are capable to judge the trust of user on content.
- Trust evaluation models are designed that are feature-driven and independent of application as well.
- Evaluation of performance is done for such models.

Study on the impact of press citation is done in (Lih, 2004) for the computation of quality to a Wikipedia article in terms of number of edits and their particular impacts. They concluded that reputation of an article can be benchmarked by analysis of metadata without the rendering of article content.

One can also get the reputation of authors to evaluate the trust on individuals in the form of feedback (Adler et al., 2008a) of readers about authors, but this mechanism about individuals is missing here. External citation perspective is also missing in the above defined methods for measuring the quality of text. Because if text is cited outside the Wikipedia in some domain specific resource or at well known research repository, then it may mean that particular article has good quality text. Moreover the sources verification process belonging to an article is also very significant to evaluate the trust on article as well to measure the quality of text that is also major lacking area of researches in qualitative evaluation.

3.3 Collaborative Information Repository's Perspective in Trust Evaluation

Wikipedia is based on open editing model which is developed in collaborative manner in

which an article written and edited by several contributors. In such system reputation of authors is very important and their collaboration matters are also considerably important in trust evaluation of content (Zeng, Alhossaini, Fikes, and McGuinness, 2006).

In (McGuinness et al., 2006) revision history is used to evaluate the trust on author. It is found that the reputation of an author affects the trust on article. Their method is based on an assumption that one article is edited by multiple authors and here each edit is called a fragment. Trust is basically computed on the basis of citation and link ratio. Following steps are proposed by them to calculate the trust associated with a fragment from an article,

- Identify authors of the article and compute the trust for each author.
- Find the provenance information about edit. Here PML (Proof Markup Language) is proposed for this purpose.
- Calculate the trust on each author, independent of data storage without using Wikipedia components.

Citation of an article is considered in two ways by them; in first, if article is referred in another article then referred article gain positive trust. In second way non-citation occurrences are count. Finally page Rank algorithm is used to evaluate the trust that finds citation for particular article. They concluded that no single technique between the citation and page rank gives best results, so hybrid techniques that include PML in combination can be used for better results.

Another model of Trust evaluation is presented in (Adler et al., 2008a) that is based on revision history and reputation of authors that contributes in content generation process. In this model, trust on each word of article is calculated based on two things. One is the reputation of authors that writes particular word, and other is reputation of editors who edits nearby words. In (Adler and Alfaro, 2007) reputation of author is measured by their text age and survival ratio. This method is resistant to tampering as it has no affect of deleting and re-insertion of text by vandals. Authors that gain the high reputation, mostly generate the high quality content and this high quality content survive for long time; this intuition is also confirmed by (Adler, De Alfaro, Pye, and Raman, 2008b).

Major limitation of fragment based methods is that overall quality of the article becomes black box. Because trust of fragments and authors is calculated as fragment-of-article or author-to-fragment graphs. The link ratio base me-

thod has also limitation, that some newly written article may have more non-cited references. Another limitation of the proposed survival ratio based methods is that they work better on few articles which were highly modified by editors. This condition is not always meets when an article has low edits.

Limitations of Feedback based Trust Models: There are questions raised in mind that why not we use feedback model to calculate the degrees of quality related to text. Answer to this question is that, open edit system is itself kind of peer review system as editor's vote for implicit features of articles (Stvilia, Twidale, Smith, and Gasser, 2008). An implementation of voting systems is implemented based on MediaWiki (Wikipedia' English version for educational purposes) which is named as "Article Feedback Tool" (Kramer, Gregorowicz, and Iyer, 2008). The major limitation with these feedback models are that every users does not evaluate or review properly. In fact, according to a study (MG Siegler, n.d.) about YouTube statistics stated, voters mostly give highest votes to videos whenever they vote. So we can conclude that user usually rates for good targets.

3.4 User's Behaviours Perspective in Trust Evaluation

Content in Wikipedia is basically the result of collaborative contributions of several contributors, so the perspective of Wikipedia contributors (reader, patroller, author, editor, admin etc) is very important. Some of these contributors, self-proclaimed "patrollers" are continuously watching the article to maintain its integrity by correcting or removing the content from the article. To help these patrollers, multi-agent cognitive based trust model (Krupa, Vercouter, Hübner, and Herzig, 2009) is proposed. It assists patroller and reducing their load as well as provides them aid regarding decision making for trust evaluation on editors/author's effort. In order to maintain the social control a Multi-agent trust model approach can perform better as it enables the system for trust evaluation of other agents with in a system. One of such model is the ForTrust model that is also inspired by the theory of Social Trust presented in (B. Bailey, L. Gurak, and J. Konstan, n.d.).

In (Javanmardi, Ganjisaffar, Lopes, and Baldi, 11) analysis is performed for trust evaluation using statistical methods considering the perspectives of registered and anonymous contributors. Power law behavior is suggested by these results of submission by registered and anonymous con-

tributors. It is observed that 7% of contributions submitted the revisions in which most of them are registered, for almost 80% of whole revisions. So, it could be summarized that 63.94% of contributions in revisions are submitted by registered contributors. An interesting factor is also revealed regarding registered contributor's perspective, that only 10% revisions are submitted by administrators and 5.5% are submitted by Bots. It is observed that feature articles are formed in result of continuous effort by experienced contributors that has high reputation (Stein and Hess, 2007), hence it does matter a lot who has contributed.

3.5 Trust Fostering Policies and Visualization Impact on Readers Trust

Trustworthiness tool's impact for Wikipedia is calculated in (Kittur, Suh, and Chi, 2008). They study the effectiveness of trust evaluation methods that how much these tools affect on reader's trust about the Wikipedia's article. It is also measured that either the visualization impacts the user's perception or not by showing them hidden information about the article e.g. text quality. It is found that visualization of editor's behavior, edit patterns and stability of article impacts on reader's trust.

Another model named WikiTrust is proposed (Zhao, Kallander, Gbedema, Johnson, and Wu, 2011b) that take advantage of social context. It includes the social relation and background information of editors and conveys it to readers with personalized and authentic information. In (Lucassen and Schraagen, 2011a) it is found that the best mechanism for trust evaluation is to use multiple methods as no single method provides all possible information for trust evaluation. Several methods are combined by them with Wikipedia Screening Task. They found that combination of these methods improve results. Three experimental approaches are proposed namely eye-tracking, online questionnaires and think aloud.

Trust of reader can also be fostered by enforcing the security policies so that readers believe that there is a proper procedure of content generation and verification. Such a security policy is propped in (Lindberg and Jensen, 2012) to enforce the integrity of content in comparison to existing Wikipedia security policy to enhance the trust of the user on information. Visualization model WikiTrust (Lucassen and Schraagen, 2011b) also helps reader in order to identify the trustworthiness of content by coloring the background of less trustworthy word with some specific colors.

Trust Evaluation Mechanisms Category	Trust Evaluation Mechanisms Techniques
Quantitative Perspective	Models based on revision history using Dynamic Bayesian Network
	Models based on revision history and article fragments
	Citation-based model
	Models based on statistical analysis of the Wikipedia
Qualitative Perspective	Models based on process-oriented pages e.g. discussion pages
	Model based on content quality (used in CalSWIM mashup as a case study)
	Model based on link analysis method and text survival ratio
	Technique based on dispersion degree score (DDS) and Normalized Discounted Cumulative Gain (NDCG)
	Model based on number of edits and their impacts
Collaborative Information	Model based on editors/authors reputation and their collaboration matters
Repository's Perspective	Model based on combination of revision history, link ratio and PML (Proof Markup Language)
	Model based on revision history and reputation of authors
	Model based on text age and survival ratio
User's Behaviour Perspective	Techniques based on Multi-agent cognition based trust model (ForTrust model based techniques)
	Model based on perspectives of registered and anonymous contributors
Trust Fostering Policies and Visualization Perspective	Techniques based on visualizations impact on Trust
	Techniques based on social context including social relation
	Techniques based on security policy

Table 1. Trust Evaluation Mechanisms Summary

4 Open Problems in Trust Evaluation on Wikipedia

There are several problems in the domain of trust evaluation which are still to be investigated are described as follows:

1) *Vagueness of Quality*: Survival ratio of editing text is a significant factor to evaluate the quality of text in the trust evaluation process for articles (Suzuki and Yoshikawa, 2012). There is supposition in this technique that article may have long editing history for finding of editor's and text quality. This technique performs well

when article has long editing history but when editors edit rarely because of any reason then there is chance that particular article's text obtain high quality which is not the actual case. Hence there is need to address such problems.

2) *Trust Evaluation using Natural Language Processing Techniques*: In several research articles primary focus is on survival ratio by counting the words to evaluate the quality. So the importance of linguistic structure is missing there e.g. sentences "B is A" and "B is not A" have only one additional word added but meaning is totally changed, so the analysis of text using NLP means a lot. Moreover, it is also established (Sabel, 2007) that analysis of text is very important in finding the text qualities. This is the major lacking area in previous researches which should be addressed.

3) *User Interface and Visualization*: Several researchers have focused to evaluate the trust on Wikipedia content but very less focus is given to find the impact of these models on reader's trust. It is observed that user's trust level about the content changes when trust is shown to user with help of good visualization.

4) *Credibility of References*: Currently if a Wikipedia article has external references then usually it is considered as a good quality article but it is not necessary that provided source is a valid and well related in the context. So in general the credibility of sources is lacking in the Wikipedia.

5) *Structure of the Content*: Structure of the content related to Wikipedia's article is also significant factor of that can provide a quality measurement. Current literature rarely focuses on this aspect. These aspects include that whether the data is well structured and organized or not, it has balanced material or not, or it contains the images and tables to support material facts and their demonstration.

6) *Social Context*: To evaluate the trust existing literature focused on the author's behavior mostly within the domain of Wikipedia while they lack the significant aspect of social context outside the domain of Wikipedia to evaluate the behavior of author/editor. A study (Suh, Chi, Kittur, and Pendleton, 2008) also states that distrust on mutable social collaborative systems such as Wikipedia can be reduced by providing readers with transparency about contributors and content generation process.

7) *Sentiment Context*: Sentiment context mean that what sentiment other user's have about a particular author during any transaction e.g. other authors may think that the author has positive/negative/neutral attitude towards a topic or an article. In social environment the attitude of

individual towards each others can be used for predicting their negative and positive attitude as well (Sepehri Rad, Makazhanov, Rafiei, and Barbosa, 2012). Sentiment context is also lacking area that can also be evaluated with the help of material logged in talk pages to evaluate the sentiment of other authors about particular topic.

5 Discussions and Conclusion

Wikipedia is most viewed and largest encyclopedic knowledge reference and it is also in list of the top ten most visited web resources (Alexa, n.d.). Wikipedia has still more reliable information irrespective of its open editing model (Giles, 2005). It is found that Wikipedia has slightly more faults (approximately 4 to every 3) than the Encyclopedia Britannica for a particular sample distribution of scientific articles. So we can say that Wikipedia is still mostly referred source for information gain.

In this article a brief survey on trust evaluation strategies and mechanism in the domain of Wikipedia is provided. The opportunities and challenges in this area are described as well as the limitations of existing models are also analyzed and presented. A list of open problems in this area is also proposed so that researchers can determine particular goals future research.

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