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Introducing Sentiment Analysis for the Evaluation of Library's Services Effectiveness

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Abstract. Increasingly, text mining approaches have come to academic and commercial foreground as an effective solution for managing textual resources. Users' and consumers' comments and reviews hyper proliferation due to web 2.0 emergence, generated the need for such techniques implementation as a way to get insights from an active world expressed textually and not limited to specific scales and options. Sentiment analysis constitutes a NLP method aiming at sentiment detection out of textual snippets. On the other hand, it is a common truth that academic libraries have been intensively based their evaluation attempts on quantitative methods. The current study proposes the use of Sentiment analysis on user comments about Hellenic Open University Distance Library and Information Center which were included to the institutional annual survey. The analysis highlighted latent information about specific aspects of the library that couldn't be detected through the constraints that scaling poses.

Keywords: Library Evaluation, Sentiment Analysis, Natural Language Processing, User Satisfaction, Distance learning library services

1. Introduction

The evaluation of library services effectiveness constitutes an integral part of library management imposed by accountability and self-improvement reasons. Libraries' strategic objectives always have been strongly connected with users' perspectives and surveys constitutes a communication channel between them (Kettunen, 2007). Currently, users' satisfaction observations are implemented mainly through questionnaires which offer a statistical depiction of users' perceptions over library services. The aforementioned traditional way has an

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endogenous deficit to unveil latent emotions over services' efficiency and value. As a result, users' ratings attempt to depict as eloquently as possible satisfaction states, having the constraint to be expressed within a confined scale.

The emergence of sentiment analysis has given the opportunity to researchers to analyze and quantify human emotions/ opinions expressed textually and to extract semantically important concepts included in their comments. Sentiment analysis is a natural language processing method assigning a polarity (positive or negative) to textual subjective statements and also identifying and extracting important concepts included within (Nanli, Ping, Weiguo, & Meng, 2012).

A measure of the success of the Hellenic Open University[1] (HOU) organizational policy and the effectiveness of its Quality Management System is students' and executives' satisfaction (academic and administrative). Accordingly, the institution conducts an annual survey including a question on user satisfaction from library services, intending to cover the absence of a specific user satisfaction questionnaire on behalf of the library. The question is based on a Likert scale accompanied by a space for open-ended comments. Consequently, this feedback system was inadequate for inference extraction for the HOU's library management. Furthermore, a single question concerning library would be affected by participants' perceptions for the other services offered by the University.

In this paper we present a sentiment analysis implementation on 788 user comments on library services mentioned on HOU's survey during the period 2012-2015. Current research intention is to introduce the specific approach as supplementary method to existing traditional questionnaires for library users' satisfaction studies. In fact, we pursue:

- To examine whether there is a correlation between the overall satisfaction score that users assign to the library services with the polarity of their comments. This correlation would prove if their rating has remained "pure" without been affected by the perceptions that they have overall institutional operation or the context of the questionnaire affects participants answering behavior.
- Secondly we attempt to discover the most important concepts regarding library services within users' statements and their negative or positive nuance.

The paper is structured as follows. Section 2 describes related work on sentiment analysis and the ways libraries adopt to exploit user comments so far in their operation; Section 3 depicts an overview of the methodological processes implemented for the analysis of users' comments. Section 4 presents

[1] Hellenic Open University (HOU) was found in 1992 aiming at the provision of distance education at both undergraduate and postgraduate level. It has the privilege to be the only distance learning university in Greece. HOU's central administrative services are located in Patras.

current research results and Section 5 highlights the most important issues of the research and indicates possible directions for future research.

2. Literature Review

Text mining has gained a nodal place in research as it constitutes a set of methods (machine learning, statistical, linguistic techniques) aiming at the automatic corpus analysis for the disclosure of latent information. The unstructured nature of textual information imposes the exploitation of such approaches for various applications such as web document based text clustering, Information retrieval, Knowledge transfer and integration, Topic tracking, Summarization, categorization, clustering, and concept linkage, detection of emotional contents of texts in online social networks, data collection, database schemas, data processing etc. (Hashimi & Hafez, 2015).

Sentiment analysis consists a part of this microcosm of methods presenting a high dynamic lately at diverse fields like shopping, entertainment, government, research and development, marketing and education (Binali, Potdar, & Wu, 2009). "Sentiment Analysis or Opinion Mining is the computational study of people's opinions, attitudes and emotions toward an entity. The entity can represent individuals, events or topics" (Medhat, Hassan, & Korashy, 2014, p.1093). Information science attempted to capitalize that expertise either for the optimization of information retrieval (Hu & Downie, 2010) or for citation analysis (Athar, 2011; Small, 2011). Hu & Downie (2010) implemented sentiment analysis on 5,296 songs in order to achieve automatic music mood classification for songs included in music digital libraries. Mood tags will operate as a practical access point in music collections of digital libraries. Additionally, Small (2011) completed a sentiment citation analysis based on the textual context of the references.

On the other hand, information professionals need such tools for the amelioration of communication management in libraries. Academic Libraries operate in a continuously changing landscape and therefore they need to know basic information about their users in order to satisfy their expectations, exploit their feedback and manage users' expectations (Jankowska, Hertel, & Young, 2006). Therefore, they need to analyze sources of comments from numerous channels. Gerolimos (2011) studied and analyzed 3,513 comments on libraries' Facebook and found that the majority of users expressed theirselves rather symbolically (like option) than textually. An analogous research was published by Al-Daihani & Abrahams (2018), which was based on a wider dataset (18,333 unique posts, 113,621 likes, and 3401 comments) from academic libraries' Facebook posts. Their main objective was the engagement analysis of library's Facebook users with the content posted in the specific social network.

However, established tools of communication and evaluation like LibQUAL+ always constitute the first options for academic libraries in order to gain feedback. Moore (2017) applied sentiment analysis to LibQUAL+ comments for

a Canadian academic library in order to gain a picture regarding three dimensions: the affect of service, the information control and library as place. The results of sentiment analysis implementations reflected LibQUAL's + quantitative results underlining the efficiency of the method.

It is a self-evident truth that libraries which serve distant learners are pressed by the imperative need to come more close to their users' need as the gap between them doesn't facilitate their communication. Therefore various studies come to light focusing on this kind of user's satisfaction (Alewine, 2012; Hensley & Miller, 2010). Current study will focus on the analysis of comments generated in the context of HOU's annual survey regarding library's user satisfaction.

3. Methodology

The isolation of the fields concerning library users' satisfaction was the primary step of the process. The variables we had at our disposal were: participants' course, participants' module, their satisfaction scoring and their comments. Subsequently, we detected the most popular words included denoting entities in the comments in order to discover their polarity. The words that we decided to study was 'library', 'service', 'usage', 'access', 'material', 'support', 'staff', 'journals', 'library usage' and 'e-library'.

An issue that we had to consider was polarity scaling. Normally polarity ranges between negative, neutral and positive, but in our case we wanted to make correlations of comments' polarity with users' satisfaction rates. For that reason, we adjusted polarity scale in order to be in accordance with user satisfaction rate (from one to five). So polarity scale readjusted as follows: 1 = very negative, 2 = negative, 3 = neutral, 4 = positive and 5 = very positive.

Our data analysis was based on OpinionBuster[2], a well-known commercial sentiment analysis tool specialized in Greek language, which supports subscription services like PaloPro (Petasis, Spiliotopoulos, Tsirakis, & Tsantilas, 2014). The specific tool can materialize named entity recognition and define the polarity of comments. OpinionBuster has been coded in C/C++ and encapsulates a wide range of NLP approaches (ontologies, machine learning algorithms etc.). Although there are plenty of tools realizing sentiment analysis in English language (Serrano-Guerrero, Olivas, Romero, & Herrera-Viedma, 2015), we should underline the fact that OpinionBuster is a pioneer software in Greek language regarding named entity recognition and opinion mining (Petasis et al., 2014). Finally, we used SPSS for the implementation of Kendall rank correlation tests.

We used a statistical measure (Kendall's tau-b) in order to determine the nature of the affinity (positive or negative). It was very important for the needs of our

[2] OpinionBuster is provided by Intellitech Digital Technologies PC: http://www.intellitech.gr/.

study to explore and summarize the strength of association between users' satisfaction rankings and polarity generated from sentiment analysis. Kendall's tau-b is a measure of affinity, which has three variants. The factor τ_b takes account of the cases of ties. It takes values in interval [-1, 1], with the sign to determine the direction of the relationship (Puth, Neuhäuser, & Ruxton, 2015). Data statistical analysis was materialized with SPSS.

4. Results and Analysis

A total of 66,783 library users completed the question about library at the annual HOU's quality survey for the period 2012-2015, while the total number of participants at the same survey was 67,326. Contrary to the large number of participants who rated the library, the number of participants who also made comments about it was 513. At the same time there were 275 comments which weren't accompanied by library ratings (Table 1). OpinionBuster processed the aggregate of the comments (n=788).

Ratings show that library users' satisfaction ranges between 2.981 to 3.063 indicating that HOU'S Library services have almost an established level of value in users eyes without having any dramatic fluctuations. Accordingly, comments' polarity oscillates between 3.086 to 3.254. Comparing average library ratings and average comment polarities seems to be almost at the same level. As it is evident from Table 1, there is no significant gap between ratings and polarity for the years 2012-2013 and 2014-2015. On the other hand, we notice for the year 2013-2014 users may at the edge of a "bipolar disorder" as they ratings didn't actually reflect the feelings that arouse from their comments. Users seem to have marginally rated library service below 3, which is a neutral rate, while at the same time their comments seem to be the best of the three years' period that we studied. These are the value bounds of averages polarities.
Aiming at the correlation of ratings and polarities, we implemented Kendall rank tau-b correlation coefficient. Table 2 indicates that the correlation is positive but not significant. The Tau correlation coefficient values range between -1 to 1, where -1 constitutes an indication of a negative relationship, while 1 constitutes a perfect relationship. Values that are very close to 0 indicate no relationship. This means in our case that when a participant rates highly the library, the polarity of his comments probably would be high too. Our results are in line with Atif's (2018) results signifying that the adoption of the sentiment analysis as a supplementary tool for any kind of survey which includes open ended questions.

	Number of participants who completed the survey	**Number of participants who rated the library**	**Number of participants who made comments about**	**Number of participants who made only comments about the**	**Average library ratings**	**Average polarity**

			library and also rated library	**library**		
2012 - 2013	21,737	19,316	141	251	3.046	3.087
2013 - 2014	23,172	23,063	198	295	2.981	3.254
2014 - 2015	22,417	22,347	174	242	3.063	3.086

Table 1. Descriptive statistics

	2012-2013	**2013-2014**	**2014-2015**
Kendall's tau-b	0.208	0.173	0.173

Table 2. Kendall's tau-b correlation

Tables 3-5 present polarities allocation to ratings. For example, analyzing the cross tabulation between participants' ratings and polarity for the year 2012-2013, we can see that those participants who rated library services with 5, made also comments having mainly polarity 5. Their strong positive attitude towards HOU's Library is echoed at their comments. Those who rated library with 4 seem to have made unbalanced comments. On the other hand, Table 3 presents a distributional unclarity for participants who rated with 1. Users' enthusiasm (5 ratings) is obvious also at their comments in the period 2013-2014 as they are

strongly positive mirrored. Analogous are the results for the period 2014-2015. Current study presents that strongly positive opinions about library's services are equally expressed either numerically or verbally. On the other hand, strongly negative ratings are not so aphoristically manifested in the form of comments. Extreme feelings and opinions (satisfaction and enthusiasm/ disappointment) are unevenly enunciated as disappointment is disguised in words, while satisfaction is clearly represented via highly weighted positive emotional expressions. Additionally, users who rate library with 2 usually weigh appropriately their statements.

		Polarity 2012-2013				
		1	**2**	**3**	**4**	**5**
Participants' ratings 2012-2013	**1**	1	2	2	4	1
	2	2	21	10	14	13
	3	1	17	8	11	4
	4	0	3	4	2	5
	5	0	0	0	3	13
Total		4	43	24	34	36

Table 3. Participants' rating and polarity cross tabulation (2012-2013)

		Polarity 2013-2014				
		1	**2**	**3**	**4**	**5**
Participants' ratings 2013-2014	**1**	4	8	5	15	10
	2	6	25	8	10	14
	3	2	13	5	13	9
	4	1	6	3	9	9
	5	0	1	0	9	13
Total		13	53	21	56	55

Table 4. Participants' rating and polarity cross tabulation (2013-2014)

	Polarity 2014-2015				
	1	**2**	**3**	**4**	**5**

Participants' ratings 2014-2015	**1**	5	14	6	9	6
	2	2	13	6	13	9
	3	4	21	16	9	7
	4	0	1	2	7	6
	5	0	2	3	6	7
Total		11	51	33	44	35

Table 5. Participants' rating and polarity cross tabulation (2014-2015)

Another important issue that motivated the implementation of sentiment analysis on library comments was the extraction of valuable information regarding entities that we could notice. OpinionBuster gave us the opportunity to attribute entities with a polarity. Via a lexical analysis of the comments, we localized the most popular words or word co-occurrences and accordingly we made a list of them that were related to the library. Additionally, we included other word co-occurrences like 'University personnel' and 'Educational material' in order to identify emotions for entities that intruded from users to library's comments.

Table 6 presents the selected entities and their polarity for the selected period according to sentiment analysis. The word 'Library' in users' comments seems to have a neutral polarity close to 3, having also a tendency to decline as the polarity for 2014-2015 survey indicates. Users' feelings about library 'Service' have also the same trend as 2012-2013 there was a slightly positive opinion (p=3.257) of it, while 2014-2015 the opinions were reversed to slightly negative (p=2.855). The word 'Usage' in their comments seem to be the HOU's library weak spot. The polarity of the word 'Usage' and 'Library usage' may be at first sight disappointing but in fact indicates participants' inability for evaluation due to its non-use in the past. Manually analysis of the comments that included the words 'Usage' and 'Library usage' showed that participants' overwhelming majority answered "I didn't make use of the library…". Therefore, a priori 'Usage' and 'Library usage' were "condemned" to be limited to levels close to neutrality. Only the period 2013-2014 slightly exceed the level of 3.

On the other hand, there were entities with noticeable positive level like 'Support' and 'Journals'. The efforts of the HOU's library for support and promotion of academic community's research work are recognized by surveys' participants. The high polarity levels of the entity 'Support' (ranges from 4,333 for the period 2012-2013 to p=3,571 for the period 2014-2015) should be correlated with the high polarity values of the entity "Library staff" (ranges from p=3.5 from the period 2012-2013 to p=4 for the period 2014-2015), as "Library staff" is that who is hidden behind any library's service. 'Journal'

entity is also one of the HOU's Library advantages. Although Greek libraries are facing budget cuts due to financial recession, HOU's Library has made notable investments on new subscriptions to academic journals, fact that is appreciated by the community. "Access" slightly positive polarity should be correlated with 'Journal's' polarities as well. 'E-Library' followed a fluctuating trend all these three years, but never dropped below neutrality.

	Polarity		
Entities	**2012-2013**	**2013-2014**	**2014-2015**
Library	2.98	2.988	2.876
Service	3.257	3.16	2.855
Usage	2.727	3.08	2.428
Access	3.421	3.133	3.148
Support	4.333	3.941	3.571
Journals	4	3.6	2.888
Library usage	2.458	2.538	2.714
E-Library	3.291	3.48	3

Table 6. Entities polarities for the years 2012- 2015

Table 7 presents the polarity distinction that was made between 'Library staff' and other 'University personnel'. It is evident that the quality of services that Library's staff offers stands at a higher level than other university personnel. It seems that Library's staff has been improved regarding skills and effectiveness all these years. On the other hand, both library 'Material' and 'Educational material' are considered to be qualitative (Table 8). 'Educational material' is included in HOU's Library collection and is considered to be very helpful for the students of a distance learning institution.

	Polarity		
	2012-2013	**2013-2014**	**2014-2015**
Library staff	3.5	3.5	4

University personnel	2.939	3.121	2.727

Table 7. Staff distinction

	Polarity		
	2012-2013	**2013-2014**	**2014-2015**
Material	3.454	3.428	3.437
Educational material	3.666	4.22	4

Table 8. Library's material distinction

At this point, we should mention some examples that sentiment analysis corrects the misjudging of the participants' ratings. Although sometimes participants didn't make use of the library, they rated it. For example, a participant wrote "I did not have to use library and administrative services, so I do not have a complete view" and rated the library with 4. This is more a perception rate than a usage rate. At the same time polarity for the words 'Library' and 'Service' was 2. This means that sentiment analysis contributes to the mitigation of irrational positive comments. Another participant hadn't rated library but made a comment: "I searched in the library's catalog, but there was no material I could use. Waiting for the books to be sent is detrimental for projects authoring". In fact, the comment is negative for the library, but this information wasn't imprinted in ratings, meaning that there is more information that is always hidden. So in that way, sentiment analysis works as added value process for non-rating cases. On the other hand, there were statements that infiltrated comments regarding other Institutional Departments, indicating that sentiment analysis should be implemented to library-dedicated surveys and not to surveys of general concept (e.g. educational material was sent promptly).

5. Conclusions

The implementation of sentiment analysis rectifies the deficiency on the contextual understanding of users' satisfaction. Our attempt indicates that sentiment analysis can become a supplementary tool in library's management hands in order to distil valuable information which is latent in texts. As Moore mentions (2017), sentiment analysis constitutes a simple and time efficient way for comments analysis in the libraries' landscape. Libraries should give the opportunity to their users to express theirselves freely via open ended questions in order to extract more information about their perceived image. Current study claims that feelings of the participants of a survey aren't always in line with their Likert scale indications.

Future works - in order to gain a clearer picture of users' perception about library services - should implement the specific technique on questionnaires or comments forms that focus exclusively on library services. Evaluating comments that are included in a non-library specific context is risky because there is a possibility participants' general negative or positive view to influence some partial aspects. Additionally, the specific technique can be further expanded to comments on libraries' social media in order to extract multichannel insights for the library's reputation. Hellenic's Open University Distance Library and Information Center intends to make capital of sentiment's analysis multidimensionality in order to exploit user comments at Facebook and library's user satisfaction surveys.

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