

Quality-Based Text Web Forum Summarization-A Review

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Abstract: Text web forum summarization assists users to manage the vast amount of available information online, by condensing thread contents and extracting the most relevant facts or topics. Accordingly, the text web forum has become a valuable source of knowledge. Forums contain testimonies from people who have had both positive and negative experiences. Regrettably, the text web forum suffers from unavoidable problems including irrelevance of posts, repeated text and non-quality information values. Furthermore, a user needs to read quality information from text web forums according to his/her needs. This study reviews the respective summarization of the text web forum and quality dimensions of the text web forum. And how quality can be improved the text web forum summarization. Therefore, the studies of summary evaluation methods are also conducted in this study. So, the evaluation can be later used to evaluate whether incorporating quality can improve text web forum summarization.

Key words: Text summarization, text web forum, text web forum summarization, quality dimensions, thread retrieval

INTRODUCTION

The rapid growth of the Internet has resulted in a massive increase in available information in different formats (e.g. text, images, videos) which are difficult to manage (Lloret and Palomar, 2012). Moreover, the appearance of social media has resulted in new forms of self-expression and communication. Recently, a steadily growing amount of information is being transferred through social media, including web forum, blogs and micro-blogging services and so forth. These services allow users to write a huge amount of short text messages, posts and comments in order to communicate about different aspects of life issues (Piskorski and Yangarber, 2013). These can comprise matters such as community issues, political issues, tourist attractions, products and medical issues. A text web forum has a conversational structure in which an asynchronous communication takes place between participants on multiple interleaved topics (Farrell *et al.*, 2001). This text web forum structure can differ from one text web forum to another (Obasa *et al.*, 2014, Almahy and Salim, 2014).

On the other hand, finding quality information in text web forums is difficult due to information overload. Further, text web forums suffer from heterogeneity of content quality (Chai, 2011). Although, forums employ some monitoring procedures over user contents, manually monitoring millions of posts is impossible. In addition,

obtaining quality information in text web forums depends largely on an researcher's philosophical viewpoint such as: accurate description of a topic; uniqueness of information and valuable content. Furthermore, studies have shown that leveraging content quality has improved the performance of many functions in forums. For instance, Bhatia and Mitra (2010) and Fan (2009) showed that utilising a procedure of thread quality significantly improved thread retrieval. Lui *et al.* (2007) used post-content quality features to classify users' expertise in forums. Sun *et al.* (2010) used some quality features such as number of views and number of replies to develop a better forum crawler. Jin *et al.* (2009) reported that the quality content in forums influences the commitment and growth of the forum users. Apart from work in forums, recent studies in web document retrieval have shown several benefits of utilising quality features (Ferguson and Smeaton, 2012, Yamamoto and Tanaka, 2011). Moreover, a number of studies have shown that leveraging quality dimensions improves the forum summarization task (Bhatia *et al.*, 2014, Jiao, 2013, Subha and Palaniswami, 2013).

Text web forum summarization overview

Structure of Text Web Forum (TWF): A text web forum has a conversational structure in which there is an asynchronous communication between participants on multiple interleaved topics. This structure differs from one

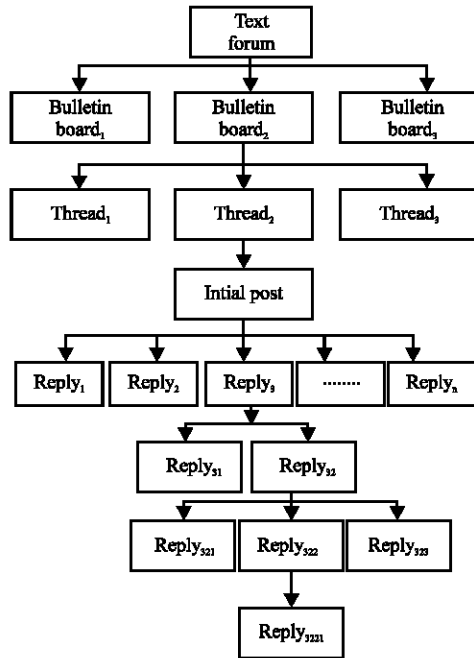


Fig. 1: Text web forum structure

text web forum to another. In its simplest text form, a text web forum consists of an initial post written by the user who opened the topic, together with comments provided by other users. The initial post with comments is called a thread. This simple form existed in the oldest discussion site, newsgroup (Almahy and Salim, 2014) (Fig. 1).

Text web forum structure takes place within a platform. A platform is made up of threads. While a thread is full of scattered topics, this is one of the challenges involved in producing the summary (Ren *et al.*, 2011). A thread is the minimal topical unit that addresses a specific topic (Obasa and Salim, 2014). It is usually initiated by an author’s post (usually called the “initial post”) which constitutes the topic of discussion. Participants who are interested in the topic send reply posts (Hatori *et al.*, 2011, Obasa *et al.*, 2014). Accordingly, this leads to an increase in the size of a thread, thus resulting in a difficulty for readers to identify with the “big picture” of the content (Almahy and Salim, 2014). Also, it is challenging for a user to read all the posts because of the huge amount of information that could be available (Hariharan *et al.*, 2010). Consequently, there is a great demand for text web forum summarization in order to provide users with the important parts of the discussion.

Motivations for summarizing text web forum: Text web forums are rich knowledge communities for several

reasons. First, the asynchronous nature and the public accessibility of forums enable communication between community members regardless of physical and temporal boundaries. That empowers users with various areas and levels of expertise by which to share and seek knowledge through in-depth discussions. Second, forums have accumulated a sizeable amount of content over a long period of time. Third, the archived knowledge contains not only factual information but also detailed solutions and troubleshooting content (Bhatia and Mitra, 2010; Seo *et al.*, 2011). In addition, the text web forum content is more comprehensive and objective than what is in the web (Seo *et al.*, 2011). Unfortunately, people have to face an ascending amount of redundant thread information when browsing text web forums. Generally, they often read only a few posts ranked ahead in a thread with large post quantities while this pattern survey reflects only the views of the incomplete conversation. Thus with an increase in the size of a thread, it is difficult for users to go through all the posts and collect information. It would be greatly beneficial, therefore, if each thread could present a brief summary of the posts. The need to summarize each thread to facilitate the extraction of important information is becoming more and more urgent (Ren *et al.*, 2011, Almahy and Salim, 2014, Krishnamani *et al.*, 2013).

Challenges for extracting information from text web forum:

The extraction of information from text web forums is more challenging than that of classic information extraction (Piskorski and Yangarber, 2013), i.e., extraction from trusted sources and well-formed grammatical texts. The main challenges encountered when processing text web forum content are discussed in a number of studies (Piskorski and Yangarber, 2013, Chai *et al.*, 2010, 2011; Wanas *et al.*, 2008; Liu *et al.*, 2007) as detailed below:

- Texts are typically very short related fragments, e.g., Facebook limits status updates to 255 characters, whereas Twitter limits messages (“Tweets”) to 140 characters
- Texts often do not follow proper linguistic rules or a formal style of writing and may contain community-specific jargon and terminology
- Texts are noisy and written in an informal setting. They typically include misspellings, lack of punctuation and capitalization, use non-standard abbreviations and do not contain grammatically correct sentences
- It has been observed that the text content within forums are often incomplete, error-prone and poorly structured

- There exists a high level of doubt regarding the reliability of the information conveyed in the text messages, e.g., compared to the news media

Quality aspect in text web forum: Quality is a subjective issue and the perceived quality of a content item will vary among its consumers. However, intersubjectivity increases when a number of people agree on the perceived quality level of User Generated Content (UGC). Intersubjectivity is a concept used in philosophy and psychology to highlight a condition existing between subjectivity and objectivity. This term describes a phenomenon that is personally experienced (subjectively) but by more than one subject. This is an important concept because we are interested in identifying UGC that is perceived as valuable (high quality) to many subjects within a social media community. The goal for measuring the perceived quality of content by the community at large is shared by Weimer and Gurevych.

In the relevant part of the thread, Hatori *et al.* (2011) considered all posts as documents in order to gauge the importance of each post. The more important sentences were then determined. It is important to remember that text web forums allow members to post content interactively. The quality of the text web forum varies drastically from excellent to abuse and spam due to the many users who participate in the forum (Altantawy *et al.*, 2009, Chen *et al.*, 2008). As the availability of such content increases, the task of identifying high-quality content on a text web forum becomes increasingly important (Chen *et al.*, 2008). Participants have different backgrounds in terms of geographical location, beliefs, motivation, requirements and knowledge (Chai *et al.*, 2010, 2011). The contents are mostly generated by participants who have little experience in creating content and contents are released without peer review. In addition, text web forums have many irrelevant posts to the topic in a thread such as junk, off-topic posts like an advertisement and trolls that negatively affect quality (Ren *et al.*, 2011). These all add up to make the process of summarization more difficult.

MATERIALS AND METHODS

Characteristics of a high-quality in text web forum: Up until now, there has been no precise definition of the topic “high-quality”. Intuitively, there are some qualitative characteristics by which to judge a high-quality topic in the human mind. People can tag high-quality topics manually according to these characteristics (Chen *et al.*, 2008). They are as follows:

Complete an activity or event: At least one complete activity or event must be discussed in a high-quality topic.

Quantity and uniqueness of information: A topic contains large amounts of quantitative material or particular contents that are worthy of attention.

Clear description: Clear description of a topic can result in a deep discussion between authors. From these discussions, people can obtain a great deal of useful information and they are likely to express their views in a clear way.

Valuable content: A topic with valuable content will attract numerous researchers to participate in and contribute their valuable views towards it.

Data and information quality: Data and information quality is commonly thought of as a multi-dimensional concept (Klein *et al.*, 2001) with varying attributed characteristics depending on an author’s philosophical view-point. Most commonly, the term “data quality” is described as data that is “fit-for-use” (Wang and Strong, 1996).

This implies that it is relative as data considered appropriate for one use may not possess sufficient attributes for another use (Tayi and Ballou, 1998). With regard to information quality evaluation, researchers do not distinguish between information and data (Strong *et al.*, 1997). Taking this into account, a common definition of data quality is the data’s fitness for use (Strong *et al.*, 1997).

After this definition, several information quality frameworks have been proposed by Lee *et al.* (2002) and Kahn *et al.* (2002). A general dimension was studied and extracted by Knight and Burn (2005). Some of those dimensions include: accuracy; consistency; timeliness; completeness; accessibility; objectiveness and relevance. The quality of the document was assumed to be distributed uniformly (Bendersky *et al.*, 2011). However, the characteristic of collection has been changed especially for web and user-generated content; hence this assumption is no longer valid (Bendersky *et al.*, 2011, Zhou and Croft, 2005).

Quality indicators: A quality indicator can refer to an information quality category, dimension or metric as hierarchically depicted in Fig. 2. Categories are used to group quality dimensions that are similar in nature. A quality dimension is defined as being a single aspect of

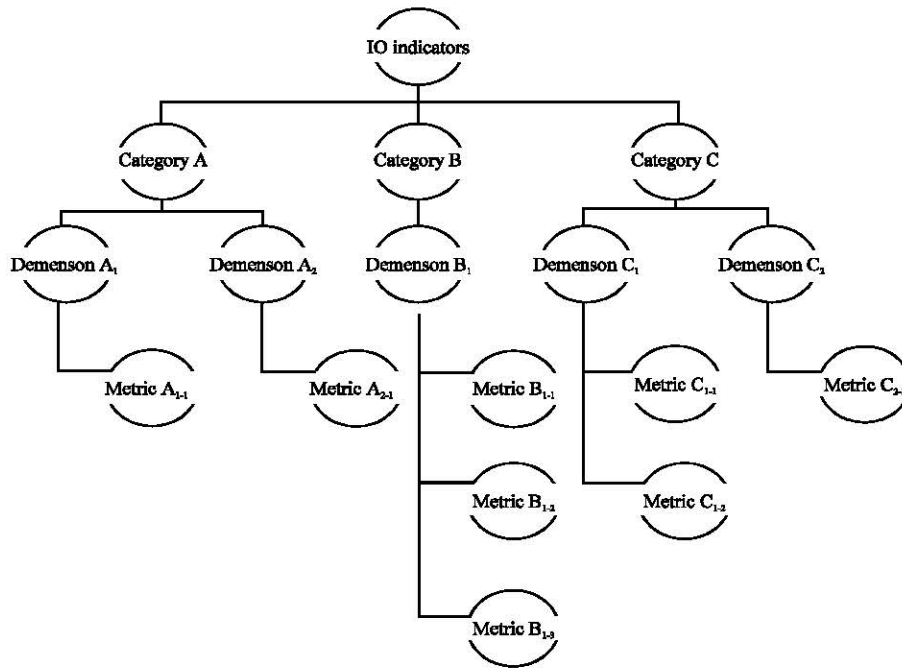


Fig. 2: Quality indicator (Wang and Strong, 1996)

information quality (Wang and Strong, 1996) and is considered as a quality trait of information. The identification and importance placed on each dimension is dependent on the context of the specific quality problem at hand. For example, accuracy is often considered an important dimension in assessing the quality of answers in community Q and A websites. Finally, metrics or features can be proposed by which to measure each quality dimension that has been selected for assessment (Chai *et al.*, 2010, 2011).

In this study we have used the term “quality dimensions” instead of “quality indicators”. Quality dimensions can be used to assist in information summarization tasks in forum threads (Bhatia *et al.*, 2014, Subha and Palaniswami, 2013). A text web forum can contain thousands of posts that are time-consuming for users to browse and read through. Quality dimensions can measure the quality of each post which can then be used as an importance weighting for information summarization tasks. Performing content quality assessment may ensure that high quality content is given more weighting than low quality content in information summarization systems (Chai *et al.*, 2010, 2011).

Studies have confirmed that data and information quality is a multi-dimensional concept (Redman, 1996; Wand and Wang, 1996; Huang *et al.*, 1998; Pipino *et al.*, 2002) and dimensions can be identified for evaluation for a given quality assessment

task. A study by Knight and Burn (2005) reviewed 12 widely-accepted data and information quality models in literature and presented a summary of the most commonly used dimensions. These can be seen in Table 1.

Content quality concepts: Research in the data and information quality field can be considered as relatively mature. The main difference between content quality and information quality is that content quality considers that the requirements of many consumers and content are often provided by untrained creators in a Web 2.0 environment. With regard to information quality is considered as information that is fit for use by its consumers within a given context (Chai *et al.*, 2010, 2011). An emerging topic that has recently branched from this domain concerns measuring the quality of User-Generated Content (UGC) on the Web. Content quality can be referred to as what we have coined as “Information quality 2.0” which involves measuring information quality but in a Web 2.0 environment. Note that measuring the quality of UGC is different to measuring the quality of an entire website which has been investigated in other research (Katerattanakul and Siau, 1999). Additionally, new quality dimensions can be evaluated within the web 2.0 environment that was previously difficult if not impossible to measure (Batini *et al.*, 2009).

Table 1: Common dimensions used in information quality assessment (Knight and Burn, 2005)

Dimension	Definition
Accuracy	Correct, reliable and certified free of error
Consistency	Presented in the same format and compatible with previous data
Security	Access to information is restricted appropriately to maintain its security
Timeliness	Information is sufficiently up-to-date for the task at hand.
Completeness	Information is not missing and is sufficient for the task at hand
Conciseness	Information is compactly represented without being overwhelming
Reliability	Information is correct and reliable
Understandability	Data is clear without ambiguity and able to be easily comprehended
Accessibility	Extent to which information is available or easily and quickly retrievable
Availability	Information is physically accessible
Objectivity	Information is unbiased, unprejudiced and impartial
Relevancy	Information is applicable and helpful for the task at hand
Usability	Information is clear and able to be easily used
Amount of data	The quantity or volume of available data is appropriate
Believability	Information is regarded as true or credible
Navigation	Data is able to be easily found and linked to
Reputation	Information is highly regarded in terms of source or content
Usefulness	Information is applicable and helpful for the task at hand
Efficiency	Data is able to quickly meet the information needs for the task at hand
Value-added	Information is beneficial and provides advantages from its use

Table 2: Content quality concepts

The concept	Definition
User-Generated Content (UGC)	UGC is a content that was created within forum platforms on the Web and these content items include articles, videos, images and audio content. However, content is most commonly referred to as textual UGC in the forum platforms
Content quality	CQ is defined as the fitness of use for UGC by content consumers within a specific forum website and content is often provided by untrained creators in a Web 2.0 environment (Katerattanakul and Siau, 1999)
Content creator	CC is defined as a user who contributes content to a text web forum. These users come from diverse backgrounds of expertise and knowledge. They often do not have previous experience in creating published material
Content moderators	CM is defined as a user with the ability to manage (e.g. create, modify and delete) existing content as well as manage users within a social media community
Content Quality Assessment (CQA)	CQA refers to the process of measuring the quality of user-generated content within a text web forum
CQA models	CQA models are often developed to automate this process in order to efficiently evaluate the large amount of UGC that accumulates in social media websites
Quality model	A quality model consists of a selection of quality features that are relevant for a given class of software applications and/or for a given assessment process (Cappiello <i>et al.</i> , 2009)

Table 3: Common dimensions used in CQA Models (Chai *et al.*, 2009)

Dimensions	Definition
Popularity	Content that is widely-viewed, used or rated highly by the community
Amount of data	The quantity or volume of content is appropriate
Reputation	Content is highly regarded in terms of source or content
Lexical	The correct use of words and rules of language in content
Timeliness	Content is sufficiently up-to-date for the task at hand
Presentation	Content is formatted to be visually appealing or easier to understand
Relevancy	Content is applicable and helpful for the task at hand
Objectivity	Content is unbiased, unprejudiced and impartial
Originality	The novelty of content to the community

These include factors such as the popularity of content to a user community. There are various types of content quality concepts terms (Chai *et al.*, 2010, 2011) that are summarized in the following Table 2.

Dimensions used in CQA models: Chai *et al.* (2011) has surveyed existing Content Quality Assessment (CQA) models in literature and provides a summary of the quality dimensions used by these models in Table 3. This research highlights nine quality dimensions. Additionally, Chai *et al.* (2010, 2011) identified three new quality dimensions used by their models. These comprise

the popularity, lexical and originality dimensions. Weimer and Gurevych, Wanas *et al.* (2008) and Chen *et al.* (2008) used quality dimensions as displayed in Table 4. It can be seen that the relevancy and popularity quality dimensions are used in all forum CQA models. These dimensions are targeted towards evaluating whether a post is related to its topic and if a post has been quoted and/or replied to by other users in their postings. Additionally, Wanas *et al.* (2008) both place importance upon evaluating the presentation and the amount of data quality dimensions in their models.

Weimer and Gurevych uniquely consider lexical aspects of forum posts while Wanas *et al.* (2008)

Table 4: Summary of dimensions and features used in text web forum (Thread retrieval)

Dimensions	Features	Researchers
Relevancy	Post relatedness to topic Post overlap with initial post Post cosine similarity with initial post Relatedness of post web link to thread topic KL divergence between the post and initial post Centroid of a reply to all replies The post is created by the thread creator Does it quote the initial post? The overlap with the previous post	Chen <i>et al.</i> (2008), Wang <i>et al.</i> (2011), Wanas <i>et al.</i> (2008), Chai (2011), Obasa and Salim (2014)
Amount of data	A post is a response to other posts Number of words in a post Number of unique words in a post No. of non-stop words used Number of characters in a post Number of sentences in a post Number of questions in a post Number of links in a post (URLs and file paths) Ratio of number of web links to number of sentences in a post Average distance of questions in a post compared to previous questions in the forum Standard deviation distance of question to previous questions in the forum Number of comments written Ratio of multimedia objects (images, videos and etc.) by the size of the blog	Wanas <i>et al.</i> (2008), Kargar and Azimzadeh (2009), Obasa and Salim (2014), Albaham <i>et al.</i> (2014) and Obasa <i>et al.</i> , (2015)
Presentation	Query likelihood language model Whether a post has HTML formatting Whether the post is copied from an e-mail Ratio of emotion icons (emoticons) used to number of sentences in a post	Wanas <i>et al.</i> (2008)
Popularity	Percentage of characters that are inside quotes of other posts Number of post replies Number of times the post is quoted by following posts Ratio of text within a post that is quoted by following posts normalized by post size	Chen <i>et al.</i> (2008), Kargar and Azimzadeh (2009)
Percentage	Of part-of-speech tags as defined in the PENN Treebank tag set Percentage of words not spelled correctly in a post Percentage of swear words in a post Percentage of words in capitals in a post	Weimer and Gurevych
Originality/Value Added	Number of exclamations in a post Number of quotes used in post Ratio of quoted text to post size normalized by post size Amount of overlap of terms used with previous posts in the thread Overlap distance of post to most overlapping posts in the thread	Chai (2011), Wanas <i>et al.</i> (2008), Wang <i>et al.</i> (2011)
Timeliness	Age of the blog First load time of a blog article Full load time of blog articles Count the time elapsed between posting the current post and initial post Count the time elapsed between posting the current post and previous post Count the time elapsed between posting the current post and next post	Kargar and Azimzadeh (2009), Burel <i>et al.</i> (2012), Wang <i>et al.</i> (2011), Chai <i>et al.</i> (2010, 2011), Wanas <i>et al.</i> (2008), (Waheed <i>et al.</i> , 2016)
Author activeness Obasa and	No. of threads created by the user No. of replies created by the user No. of posts created by the user Ratio of author's initial post to his total post count Ratio of author's replies to total post count No. of threads the user participated in Average time between author's consecutive posts	Fan (2009), Burel <i>et al.</i> (2012), Chai <i>et al.</i> (2010 2011), Salim, Ismail <i>et al.</i> (2015) and Obasa <i>et al.</i> (2016)
Ease of understanding	No. of Wh-type words No. of question marks No. of exclamation marks No. of noun markers No. of stop words No. of Noun Marker	Obasa <i>et al.</i> (2016), Obasa <i>et al.</i> (2015) and Waheed <i>et al.</i> (2016)
Lexical	Ratio of consecutive capitalization used to number of sentences in a post Ratio of consecutive punctuation marks used to number of sentences in a post	Wanas <i>et al.</i> (2008) and Obasa <i>et al.</i> (2015)

Table 4: Conitnue

Dimensions	Features	Researchers
Reputation	No. of friends	Kargar and Azimzadeh (2009) and Wellsandt <i>et al.</i> (2015) Waheed <i>et al.</i> (2016) Last login time
	No. of hyperlinks	
	Last login time	
	Last update time	
	Availability	
Objectivity	No. of positive words	Obasa and Salim (2014), Wellsandt <i>et al.</i> (2015), Obasa <i>et al.</i> (2015)
	No. of negative words	
Completeness	Number of replies	Heydari <i>et al.</i> (2016), Wellsandt <i>et al.</i> (2015)
	Status of the thread	
Comprehensiveness	Number of users	Heydari <i>et al.</i> (2016)
	Ratio of number of users to number of messages	
Politeness	Amount of posts conveying thanks	Heydari <i>et al.</i> (2016), Watson <i>et al.</i> (2016),
	Number of swear words	
	Number of attacks on other users	
Visibility	The position of the post in the thread	Obasa and Salim (2014), Chai <i>et al.</i> (2010, 2011)
	Post belongs to the first 5 posts	
Question features	Features from the question being answered	Agichtein <i>et al.</i> (2008)
	Features from the asker of the question being answered	
	Features from the other answers to the same question	
User features	Features from the answers of the user	Agichtein <i>et al.</i> (2008)
	Features from the questions of the user	
	Features from the votes of the user	
	Features from answers received to the user's questions	
	Other user-based features.	
Answer features	Features directly from the answers received	Agichtein <i>et al.</i> (2008)
	Features from the answerers of the question being responded to	
Readability	Count the number of syllables per word in the post	Burel <i>et al.</i> (2012), Chai <i>et al.</i> (2010 2011)
	Count the number of words per sentence in the post	
	Count the number of paragraphs in the text of a post	
	Count the average number of words in a sentence	
	Count the average sentence length in the post	
	The number of formatting tags	

differentiate by evaluating originality and timeliness features. However, the suitability of lexical features is questionable because forum postings on the Web have been characterized as not following proper linguistic rules (Wanas *et al.*, 2008). Chen *et al.* (2008) evaluates two features in order to build a reply graph of postings and to evaluate the relevancy of a posting to the original topic.

Quality of the thread retrieval: There have also been studies that specifically analyze text web forums but not in the context of summarization. Kim focus on finding a way to semi-automate grading based on the quality of discussion participation. Their corpus consists of discussion threads from university undergraduate computer science students. Kim used speech acts to find threads with unanswered questions and confusions. Instructors can use this information to help determine where to focus their attention.

Some interesting findings are as follows; about 95% of all threads start with a question post and an answer directly follows that question in 84% of all cases. They also found that acknowledgements are usually found at the end of a thread (73%). Nevertheless, they used a domain specific corpus which consists predominantly of threads that have only two messages: question-answer pairs. Such threads are less interesting to summarize,

since the need for a summary becomes more pressing as the thread length increases. Heydari *et al.* (2016) assessed the significance of quality dimensions in voting model thread retrieval. They investigated the relevance score of retrieval methods with and without quality features. Results showed that some of the quality dimensions of completeness, comprehensiveness and politeness improved the retrieval method and could be used in further research to investigate their role in different retrieval methods. They have demonstrated that quality optimizations are a reliable way to improve thread retrieval performance.

Text web forum are the forum structural dimensions such as relevancy, amount of data, author Activeness, ease of understanding and etc. These dimensions, their features are shown in Table 4. Quality dimensions can be used to assist in text summarization tasks in forum threads. They can contain thousands of posts that are time-consuming for users to browse and read through. Quality indicators can measure the quality of each post which can then be used as an importance weighting for information summarization tasks. Performing content quality assessment may ensure that high quality content is given more weighting than low quality content in information summarization systems (Bhatia *et al.*, 2014, Chai *et al.*, 2010, 2011).

Table 5: Quality indicators and their description (Subha and Palaniswami, 2013)

Quality indicator	Description	Notes
Optionality	An optionality indicator reveals a requirement sentence containing an optional part (i.e. a part that can or cannot be considered)	Optionality-revealing words: possibly, eventually if that is the case if possible if appropriate if needed
Subjectivity	A subjectivity indicator is pointed out if a sentence refers to personal opinions or feelings	Subjectivity-revealing wordings: similar, better, similarly, worse, having in mind, taking into account; take into consideration as [adjective] as possible
Vagueness	A vagueness indicator is pointed out if the sentence includes words holding inherent vagueness, i.e. words having a non-uniquely quantifiable meaning	Vagueness-revealing words: clear, easy, strong, good, bad, efficient, useful, significant, adequate, fast, recent, far, close in front
Weakness	A weakness indicator is pointed out in a sentence which contains a weak main verb	Weak verbs: can, could, may
Implicitly	An Implicitly Indicator is pointed out in a sentence when the subject is generic rather than specific	Subject expressed by: demonstrative adjective (this, these, that, those) or pronouns (it, they). Subject specified by: adjective previous, next, following, last) or preposition
Readability	It is the value of ARI (Automated Readability Index) [ARI = WS+ 9*SW where WS signifies the average words per sentence and SW refers to the average letters per word]	

Quality aspect in text summarization: Automatic Text Summarization (ATS) is an important step for information management tasks. It solves the problem of selecting the most important portions of the text.

High quality summarization requires sophisticated Natural Language Processing (NLP) techniques (Babar and Patil, 2015) A good summarization technology aims to combine the main topics with completeness, readability and conciseness, according to (Nandhini and Balasundaram, 2012). Finding a connection between adjacent sentences in the document can help to identify and form coherent chunks in the document. Consequently, the formation of coherent chunks greatly improves the amount of information of the text selected and hence the quality of text summarization (Sankar and Sobha, 2009).

Quality factor assessment in text summarization: Quality indicators are syntactic aspects of the requirements specifications that can be automatically calculated and provide information on a particular quality property of the requirements specifications themselves. The system uses a decision tree method to evaluate the quality of the NL requirement document. Table 5 shows the different quality indicators and their description.

Quality aspects for text web forum summarization: Forums allow members to post content interactively. The quality of the forum varies drastically from excellent to abuse and spam (Altantawy *et al.*, 2009) due to the number and variety of users who participate in the forum. On the other hand, forums have many irrelevance posts to a topic in a particular thread such as: junk, off-topic posts like an advertisement and trolls that negatively affect quality (Ren *et al.*, 2011). That makes the action of forum summarization more and more difficult. The researcher relates the way in which the increment of data available

will make the task of identifying high quality data in a forum more important. Chai (2011) highlighted some reasons why the quality of user-generated contents (such as the diversity of user background in terms of geographical location, beliefs and knowledge) can differ. Contents are mostly generated by users who have little experience in creating content and contents are subsequently released without peer review. In addition, contents are consumed by millions of users who have different motivations and requirements. Thus, we need to have the capacity to determine quality posts in a thread to be able to extract quality summary.

Liu *et al.* (2007) attempt to detect reviews with low quality by first removing biases like imbalance vote bias, winner circle bias and early bird bias, respectively. They argue that since other studies did not remove these biases, their results are subject to them and do not model a review’s helpfulness in its pure form. They used Amazon review dataset for digital cameras and made their own specification of what properties a good (and conversely bad) review should have. Following this, they used manual annotation of reviews according to the specifications so as to avoid aforementioned biases. They defined four categories of review quality which represent different values of the reviews to users’ purchase decision. These include: “best review”, “good review”, “fair review” and “bad review”. To detect low-quality reviews, their proposed approach explores three aspects of the product review process, namely, informativeness, subjectiveness and readability. They proposed a classification-based approach to low-quality product review detection which yields better performance of opinion summarization.

Text summarization evaluation: Text quality is often assessed by human annotators. Also, the most common approach is by means of a content evaluation summary;

which is carried out by comparing its content to a human-model one. This is considered as a reference summary (Steinberger and Jezek, 2009). The conception of what a good summary is varies considerably between different people and also depends on what the summary is intended by Lloret and Palomar (2012). Generally, the main approach for summary quality determination is the intrinsic content evaluation which is often done by way of comparison with an ideal summary (Steinberger and Jezek, 2009). Basically, methods for evaluating a summary can be broadly classified into two broad categories: intrinsic or extrinsic (Jones and Galliers, 1995).

Intrinsic content evaluation: Content-based measures compare the actual words in a sentence rather than the entire sentence. Their advantage is that they can compare both human and automatic extracts with human abstracts that contain newly written sentences (Steinberger and Jezek, 2009). They typically contain a great deal of evaluation tools which can be used to assess the content of a summary at different levels. The well-known information retrieval metrics, namely, precision, recall and F-measure have been also adapted to ATS.

Recall, Precision, F-measure and Relative utility: Recall (R) refers to the number of sentences occurring in both system and ideal summaries divided by the number of sentences in the ideal summary Precision (P) signifies the number of sentences occurring in both system and ideal summaries divided by the number of sentences in the system summary. F-measure is a combination of both precision and recall (Nenkova, 2006, Hassel, 2007). However, using these metrics, it is possible that two equally good extracts are judged very differently. Relative utility (Radev and Tam, 2003) has been proposed as a way to address the human variation and semantic equivalence problems existing in P/R evaluation.

Pyramid method, factoid score and summary content units: In view of this, the Pyramid method is suggested in (Passonneau, 2010) as well as an information-based summarization metric called factoid score (Teufel and Halteren, 2004). Hence, automatic summaries are evaluated regarding them as well as atomic information units which represent the meaning of a sentence. The idea is to use several reference summaries as gold standard and measure the information overlap among them. In addition, the purpose of Summary Content Units (SCU) is to identify information with the same meaning across different human-authored summaries. Each SCU has a weight depending on the number of human assessors, who expressed the same information.

RESULTS AND DISCUSSION

ROUGE evaluation: Another tool for automatically evaluating a summary is developed. The term Rouge stands for Recall-Oriented Understudy for Gisting Evaluation and refers to precision, recall and F-measure. This tool relies on n-gram co-occurrence. Different types of n-grams can be computed such as unigrams (Rouge-1), bigrams (Rouge-2) or the longest common subsequence (Rouge-L). The hypothesis of this method is that two texts that have a similar meaning must also share similar words or phrases.

Basic elements and paraeval evaluation: The underlying idea of this method is to split a sentence into very small units of content, so as to tackle and improve the drawbacks derived from comparing fixed n-gram words as proposed by Hovy. Further, Zhou *et al.* (2006) suggested ParaEval as a summarization evaluation method, facilitating the detection of paraphrase matching according to a three-level strategy. First, there is the occurrence of multi-word paraphrases between phrases in the reference summaries. Next, for those fragments that do not match, the method tries to find synonyms between single-words. Then, if this also fails, simple lexical matching is finally performed.

Grammatical evaluation: Furthermore, Branny (2007) text grammars are employed to automatically evaluate text summaries. A text grammar is a way of describing a valid text structure in a formal way. It also takes into consideration surface and deep structure by means of relations between sentences (microstructures) and the structure of the text as a whole (macrostructure), respectively. Under the assumption that vocabulary overlapping is not enough to be able to measure the informativeness of a summary, this approach relies on a list of propositions previously identified. The human element then needs to decide whether each proposition is relevant or not and establish several groups in order to face the problem of quantifying the informativeness of each proposition.

Quality evaluation: In general, one fault of the current evaluation methods is that they only gauge the quality of a summary according to its content and they were not considered in the light of other important aspects such as coherence or non-redundancy (Lloret and Palomar, 2012). The evaluation concerning the quality of a summary taking into consideration other issues different from its contents, has always been in the mind of the researchers. The goal of the FAN protocol described by Minal was to

assess the quality of an abstract independently from the source text and the information it contained. Four criteria were proposed. Firstly, a number of anaphora was deprived of referents. Secondly, there was a rupture of textual segments. Next, the presence of tautological sentences was established. Finally, legibility of the abstract was determined. All these criteria were evaluated manually by two jurors.

In light of this, another protocol was also proposed: the MLUCE Protocol. The idea behind this protocol is to enable potential users to evaluate summaries, depending on what they wanted the summary for. For instance, they may want the summary merely to decide to read the whole document. Conversely, they may require it to serve as a synthesis of the source document. Again, the evaluation is carried out manually as it is for the FAN Protocol. Attempts to evaluate indicativeness and acceptability have also been addressed by Saggion and Lapalme (2000). They have determined if a selected sentence by a summarization system is adequate compared to what humans would have selected; hence human intervention is needed to evaluate this criterion. More recently by Lloret *et al.* (2013) quantitative and qualitative measures were performed for evaluating both the information contained in the summaries as well as user satisfaction. Therefore, two approaches are able to keep the relevant information of the source documents however, the latter is more appropriate from a human perspective.

Furthermore, Conroy and Dang (2008) the need for having tools which assess content as well as other linguistic aspects is addressed. In the DUC and TAC conferences, summaries are evaluated with respect to give linguistic quality questions (grammaticality, non-redundancy, referential clarity as well as structure and coherence) which do not involve any comparison with a reference summary (Gambhir and Gupta, 2017). This type of evaluation is manually performed by expert human assessors, who score the quality of a summary according to a five-point scale. Also we can find some studies which predict text quality through the analysis of various readability factors (Pitler and Nenkova, 2008). The idea here is to analyze the quality of a text by means of different criteria including vocabulary, syntax or discourse in order to account for the correlation between those factors and human readability ratings previously gathered. Another approach, suggested by Vadlapudi and Katragadda (2010), attempts to automatically evaluate the grammaticality of a summary. N-gram models (in particular unigrams, bigrams, trigrams and the longest common subsequence) are used for capturing this aspect.

Although, the aforementioned methods really help to evaluate automatic summaries, there are several challenges related to the quality evaluation that remain still unsolved.

CONCLUSION

This study conducted a research study for the state-of-the-art methods in text web forum summarization, focusing especially on the quality dimensions raised over the last years in the areas of thread retrieval and information retrieval. Furthermore, the quality of text summarization evaluation methods were presented. However in order to provide some background information about this research, a brief review on motivations, challenges and quality aspects for summarizing text web forum was conducted. Moreover, data and information quality with regard to concept and characteristics of a high-quality topic were described in order to provide a deep perspective of this research field. Issues of highlighting quality dimensions and content quality concepts were included and more attention was paid to dimensions used in CQA models and the level of quality factor assessment. Furthermore, quality aspects with regard to text summarization and text web forum summarization were described. Consequently, although more than half a century has passed, text summarization is still alive with a great interest among the research community. Indeed, text web forum summarization still does not receive a sufficient quantity of attention. Finally, it can be deduced that the performance of text web forum summarization is still moderate and the generated summaries are far from perfect. It can be seen how the combination with quality dimensions leads to the improvement of the quality performance of the summary and helps to develop text web forum summarization.

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REFERENCES

- Agichtein, E., C. Castillo, D. Donato, A. Gionis and G. Mishne, 2008. Finding high-quality content in social media. Proceedings of the 2008 International Conference on Web Search and Data Mining, February 11-12, 2008, ACM, New York, USA., ISBN:978-1-59593-927-2, pp: 183-194.

- Albaham, A.T., N. Salim and O.I. Adekunle, 2014. Leveraging post level quality indicators in online forum thread retrieval. Proceedings of the 1st International Conference on Advanced Data and Information Engineering (DaEng-2013), June 3, 2013, Springer, Singapore, pp: 417-425.
- Almahy, I. and N. Salim, 2014. Web Discussion Summarization: Study Review. In: Proceedings of the 1st International Conference on Advanced Data and Information Engineering (DaEng-2013), Herawan T., M. Deris and J. Abawajy (Eds.). Springer, Berlin, Germany, pp: 649-656.
- Altantawy, M., A. Rafea and S. Aly, 2009. Summarizing online discussions by filtering posts. Proceedings of the IEEE International Conference on Information Reuse and Integration, August 10-12, 2009, IEEE, Cairo, Egypt, ISBN:978-1-4244-4114-3, pp: 426-427.
- Babar, S.A. and P.D. Patil, 2015. Improving performance of text summarization. *Procedia Comput. Sci.*, 46: 354-363.
- Batini, C., C. Cappiello, C. Francalanci and A. Maurino, 2009. Methodologies for data quality assessment and improvement. *ACM Comput. Surv.*, 41: 16-52.
- Bendersky, M., W.B. Croft and Y. Diao, 2011. Quality-biased ranking of web documents. Proceedings of the 4th ACM International Conference on Web Search and Data Mining, February 09-12, 2011, ACM, New York, USA., ISBN:978-1-4503-0493-1, pp: 95-104.
- Bhatia, S. and P. Mitra, 2010. Adopting inference networks for online thread retrieval. Pennsylvania State University, Centre County, Pennsylvania. <https://pdfs.semanticscholar.org/7629/6dd7e82ccb149f681bf7cca2e0e032324833.pdf>.
- Bhatia, S., P. Biyani and P. Mitra, 2014. Summarizing online forum discussions-can dialog acts of individual messages help?. Pennsylvania State University, Centre County, Pennsylvania. <http://sumitbhatia.net/papers/emnlp14.pdf>.
- Branny, E., 2007. Automatic summary evaluation based on text grammars. *J. Digital Inf.*, 8: 1-6.
- Burel, G., Y. He and H. Alani, 2012. Automatic Identification of Best Answers in Online Enquiry Communities. In: *The Semantic Web: Research and Applications*, Simperl, E., P. Cimiano, A. Polleres, O. Corcho and V. Presutti (Eds.). Springer, Berlin, Germany, pp: 514-529.
- Cappiello, C., F. Daniel and M. Matera, 2009. A Quality Model for Mashup Components. In: *Web Engineering Lecture Notes in Computer Science*, Gaedke, M., M. Grossniklaus and O. Diaz (Eds.). Springer, Berlin, Germany, pp: 236-250.
- Chai, K., C. Wu, V. Potdar and P. Hayati, 2011. Automatically Measuring the Quality of user Generated Content in Forums. In: *Advances in Artificial Intelligence*, Wang, D. and M. Reynolds (Eds.). Springer, Berlin, Germany, pp: 51-60.
- Chai, K., P. Hayati, V. Potdar, C. Wu and A. Talevski, 2010. Assessing post usage for measuring the quality of forum posts. Proceedings of the 2010 4th IEEE International Conference on Digital Ecosystems and Technologies (DEST), April 13-16, 2010, IEEE, Perth, Australia, ISBN:978-1-4244-5553-9, pp: 233-238.
- Chai, K.E.K., 2011. A machine learning-based approach for automated quality assessment of user generated content in web forums. Ph.D Thesis, Curtin University, Perth, Western Australia.
- Chen, Y., X.Q. Cheng and Y.L. Huang, 2008. A wavelet-based model to recognize high-quality topics on web forum. Proceedings of the 2008 IEEE/WIC/ACM International Conference on Web Intelligence and Intelligent Agent Technology, Vol. 01, December 09-12, 2008, IEEE, Washington, USA., ISBN:978-0-7695-3496-1, pp: 343-351.
- Conroy, J.M. and H.T. Dang, 2008. Mind the gap: Dangers of divorcing evaluations of summary content from linguistic quality. Proceedings of the 22nd International Conference on Computational Linguistics, Vol. 1, August 18-22, 2008, Association for Computational Linguistics, Stroudsburg, Pennsylvania, ISBN:978-1-905593-44-6, pp: 145-152.
- Fan, W., 2009. Effective search in online knowledge communities: A genetic algorithm approach. Ph.D Thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.
- Farrell, R., P.G. Fairweather and K. Snyder, 2001. Summarization of discussion groups. Proceedings of the 10th International Conference on Information and Knowledge Management, October 05-10, 2001, ACM, New York, USA., ISBN:1-58113-436-3, pp: 532-534.
- Ferguson, P. and A.F. Smeaton, 2012. Index ordering by query-independent measures. *Inf. Process. Manage.*, 48: 569-586.
- Gambhir, M. and V. Gupta, 2017. Recent automatic text summarization techniques: A survey. *Artif. Intell. Rev.*, 47: 1-66.
- Hariharan, S., R. Srimathi, M. Sivasubramanian and S. Pavithra, 2010. Opinion mining and summarization of reviews in web forums. Proceedings of the 3rd Annual ACM Conference on Bangalore Conference, January 22-23, 2010, ACM, New York, USA., ISBN:978-1-4503-0001-8, pp: 24-24.

- Hassel, M., 2007. Resource lean and portable automatic text summarization. Ph.D Thesis, Royal Institute of Technology, Stockholm, Sweden.
- Hatori, J., A. Murakami and J.I. Tsujii, 2011. Multi-Topical Discussion Summarization using Structured Lexical Chains and Cue Words. In: Computational Linguistics and Intelligent Text Processing, Gelbukh, A. (Ed.). Springer, Berlin, Germany, pp: 313-327.
- Heydari, A., M. Tavakoli, Z. Ismail and N. Salim, 2016. Leveraging quality metrics in voting model based thread retrieval. *World Acad. Sci. Eng. Technol. Intl. J. Comput. Electr. Autom. Control Inf. Eng.*, 10: 117-123.
- Huang, K.T., Y.W. Lee and R.Y. Wang, 1998. *Quality Information and Knowledge Management*. 1st Edn., Prentice Hall, New Jersey, ISBN-13: 978-0130101419.
- Ismail, Z., A. Heydari, M. Tavakoli and N. Salim, 2015. Incorporating author's activeness in online discussion in thread retrieval model. *ARPN. J. Eng. Appl. Sci.*, 10: 473-479.
- Jiao, J., 2013. A framework for finding and summarizing product defects and ranking helpful threads from online customer forums through machine learning. Ph.D Thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.
- Jin, X.L., C.M. Cheung, M.K. Lee and H.P. Chen, 2009. How to keep members using the information in a computer-supported social network. *Comput. Hum. Behav.*, 25: 1172-1181.
- Jones, K.S. and J.R. Galliers, 1995. *Evaluating Natural Language Processing Systems: An Analysis and Review*. Springer, Berlin, Germany, ISBN:3-540-61309-9, Pages: 235.
- Kahn, B.K., D.M. Strong and R.Y. Wang, 2002. Information quality benchmarks: Product and service performance. *Commun. ACM.*, 45: 184-192.
- Kargar, M. J. and F. Azimzadeh, 2009. A framework for ranking quality of information on weblog. *World Acad. Sci. Eng. Technol.*, 56: 690-695.
- Katerattanakul, P. and K. Siau, 1999. Measuring information quality of web sites: development of an instrument. *Proceedings of the 20th International Conference on Information Systems*, December 12-15, 1999, USA., pp: 279-285.
- Klein, K.J., A.B. Conn, D.B. Smith and J.S. Sorra, 2001. Is everyone in agreement? An exploration of within-group agreement in employee perceptions of the work environment. *J. Appl. Psychol.*, 86: 3-16.
- Knight, S.A. and J. Burn, 2005. Developing a framework for assessing information quality on the world wide web. *Inf. Sci. J.*, 8: 159-172.
- Krishnamani, J., Y. Zhao and R. Sunderraman, 2013. Forum summarization using topic models and content-metadata sensitive clustering. *Proceedings of the 2013 IEEE/WIC/ACM International Joint Conferences on Web Intelligence (WI) and Intelligent Agent Technologies (IAT)*, Vol. 03, November 17-20, 2013, IEEE, Washington, USA., ISBN:978-0-7695-5145-6, pp: 195-198.
- Lee, Y.W., D.M. Strong, B.K. Kahn and R.Y. Wang, 2002. AIMQ: A methodology for information quality assessment. *Inform. Manage.*, 40: 133-146.
- Liu, J.J., Y.B. Cao, C.Y. Lin, Y.L. Huang and M. Zhou, 2007. Low-quality product review detection in opinion summarization. *Proceedings of the Joint Conference on Empirical Methods in Natural Language Processing and Computational Natural Language Learning*, June 28-30, Association for Computational Linguistics Press, Prague, Czech Republic, pp: 343-342.
- Lloret, E. and M. Palomar, 2012. Text summarisation in progress: A literature review. *Artif. Intell. Rev.*, 37: 1-41.
- Lloret, E., R.M.T. Ferri and M. Palomar, 2013. Compendium: A text summarization system for generating abstracts of research papers. *Data Knowl. Eng.*, 88: 164-175.
- Nandhini, K. and S.R. Balasundaram, 2012. Significance of learner dependent features for improving text readability using extractive summarization. *Proceedings of the 4th International Conference on Intelligent Human Computer Interaction (IHCI)*, December 27-29, 2012, IEEE, Tiruchirappalli, India, ISBN:978-1-4673-4369-5, pp: 1-5.
- Neenkova, A., 2006. *Summarization evaluation for text and speech: Issues and approaches*. Stanford University, California, USA. <http://ai2-s2-pdfs.s3.amazonaws.com/6dab/83e7042740a2e04f8f9c9465f92f63b43e23.pdf>.
- Obasa, A.I. and N. Salim, 2014. Mining faq from forum threads: Theoretical framework. *J. Theor. Appl. Inf. Technol.*, 63: 39-50.
- Obasa, A.I., N. Salim and A. Khan, 2015. Enhanced lexicon based model for web forum answer detection. *Proceedings of the 2015 5th International Conference on Digital Information Processing and Communications (ICDIPC)*, October 7-9, 2015, IEEE, Johor, Malaysia, ISBN:978-1-4673-6832-2, pp: 237-243.
- Obasa, A.I., N. Salim and A. Khan, 2016. Hybridization of bag-of-words and forum metadata for web forum question post detection. *Indian J. Sci. Technol.*, 8: 123-147.

- Obasa, A.I., N. Salim and A.Y.A. Khassawneh, 2014. A survey of challenges and resolutions of mining question-answer pairs from internet forum. *J. Technol.*, 71: 103-109.
- Passonneau, R.J., 2010. Formal and functional assessment of the pyramid method for summary content evaluation. *Nat. Lang. Eng.*, 16: 107-131.
- Pipino, L.L., Y.W. Lee and R.Y. Wang, 2002. Data quality assessment. *Commun. ACM.*, 45: 211-218.
- Piskorski, J. and R. Yangarber, 2013. Information Extraction: Past, Present and Future. In: *Multi-Source, Multilingual Information Extraction and Summarization*, Poibeau, T., S. Horacio, P. Jakub and Y. Roman (Eds.). Springer, Berlin, Germany, ISBN:978-3-642-28568-4, pp: 23-49.
- Pitler, E. and A. Nenkova, 2008. Revisiting readability: A unified framework for predicting text quality. *Proceedings of the Conference on Empirical Methods in Natural Language Processing*, October 25-27, 2008, ACM, Stroudsburg, Pennsylvania, pp: 186-195.
- Radev, D.R. and D. Tam, 2003. Summarization evaluation using relative utility. *Proceedings of the 12th International Conference on Information and Knowledge Management*, November 03-08, 2003, ACM, New York, USA., ISBN:1-58113-723-0, pp: 508-511.
- Redman, T.C., 1996. *Data quality for the information age*. Artech House, Norwood, Massachusetts.
- Ren, Z., J. Ma, S. Wang and Y. Liu, 2011. Summarizing web forum threads based on a latent topic propagation process. *Proceedings of the 20th ACM International Conference on Information and Knowledge Management*, October 24-28, 2011, ACM, New York, USA., ISBN:978-1-4503-0717-8, pp: 879-884.
- Saggion, H. and G. Lapalme, 2000. Selective analysis for automatic abstracting: Evaluating indicativeness and acceptability. *Proceedings of the International Conference on Content-Based Multimedia Information Access*, Vol. 1, April 12-14, 2000, ACM, Paris, France, pp: 747-764.
- Sankar, K. and L. Sobha, 2009. An approach to text summarization. *Proceedings of the 3rd International Workshop on Cross Lingual Information Access: Addressing the Information Need of Multilingual Societies*, June 04-04, 2009, ACM, Stroudsburg, Pennsylvania, ISBN:978-1-932432-33-6, pp: 53-60.
- Seo, J., W.B. Croft and D.A. Smith, 2011. Online community search using conversational structures. *Inf. Retrieval*, 14: 547-571.
- Steinberger, J. and K. Jezek, 2009. Evaluation measures for text summarization. *Comput. Inf.*, 28: 251-275.
- Strong, D.M., Y.W. Lee and R.Y. Wang, 1997. Data quality in context. *Commun. ACM*, 40: 103-110.
- Subha, R. and S. Palaniswami, 2013. Quality Factor Assessment and Text Summarization of Unambiguous Natural Language Requirements. In: *Advances in Computing, Communication and Control*, Ummikrishnan, S., S. Surve and D. Bhoir (Eds.). Springer, Berlin, Germany, pp: 131-146.
- Sun, J., H. Gao and X. Yang, 2010. Towards a Quality-Oriented Real-time Web Crawler. In: *Web Information Systems and Mining*, Wang, F.L., Z. Gong, X. Luo and J. Lei (Eds.). Springer, Berlin, Germany, pp: 67-76.
- Tayi, G.K. and D.P. Ballou, 1998. Examining data quality. *Commun. ACM.*, 41: 54-57.
- Teufel, S. and V.H. Halteren, 2004. Evaluating information content by factoid analysis: Human annotation and stability. *Radboud University Nijmegen, Nijmegen, Netherlands*. <http://www.cl.cam.ac.uk/~sht25/papers/zemnlp04.pdf>.
- Vadlapudi, R. and R. Katragadda, 2010. On automated evaluation of readability of summaries: Capturing grammaticality, focus, structure and coherence. *Proceedings of the NAACL HLT 2010 Student Research Workshop*, June 02-02, 2010, ACM, New York, USA., pp: 7-12.
- Waheed, M., K. Kaur and A. Qazi, 2016. Students' perspective on knowledge quality in E-learning context: A qualitative assessment. *Internet Res.*, 26: 120-145.
- Wanas, N., E.M. Saban, H. Ashour and W. Ammar, 2008. Automatic scoring of online discussion posts. *Proceedings of the 2nd ACM Workshop on Information Credibility on the Web*, October 30-30, 2008, ACM, New York, USA., ISBN: 978-1-60558-259-7, pp: 19-26.
- Wand, Y. and R.Y. Wang, 1996. Anchoring data quality dimensions in ontological foundations. *Commun. ACM.*, 39: 86-95.
- Wang, G., X. Liu and W. Fan, 2011. A knowledge adoption model based framework for finding helpful user-generated contents in online communities. *Department of Business Information Technology, Blacksburg, Virginia*. <http://aisel.aisnet.org/icis2011/proceedings/knowledge/15/>.
- Wang, R.Y. and D.M. Strong, 1996. Beyond accuracy: What data quality means to data consumers. *J. Manage. Inform. Syst.*, 12: 5-34.

- Watson, C., A. Wilson, V. Drew and T.L. Thompson, 2016. Criticality and the exercise of politeness in online spaces for professional learning. *Internet Higher Educ.*, 31: 43-51.
- Wellsandt, S., T. Wuest, K. Hribernik and K.D. Thoben, 2015. Information Quality in PLM: A Product Design Perspective. In: *Advances in Production Management Systems*, Umeda, S., M. Nakano, H. Mizuyama, N. Hibino and D. Kiritsis et al. (Eds.). Springer, Berlin, Germany, pp: 515-523.
- Yamamoto, Y. and K. Tanaka, 2011. Enhancing credibility judgment of web search results. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, May 07-12, 2011, ACM, New York, USA., ISBN:978-1-4503-0228-9, pp: 1235-1244.
- Zhou, L., C.Y. Lin, D.S. Munteanu and E. Hovy, 2006. Paraeval: Using paraphrases to evaluate summaries automatically. *Proceedings of the main Conference on Human Language Technology Conference of the North American Chapter of the Association of Computational Linguistics*, June 04-09, 2006, ACM, New York, USA., pp: 447-454.
- Zhou, Y. and W.B. Croft, 2005. Document quality models for web ad hoc retrieval. *Proceedings of the 14th ACM International Conference on Information and Knowledge Management*, October 31-November 05, 2005, ACM, New York, USA., ISBN: 1-59593-140-6, pp: 331-332.