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Received: January, 2015

1st Revision: March, 2015

Accepted: April, 2015

**DOI: 10.14254/2071-
789X.2015/8-1/24**

EXTRACTION OF SOCIAL NETWORKS IN MODERN DIGITAL LIBRARY ENVIRONMENT

Abstract. The article examines the concept of social networking, implementation of the information communication technologies in the social network procedures, formation of online social networks. Observed implementation of these technologies in establishment of the modern digital libraries and presented possible perspectives of the social digital library formation. Also was described the solution of some tasks using fuzzy sets theory and bibliometric methods for control of library management by analyzing of relations between users and resources of digital libraries.

Keywords: Digital library, social network, social digital library, WEB2, collaborative resources, fuzzy sets, bibliometrics, library management, user content.

JEL Classification: D85

Introduction

The term “digital library” encompasses a wide range of working systems and research prototypes, collections of information and documents, and technologies (Ioannidis et al., 2005). In other hand latest years make modern society be more social accompanying with implementation of information communication technologies, Internet, network concept, portative equipment and etc. features. Psychology and philosophy of information retrieval changed in many aspects such as openness, copyright procedures, standards, information management systems and so on. Also the same situation happening with the sociological and physiological structure of the modern information consumers. Observing their behavior possible to view different methods of approaching, which they are very exacting to quality, time management and to

networking in their information needs. But we have to say sometimes they are very lazy and impatient in this procedures.

Regarding mentioned features digital library information systems comparing with “classic” structure becoming very `amorphous`, gathering latest implementations, but keeping some main core merits. Modern DLs is not just an information system, it consist sharing, interchange, relations, cooperation and related activities which reveals sociocentric, sociotechnical aspects of this environment.

View of modern digital library and information society

Modern technologies and ideas have the important ability to create linkages among information resources, systems, groups, individuals and in order of this possibilities direct way to good communication which is very important in modern information society. In simple practice we can observe that most times many respondents are not aware what their library or digital library has newly acquired, recently used, what thinking users about information which they were provided, they have not enough social library environment and certainly this is a lack of socialization (Schrier, 2011).

Observing digital librarianship we can pay attention many digital librarians participate in relevant online conversations, activities for knowledge sharing, advertise and encourage the use of their collections, using social media tools such as blogging, Twitter, Facebook, and YouTube. What does mean this changes? The rapid integration of the Web2 ideology conceptually changed meaning of information interchange, sharing and gathering. Modern librarians and information specialists, especially specialists from the former Soviet Union Republics now has the new tasks, goals and missions, which they need to involve to the new world of information society which very different from previous ones. From modern digital librarianship view the main potential aspects of structure of the new information society are **1. human factor:** from one side intellectual source and from an other side is consumer (user, customer) **2 content:** the end product of the intellectual source and the medium for to satisfying information needs of individuals or the group consumers (user, costumer) **3. ICT and modern ideology approaches:** the third aspect is the set of elements leading the way of integration of the core aspects mentioned before. Fast involving of the ICT to the library-information system making this environment more hi-techy, global, networked, without physical borders, race, age discriminations and more sociable. Modern ideology approaches such CRM (Customer Relationship Management) create new ways available to establish new economic models for the library-information environment. Another example is vice versa of previous one is the idea of `openness` or `Open Access` making resource collections online available to every one, more accessible and sociable .

According this ideas we are moving to the next generation digital libraries, or Digital Library 2.0. This opportunities leads the next aim, goal and mission for today’s digital libraries and their organizers? This new possible structure of “social digital libraries” describe some main concepts such as “architecture of participation”, “rich user experience”, “social interaction”, “semantic interrelations”, “latest IT implementations-automated management” (Anderson et al., 2012).

Way to the Social Digital Libraries: historical analysis, crossroads, sociality and technology

Before moving to the new theoretical ideology of the SDL’s possible structure, necessary to understand how digital library can express sociality itself and what could introduces today’s online social networks, social media tools in digital library environment.

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From ancient periods the traditional libraries know place as express the most social active, intellectual meeting place for scholars, where knowledge and culture collected and introduces for ages. Accordingly to this comment three main cases attracts attention: the brilliant example is the The Royal Library of the Alexandria in Egypt in period of III century BC founded by Ptolemy I Soter, which one of miracles of the ancient world history. Then coming the second global important case in renaissance period XIV-XVII centuries, German inventor Johannes Gutenberg's masterpiece, and the first book ever printed from movable type, is the "Forty-Two-Line" Bible, completed no later than 1455 (Mortimer, 2003). The third important practical example in technology and book history have to be mentioned as a first electronic book invention, inventor of this idea and tool was the American author Michael Hart which invented "Guttenberg" project in the middle of the XX century.

There might be question, why this three examples? what is the relations between these three different periods of the history? what introduces this cases in separately? What is the sociality in this procedures?

The first example: "The Royal Library of the Alexandria", the key ideology and mission in this library was to collect a copy of every single book ever written for this period which in other way shows "mono copies" principle of the fixed resources, where scholars need to come from long distances. But it makes appropriate, comfort atmosphere for controversies, discussions, debates and etc. dynamic social activities in the library (Gorny, Vigursky. 2002).

The second example: "J. Guttenberg's first book printed", performing against "Alexandria principle", this opportunity makes "multi copy idea", the important benefit that the different libraries get the original copies of books published in the same conditions. This idea constantly change the previous one and introduces the new possible technology of spreaded information environment, makes another ideas, graphs of social environment in the libraries, which was the main principle continue long period till middle of the XX century (Mortimer. 2003).

The third example: the ideas of "Invention of e-book", "digital document", "digital library", the new social information institute idea built on historical basises and practices. Before M. Hart's project there were some first theoretical works on this topic, such as "As we may think" by V. Bush, "Libraries of the future" by J. C. R. Licklider. But in practical side "Guttenberg" project starting in 1971 retrieve back "Alexandria principle" with mono copy and location idea for fixed information, also introducing original "Guttenberg principle" with multi copy idea (Arms, 2000). According this technical and ideological opportunities, to launching of the "digital libraries" becoming more actual topic, its unique and active presence in society makes this "zero one" environment one of the most needed social place for academic, public online networking.

Moving to the XXI century, exploring new ICT and online social tools. But academic understandings of ideas as a "social network", "social groups" also went to the late of XIX century on researches of Émile Durkheim and Ferdinand Tönnies. (Winch. 2012) So we observe that this idea also not a new and was the base for the modern information communication technologies implementation object. Today's online social network's (media tools, networking and etc. related issues) concept part of the modern, fast developing technological "triangle", closely and logically related with other two 'Cloud' and 'Web2' technologies concepts. The main feature of this technologies is user based (patron, customer and etc. meanings) content, active participation, interconnection, interrelation and all meanings concerning human beings negotiations. (Xie, Iris, Stevenson, 2014). The best public, business types of the medianetwork examples are fast integrated to the virtual world such as Facebook, Twitter, LinkedIn and other online systems. In this case the object of the article not to observe the structure of the mentioned online social network examples, almost all active users know main features, the architecture of this type of systems, excluding administrative procedures, a lot has been written about benefits

of these technologies, but how to use these benefits, to retrieve necessary properties and implement in right order to digital library information systems? This is core meaning and research topic. This meaning makes view of the Social Digital Library concept under Next Generation Digital Libraries idea. Social network features make available options for the digital libraries such as personalization, user ratings and reviews, faceted navigation, resources recommendation and etc. possible examples. These simple examples will be described in further parts, observing implementations possibilities of the search engine, metadata, standards and protocols in the theoretical model of the Social Digital Library. This planning model presented by the ideas of the library-information specialists and information-communication technologies specialists.

Theoretical structure of the Social Digital Library

“Internet” may seem the easiest way, but it is likely to lead you astray, especially if you are new to the research world. As we know all academic activities and related procedures start from the library and in classic understanding and structure there are many references, bibliographic guides, directories and etc. which navigate the users to the needed information (Booth et al., 2008). This idea and the philosophy come from traditional-historical librarianship, but modern model’s goal is organizing digital library accompanying with social media tools, information management and regulation, technical infrastructure, IT infrastructure and research-search skills. In other understanding social networking via social digital libraries could enable librarians and users (customers, patrons [in US literature]) not only interact, but process, organize, systemize, make more semantic related and share information resources in electronic medium (Worrall, 2014). What can view and offer this combination of tools to modern digital library society?

The possible estimated theoretical structure, understanding, terminology and etc. of social digital library would be built on library-information science and social networks standards. In this case we are trying to move up from general to specific detail researching, implementing these ideas. The first entrances would be the main gates to SDL, which can consist from four main access points and interconnected data bases:

1. Creator (author, editor, composer and etc.)
2. Resource (Intellectual property)
3. User (customer, patrons, readers)
4. Subject (Thesaurus, Ontology).

1. Creator (Author, editor, composer and etc.): This access point in first stage opens the network of people who produce resources in or out of SDL. Every author has their personal and open information registered data which semantically connected with related authors. Main data set could be - Personal information; - Professional information; - Related skill and etc. These data sets can include person, family or corporate body information (Hart, 2010).

2. Resource (e-book, audio-video document, and image) access point taken into account for all information resources collected in the SDL. These resources firstly systemize by type and characteristics as an online, off line, text, audio-visual, image and etc. Then individual metadata processing for each resource with main and added entries, this bibliographic and authority information can be in different standards such as MARC21, MARCXML, Dublin Core, FRBR, FRAD. The creation of semantic linked data between documents make integrated the “Resource” and other three access point’s entities. This set of metadata collection would be expansion of the new generation library catalogs. The main features are - intuitive interfaces; enhanced search capabilities including user-generated tags, reviews and comments; intellectual relevancy-ranked results; fuzzy logic or “did you mean, maybe you mean...?” or other kind of

search assistance; user generated content, special social tools in items like a tagging, bookmarking, rating, reviewing and other related possibilities (Tarulli, 2012). Except bibliographic data would be additional information about further readings,

3. User (customer, patron, reader). The access point for the first step interconnection with other users. This is a first level that each single user is part of the any group within the system. The structure similar the “Creators” data base but different functionality and relationship. The “User” data base and access point structure would built on classic social networks model and has the same and additional functions. The main features are customizable user accounts; opportunity to share registration, catalogue data: bibliographic records, personal registered records with other social networks; compatibility with mobile devices make this social activities in more wide range of society; ability to make research not just in one data base, also to interconnect with other related library websites, databases and different sources.

4. Subject (Thesaurus, Ontology, Taxonomy and related points). The subjects access point and data base is the classification of knowledge and in current situation linked with other data bases systemize and organize huge value of information between “Author”, “User” and “Resource” data bases (Webber, Peters, 2010).

Social networking of Social Digital Libraries

Organizing of four main core data bases and linked data between this information would provide social networking and future development overview of planned SDL. In this part possible to observe connections, relationship, interaction between information and human resources, how they talk each other, built their social semantic linked data. Let’s start from the easiest understanding of these kind social opportunities. For example one of the main academic social environments are universities which most times require students to purchase their textbooks and of course they scribble comments, highlight elements, underline words and phrases, correlate distinct parts in the books to foster critical thinking (Chowdhury et al., 2010). Then make discussion and promotion related to this ideas, and we can ask question: “don’t we make this activities in social digital library environment?” How can we convert these procedures to digital society?

The key point of SDL consists of relationship between four data bases as we mentioned before. Each registered data has semantic link to other data bases information, for example if user make research on any specific monograph, he get access to author information, the comments, reviews, bookmarks made in current document, also information about users group who are interested in this book, according topic he will get access to full data base of related subjects. These social opportunities are the first layer activities, in further steps users can get access to depth of SDL’s networked society. Social networking tools and activity mechanisms accordingly four main data bases.

Interconnection between information resources: systematization, sorting and interconnecting of information resources acquired in SDL. The criteria for procedures are material type, usage, subject and other related issues.

Interconnection between users: librarians can use this tool get connected with users, or user themselves can make friends, organize online discussions and share resources. Individuals can create a blogs for disseminating information, online chatting or virtual reference services by professional library-information specialists. Each user can create personal cloud space (virtual library) broadcast, classes, and webinars, encourage active and related user groups to share their presentations, ideas for the greater community.

Systemized connected and controlled data about creators (authors, editors and etc.): this is a separate interconnected registered data (authority files) about intellectual community, different authors can make special interest groups, academic webinars and other valuable activities.

Systemized connected and controlled data about subject headings related with information resources: the set of thesaurus, controlled vocabulary which the main function collect, organize and disseminate documents. The popular subject headings are LCSH (Library of Congress Subject Headings), Sears list of Subject Headings, Canadian Subject Headings, MeSH (Medical Subject Headings) and other global subject headings might good example for implementation.

Interconnection between information resources and human resources: information distribution the best way to make marketing of new acquired documents, SDL can share new e-books, images and etc. After internal technical procedures users also can help gather missing information about processed documents and other related documents.

Analysis of interconnections between users and resources in digital libraries

In the little example mentioned main difference between classic and modern understandings of digital library. The expression social networks between resources in classic digital library is not hi-functional at first glance, because there are specific places for each resource in virtual shelves or in the part of hosts and most times they don't interconnect ('talk') to each other. But analyzing of each query and usage, relating logically and semantically these resources brings to extraction of social networks between them (fig. 1.).

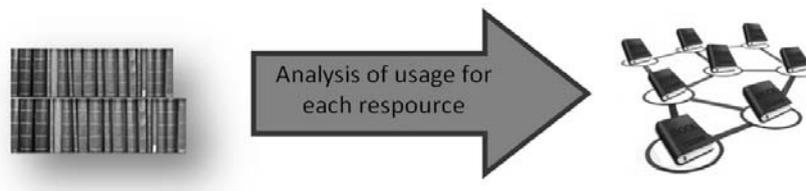


Figure 1. Extraction of social networks between resources by usage analysis

Another idea for modern Social Digital Library social communities in digital libraries possible to connect users of similar interests or resources with similar characteristics together and play essential roles in digital library management (Bramoullé, Djebbari, Fortin, 2009). Analysis of interconnection between library users or resources using different indicators helps us to determine the most suitable resources or the most active users. This type of information is necessary for library management.

Since its inception in 1965, the theory of fuzzy sets has advanced in a variety of ways and in many disciplines. After 1992 fuzzy set theory, the theory of neural networks and the area of evolutionary programming have become known under the name of “computational intelligence” or “soft computing” (Zimmerman 2010). Fuzzy sets theory had found many ways for application in bibliometrics and research evaluation, e.g. fuzzy ranking methods, fuzzy similarity relations for journal ranking (Pan Su et al. 2013), fuzzy clustering methods for automatic term identification in bibliometric mapping (Van Eck et al. 2010).

In this paper fuzzy model for classification of resources was offered and solved for definition of resources' suitability degree. Let's fix the formula and characteristics: N resources (books) in library $B = \{b_1, b_2, \dots, b_N\}$, number of users for k th resource is u_k and number of queries for k th resource is q_k . For usage of resources (u_k) “few”, “many”, “a lot of” and for queries number (q_k) “a little”, “few”, “many” and “a lot of” terms were defined. Suitability of resources

are defined by following terms: “non-suitable”, “less suitable”, “suitable”, “more suitable”. Rules base constructed for current task:

- IF uk=“few” AND qk=“a little” THEN bk= “non-suitable”
- IF uk=“few” AND qk=“few” THEN bk= “less suitable”
- IF uk=“many” AND qk=“many” THEN bk= “suitable”
- IF uk=“a lot of” AND qk=“a lot of” THEN bk= “more suitable”.

Represented task was solved in Matlab by Mamdani model (fig. 2). In surface for solved task blue color determines the “non-suitable” resources, amount of yellow color in graphic determines the level of suitability of resources, the yellow points in surface are most suitable resources for mentioned library.

Example: let u_1 – is usage for the first resource is equal to 32 and q_1 – number of queries is equal to 56, in this case suitability degree of the first resource will be equal to 0,88. Received result shows high suitability of the first resource.

By the same principle we can determine activity degree of users and define the course of following actions for increasing their activity by analyzing of users’ areas of interest or way of life. Input variables for definition of user’s activity may be identify by different ways, e.g. calculating the number of hours stayed in given page, number of used resources, number of queries, etc.

Also we can cluster resources by disciplines on analyses of their users’ specialty or other resources which they are used together.

There is some extraction model of social networking from users or resources environments for constructing of co-authorship networks which was used in practice (Liu et al., 2005). Let’s see the procedure: there are M users in digital library, the graph of interconnection between users is $G = (R, E, W)$, there R is the set of nodes (users), E is the set of edges (relations between users) and W is the set of weights associated with each edge connecting a pair of users. Determining of the weight of links between users is described below:

If users r_i and r_j are users of resource b_k , then $g_{ijk} = 1/(f(b_k) - 1)$ – represents the exclusivity of relation between users r_i and r_j , here $f(b_k)$ is the number of users of resource b_k , $c_j = \sum_{k=1}^M g_{ijk}$ - is the frequency of users r_i and r_j , now we can define normalized weight of relation between users r_i and r_j by following formula:

$$\omega_j = \frac{c_j}{\sum_{k=1}^M c_k}.$$

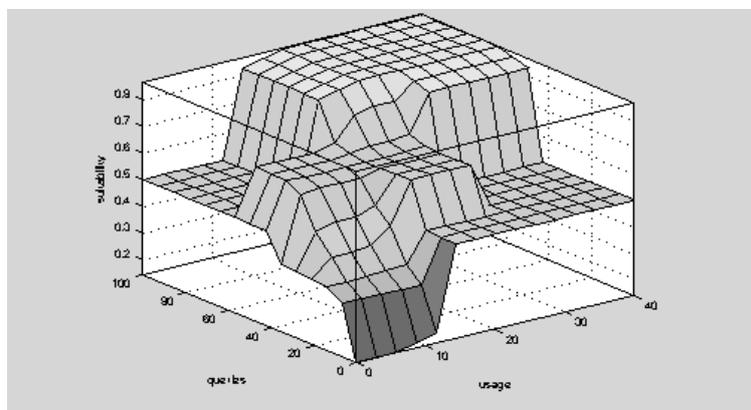


Figure 2. Surface received in MATLAB as result of determining the suitability of resources

Source: own calculation

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Using weights we can define the place for each user in social network of digital library users and also cluster them.

Example. Define network for r_1, \dots, r_4 users, if resources which they use b_1, \dots, b_5 distributed as following:

$$b_1 - r_1 r_2 r_4$$

$$b_2 - r_2 r_4$$

$$b_3 - r_1 r_3 r_4$$

$$b_4 - r_1 r_3$$

$$b_5 - r_1 r_3 r_4$$

Using data about distribution of resources between users or on the contrary distribution of users between resources we can calculate weights of their relations (table 1, 2) and define network between these users and resources (fig. 3 (a, b)). Also using different software for bibliometric mapping and scientific analysis we can define some clusters – most strongly communicated groups of users and resources in digital libraries. In figures received by using VosViewer (www.vosviewer.com) software were demonstrated 2 clusters ($\{r_1, r_3\}$ and $\{r_2, r_4\}$) for users and 2 clusters ($\{b_3, b_4, b_5\}$ and $\{b_1, b_2\}$) for resources in given example.

Table 1. Calculated weights of relations between users on base of example 1

	r_1	r_2	r_3	r_4
r_1	-	0,16	0,3	0,5
r_2	0,25	-	-	0,75
r_3	0,5	-	-	0,5
r_4	0,375	0,375	0,25	-

Source: own calculation.

Table 2. Calculated weights of relations between resources on base of example 1

	b_1	b_2	b_3	b_4	b_5
b_1	-	0,45	0,28	-	0,28
b_2	0,67	-	0,17	-	0,17
b_3	0,22	0,09	-	0,13	0,35
b_4	-	-	0,5	-	0,5
b_5	0,28	0,11	0,45	0,17	-

Source: own calculation

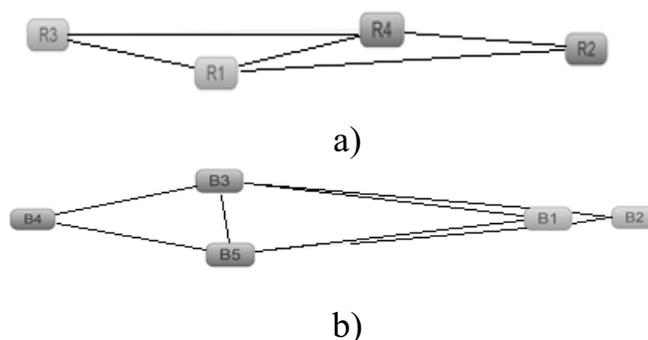


Figure 3. Received networks of users (a) and resources (b) on base of example 1.

Source: own calculation

Conclusion

As we observed “Web” and “Digital” technologies introduces new way of organizing information resources; creating of digital social society, networks; personal, individual data such as family trees, birth and death registers, wills and etc.; semantic relations, bibliometrics, intellectually analyzing methods and features and etc. functionalities.

Analysis of main core databases in social digital library environment – creators and users’ databases, resources database. Then action of this data bases in face of interconnection between users, interconnection between resources, interconnection between users and resources to each other gives more opportunities for resources clustering by disciplines which they belongs to, there suitability, and grouping of users by their activity, mains of interest, specialty, hobbies and etc. characteristics. Received information on result of such analysis is very important for digital library management, systemized and clustered information, modern policy and procedures, and conducting to the global information competition.

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