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INFOVIS: A COLLABORATIVE SYSTEM FOR VISUALIZING REPOSITORIES

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Resumen

Este artículo pretende conceptualizar un nuevo paradigma comunicativo aplicado a repositorios científicos académicos. La publicación de artículos y consulta como revistas, libros y otros documentos, son una parte integral del proceso de investigación. La búsqueda de la información en repositorios académicos, a menudo resulta ser ineficiente debido a la amplia gama de resultados obtenidos, que difícilmente se enmarcan en el campo/temática específica del usuario. En este sentido, se evidencia una problemática que parte de la relación del usuario con el repositorio académico de la información científica. La relación de la información encontrada no siempre es la adecuada para los intereses específicos que el usuario pretende encontrar. Siendo que esta información se consulta por un gran número de usuarios con un interés específico en un determinado tema, y éstos en el curso de la búsqueda, manejan una cantidad significativa de documentos. Sabemos que existe una estructura relacional y jerárquica que resulta de la interacción entre los diferentes usuarios, sus intereses específicos y la búsqueda efectuada. De esta manera, es fundamental tener en cuenta la experiencia del usuario y el papel preponderante que éste podría representar en la filtración de la información.

Las técnicas InfoVis desarrolladas para redes de conocimiento, constituyen una hipótesis de partida para el problema planteado. Este artículo presenta un análisis breve en torno a los principales proyectos de referencia, que a pesar de estar basados en un análisis de citas de artículos fundados en el factor de impacto, presentan como característica principal, la visualización de patrones entorno a una amplia estructura de citaciones y relaciones entre las distintas áreas. Con base en el modus operandi de estas interfaces de visualización, este artículo se propone un nuevo enfoque, para visualizar la información, basada en la experiencia del usuario en lugar del usual enfoque centrado en "objeto" de la citación.

Palabras-clave: DILUVIO DE INFORMACIÓN, DISEÑO DE COMUNICACIÓN, ESTRUCTURAS JERÁRQUICAS, ESTRUCTURAS RELACIONALES, TAXONOMÍAS SOCIALES, VISUALIZACIÓN DE INFORMACIÓN.

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Abstract

This article aims to conceptualize a new communicative paradigm applied to academic scientific repositories. The publication and the querying of articles, papers, journals, books and other documents, are an integral part of the research process. However, the querying and information visualization process in a scientific academic repository, often proves to be inefficient, and a hard task, because the wide range of results hardly fits in the user's specific subject. In this sense, this paper highlights a problem that emerges from the user's relationship with an academic repository of scientific information. In particular, a problem that is related to the "object content" (results) that best suits the interests/user's specific subject. However, if we equate that this information is accessed by a significant number of users with a specific interest in a topic, and in the course of their research they handle a significant amount of information, it is then possible to consider the existence of a hierarchical and relational structure of evidences, that emerges from the relationship established between the various users and their specific interests and the querying performed. Therefore, it is fundamental to consider the user's experience and the leading role that it could represent in filtering information.

The Information Visualization (InfoVis) techniques directed to knowledge networks also constitutes a fundamental approach. In this sense, this paper presents a brief analysis around major reference projects, which although based in the metric of article citations (impact factor), the primary goal lies in the visualization of an extensive citation structure and the relations established between the different scientific fields. However, based on the modus operandi of these visualization interfaces, the main objective of this paper is to propose a new approach, where the filtering and the visualization of information is based in the user's experience instead of the usual citation "object" centered approach.

Keywords: COMMUNICATION DESIGN, FOLKSONOMIES, HIERARCHICAL STRUCTURES, INFORMATION FLOOD, INFORMATION VISUALIZATION, RELATIONAL STRUCTURES.

1. INTRODUCTION

An efficient communication of information is a complex task that the global networked society faces. A typical example is that there is still a great difficulty in effectively communicating information in various sectors and services of society (Wurman 2001, 9). According to Wurman (2001: i), what in fact this reflects is not an excess of information, but an explosion of "non-information", data that simply doesn't inform. The main question that arises around the abundance of information, leads us to another subject related to the problem which comes during the continuum understanding process (Shedroff 1994, 4). Specifically, when we feel overwhelmed either cognitively or perceptually by a type of information that does not correspond to our specific interest (Wurman 2001, 14-15). In fact, a large part of the published and accessed information is not subject to a process of efficient filtration (Thackara 2006, 163). A process that should consider not only the state of knowledge (Shedroff 1994), but also the shape, structure and framework as fundamental aspects in the relationship between the user and the information (Thackara 2006, 163). Wurman (2001: 9), states that the task of developing and exploiting new forms that aim for a more efficient meaning of content is entirely the responsibility of the Design/er.

The publication and querying of scientific articles, journals, books and other documents, are an important part on the academic research process, and in the researcher quotidian. The digital knowledge repositories (DKR) have facilitated numerous tasks related to the querying of knowledge objects (KO) (e.g. articles, journals, books, among other examples). Despite the easy accessibility, the search of relevant information in a DKR proves to be an arduous and a time-consuming task. Normally the standard search engines used in the DKR only allow a limited refined search based on keywords, name of author/s, title, year, relevance, related articles (descendants), among other examples. Data related to the user characteristics, e.g, academic field, academic degree, which articles were consulted by the user, among other examples, are practically nonexistent. In fact, the search and information visualization process in DKR often proves to be time-consuming and an inefficient process, in part, because a large part of the obtained results are not specifically aimed to the specific interests of the researcher. This is also a cross-cutting issue in the digital academic knowledge repositories (DAKR). Despite of the DAKR primary function be directed to the storage, structuring and search/querying of KO, they can also be redesigned to better support researchers. In fact, the specific problematic related to the search and information visualization of KO in DAKRs, it is defined by the filtering and framing of the results in the perceptual and cognitive field of the user. In this sense, InfoVis has enabled the structuring of a precise and efficient relationship with information (Card et al. 1999), (Tufte 2009; 2011), (Chen 2006), (Manovich 2010), (Fry 2007), (Mazza 2009), (Lima 2011; 2014); (Meirelles 2013), (Liu et al. 2014,1373-1393). It enables to go far beyond simple data gathering as it allows viewing in an analytic and synthetic way, but also to assign data to a form and efficient framework in the perceptual and cognitive field of the user (Ciuccarelli 2009). Therefore, the main objective of this this article is the conceptualization of an interface/visualization directed to the viewing of the structures that emerge from the relation established between the user and the KOs stored in DAKRs.

1.1.CONTEXT OF THE SPECIFIC PROBLEMATIC

The artifacts developed over several ages, such as maps, libraries, encyclopedias, and databases show the cultural evolution of information systems. The current development of Information and Communication Technologies (ICT) have enabled significant progress e.g. in logistics, financial management, accessibility, knowledge systems, among other exemples. The DKRs are such example, by improving the browsing and the retrieval/searching of information. The DKRs are characterized as being complex and multifaceted information structures. Normally the organization and information browsing/search process is based on an indexing system (database), which enables the user to find KOs by querying for relevant metadata, e.g. subject, title, ISBN, DOI, year of publication, authors, publishers, reviews, detailed descriptions as abstracts or summarys, number of downloads, impact factor, relevance, descent articles (ACM Digital Library). However, faced with the exponential volume of stored data, and taking into account the specific research interest of the user, the standard search engines proves to be inefficient, in part by the wide range of results obtained (lists). The user chooses mostly the first result, despite the additional filters available to support search and browsing tasks. According to Chen et al. (1998, 583-584), navigation and search tasks are susceptible to the problem of information overload. Usually, the browsing behavior is adopted when the user does not have a specific research objective (idem 1998). Task that reveals to be an inefficient process for the user who wants a more targeted approach, by the fact that results are typically found in a serendipitous manner. When the user has a specific purpose in mind, the adopted behavior is the searching mode (Zhu et al 2006, 160), performing additional tasks to obtain details about the searched subject, like reading the abstracts, or the references section. In this sense, the current analysis context describes the specific problematic, which is the relationship between the user, the DKRs and the search and browsing tasks perfomed.

2. FOLKSONOMIES AND REPUTATION SYSTEMS

The increased storage capacity and the resulting exponential publication of data, led to a constant search of information sources based in self-interests (Wurman 2001, 8). As stated by Darlin (in Johnson 2011, 118), "Everything we need to know comes filtered and vetted. We are discovering what everyone else is learning, and usually from people we have selected because they share our tastes." Fact which in turn enables access to an independent type of information that was not easily available previously (e.g. product features, ratings, reviews), allowing the user to perform a more oriented approach. Currently, the user has at his disposal a number of tools that allow a more sustained research. A typical example is that we seek the users feedbacks, ratings, reviews and comments within a networked community with a common interest for a given product or content. Content tagging systems are not an innovation of current ICT. According to Wright (2008, 25), the first taxonomic systems precedes the first pre-literate civilizations. In this sense, it should be noted that the first taxonomic systems are not based on a scientific culture, but on an oral culture rooted in tribal communities, directly related to the necessity to categorize the species. These were used to classify and organize into categories a body of knowledge related with the natural world (e.g. plants, animals, environment, among other examples) (ibid. 2008, 22-38). The use of the classification systems, allied to a strong survival instinct, has triggered the need to categorize, collect and thus spread a set of valuable information about the natural world (ibid. 2008, 24). In fact, folksonomies were fundamental tools to the group's survival, since the domain knowledge about the flora and fauna guaranteed the perpetuation of the community/ human species (ibid. 2008, 24-25). The form and the categorization mechanisms used until nowadays were shaped by folksonomies. In fact, these mechanisms are directly influenced by the principles that shape hierarchical and relational structures. For example, a folksonomy is a hierarchical system which depends on the agreement (consensus) of the meaning within a social network community (relational structure), where the categorical hierarchy establishes the framework for the acceptance of the meaning, while the underlying social network structure establishes the cultural consolidation of that meaning (idem 2008, 29).

The current collaborative tagging systems are an example of the evolution of folksonomies. Therefore, the interaction between users and content is supported by an open system of collaborative tagging, that allows the user to publicly classify the resources available (e.g. Del.icio.us). However, it should be noted that the stability of a community is the result of an immediate and conscious feedback whether at individual or collective level (Golder et al. cit in idem 2008, 39). Thus, the contribution of each individual user gives rise to an emergent social feedback of categorization standards (Golder et al. 2006), (Obreiter et al., 2003). According to Quintarelli (2005), a folksonomy emerges from an association between keywords and content, based on the "wisdom of the crowds". It should also be noted that according to Quintarelli (2005), folksonomies trigger serendipity, which means they are not an objectified solution to an targeted search, however constitute a valuable resource on the labeling of contents.

Another factor to consider is the credibility of tagging and assigned ratings. In fact, the peer to peer reputation and tagging systems developed up to date have a limitation in terms of credibility (Thackara 2006, 163), more specifically the ratings and reviews that we use as a reference e.g. when buying online products. Dellarocas (cit. in Rheingold 2002: 127) and Resnick (2000) emphasized that the main problem detected in open reputation systems based on user feedbacks (e.g. Amazon, Ebay), lies in the vulnerability associated with the manipulation of ratings and reviews. One of the main factors contributing to the limitations of the evaluation systems applied to the Web, comes from the fact that these systems are an open network structure (Resnick 2000). In fact, the main problem detected in open reputation systems technologies lies precisely in their vulnerability and consequent susceptibility to manipulation (Dellarocas cit. in Rheingold 2002, 127). Despite the issues of relevance and degree of reliability of the reviews and classifications used on open network systems, the underlying concept of reputation systems allows users to play an individual role in a large cooperative network, wherein the individual feedback of each user contributes to the building of a broad view about a particular product or service. This implies that if the user of the open networked communities shares "what he knows and how he feels", it is then possible to create a reliable "database" to extract knowledge and create opportunities (Smith cit. in Rheingold 2002, 30).

Reputation systems are characterized as the point of convergence between technology and cooperation (Rheingold 2002, 114), and therefore go beyond quantitative efficiency, enabling a rapid performance of tasks and processes considered slow and expensive (e.g. product analysis). In fact, according to Rheingold (2002, 114), "connecting human social proclivities" to the efficiency of information technologies, triggers an unprecedented scale factor of cooperation.

3. RELATED WORK

The bibliographic citation is a common practice in various types of academic publications and an important measure of credibility. The citation ranking developed by Garfield (1955), is a tool that allow to measure the impact factor of scientific papers by the number of citations. This means that the relevance/impact factor of a paper, stems from the number (frequency) of citations (Wright 2008, 203). In this sense, the science citation index (SCI) has allowed measuring the impact factor of one particular scientific paper, based on the cumulative value of citations. This means that the importance of a scientific paper is determined collectively by the research community (ibid 2008, 204). In this sense, the references section of a scientific paper, is a key element that allows to verify the existence of a relational structure. In fact, large parts of quantitative studies (bibliometrics) in the field of science, are characterized by the analysis of scientific citation flows, which are based not only in the reference/citation between publications, but also, in co-authoring publications, including collaborative structures between researchers (Staudt 2011, 1). In fact, quantitative analysis around scientific structures are mainly defined by the number of papers written, number of authors of a paper, number of researchers involved, the existence and extent of a network of researchers, and degree of cluster (Newman 2001).

Taking into account the problematic of visualization and filtering information, it's important to analyze some major reference interfaces dedicated to the visualization of scientific knowledge networks aimed at the visualization of trends and citation patterns, and to the classification and tagging of contents. Thus, the following three interfaces are highlighted:

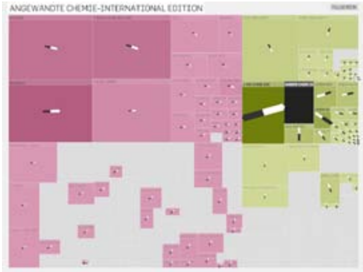

Fig. 1. Well-formed Eigenfactor, 2009). Moritz Stefaner, Hierarchical edge bundling algorithm.
Fig. 1.1. Well-formed Eigenfactor, 2009. Moritz Stefaner, Treemap algorithm.

The Well-formed Eigenfactor is an academic research project which results from a collaboration between the Eigenfactor Institution (data analysis) and Stefaner (Visualization) (2009). It is an interface that consists of four interactive visualizations (in this paper we only highlight two modes), that aims to the exploitation of citation patterns based on Eigenfactor metrics. The main objective of the interface lies in the mapping and visualization of citation patterns between various scientific journals. Given that academic references incorporate a vast network of citations, the Eigenfactor metric uses the overall structure of a network of scientific publications to evaluate the impact factor of each journal based on the citations number of Thomson Reuters Journal Citation Reports from 1997 to 2005. The aggregation of different networks results from the use of a theoretical method developed by Rosvall et al. (2008). With regard to visualization techniques used in the interface, we highlight the circular relational structure and the hierarchical edge bundling algorithm developed by Holten (2006) [Fig.1], and the tiling algorithm treemap of Johnson et al. (1991) and Shneiderman (1992) [Fig.2]. Regarding the hierarchical clustering algorithm (circular relational structure), it is important to highlight that the hierarchical grouping of the edges allows a reduction of the visual clutter (Holten 2006). The treemap visualization technique based on the squarified treemap algoritm (Bruls et al. 2000) and ordered treemap algoritm (Shneiderman et al. 2001), (Bederson et al. 2002), consists of a hierarchical contention structure, where the size of the rectangles representing the journals, varies according to the Eigenfactor score scale. Also the arrow size indicates the amount of citation flow, where the the black indicates the outgoing citation and the white the incoming citations flows (Stefaner, 2009).

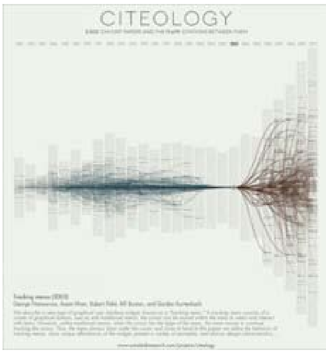

Fig. 2. Citeology: Visualizing Paper Genealogy, 2012. Matejka et al. Horizontal Relational Structure

The Citeology: Visualizing Paper Genealogy developed by Matejka et al. (2012), is an interactive display aimed to the representation of the relationships between scientific papers, based on a sample of 11,699 citations between 3,502 scientific papers published between 1982 and 2010 at two series of conferences by the Association for Computing Machinery Conference on Human Factors in Computing Systems (ACM CHI) and User Interface Software and Technology (UIST) (Matejka et al. 2012, 181-190). The relational structure (horizontal) represents the genealogy of the selected paper, where the blue branches establishes the connections to the descendant papers and the red branches establishes the connections to the ancestor papers (ibid. 2012, 183). The lines connecting nearby generations are thicker and opaque, and for distant generations the line is thinner and transparent (idem 2012, 183).

Fig. 3. *MACE: Metadata for Architecture Contents in Europe,* 2006. Moritz Stefaner. Radial hierarchical relation structure.

The Metadata Platform for Architectural Contents in Europe (MACE), closed in 2013, is an interdisciplinary project, aimed at students, teachers and architecture professionals. The platform consists of an interconnected infrastructure of repositories spread throughout Europe. The MACE platform is an access service and efficient search of the stored content learning objects (LOs). It should be noted that the content search is based on a collaborative tagging system. For the content enrichment (tagging) different types of metadata are used (Stefaner et al. 2008, 29). The browsing of the tagging vocabulary is supported by an interactive structure of the terms and their relationships, namely a radial hierarchical (tree) relacional structure (Lima 2011, 132), which provides an overview of the used classification terms (Stefaner 2006). It shows more than 2,800 tags used by the platform in a variety of languages (Lima 2011, 132). It should be noted that the radial hierarchical structure [Fig. 3] is based on the algorithm developed by Yee et al. (2001, 43-50), highlighting the implemented improvements at the level of the edges based on the Gestalt law of good continuation (Stefaner et al., 2008, 44). The varying sizes of the circles translates the number of resources related to the tag as well as the volume of usage (ibid. 2006).

4. DISCUSSION AND FUTURE WORK

Of the three analyzed interfaces, the Well-formed Eigenfactor is based on the visualization of journals citation patterns, this means that within a given filed or subject, it becomes possible, based on the Eigenfactor metric, to observe trends and patterns. In the case of the Citeology, the interface provides a temporal and chronological perspective of the citations network, from one selected scientific paper. At the level of interactivity, we highlight the absence of a zoom feature. The wide range of results obtained, in the first place, incites the adoption of a search behavior. Taking into account the specific research topic of the user, it forces a brief reading of the selected papers. However, as mentioned in the previous point, the individual reading process of each KO is a time-consuming and a inefficient procedure.

Since the previous cases provide solutions for viewing patterns and trends, specifically interfaces aimed for the visualization of scientific network knowledge structures based on impact factor of an journal, e.g. in the case of the Well formed Eigenfactor. The MACE interface incorporates simultaneously a content enrichment process based on a collaborative tagging system, and an interactive structure that provides an overview of the used terms. However, it should be highlighted, that the issues related to credibility of the classifications and tagging processes is one of the main problems identified in open network systems. Yet in the MACE platform, the used terms are subjected to an approval process conducted by specialists (Stefaner 2008, 38). It should also be noted that, according to Quintarelli (2005), the collaborative tagging systems do not provide a solution for a more targeted approach/search.

Despite of the different approaches presented, the techniques and strategies adopted provide fundamental clues to the conceptualization of new ways to interact with DAKRs. However, one of the main problems of the DAKRs interfaces is an approach exclusively centered in achieving results (more data), not including the user's feedback. In this sense, it becomes clear the need to develop new paths aimed to the visualization of structures that emerges from the relationship between the community and the search for KOs, and a scenario that includes the participatory role of the user in the enrichment of the contents.

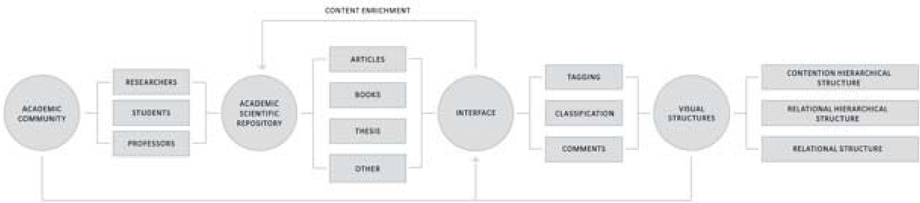

Fig. 4. Interface Architecture

Regarding to future lines of research, it is necessary to briefly explain a problem that emerges from the relationship of the user with a DAKR. The following example illustrates metaphorically the referenced problem: when we stand before a large amount of KOs, and according to our particular subject, we frequently face a vast informational ocean (Wright 2008: 171-175). In this sense, the question that arises from this experience is logically what is the most appropriate or specific KOs to a user's search, taking into account the user specific interest. The specific problematic enunciated, namely the relationship between the user and the Academic repository, such as the RiuNet UPV (Institutional Repository of the Polytechnic University of Valencia), is defined by the filtering and visualization of results. Although they only allow the statisticall view of the number of times that the KOs were downloaded or specify a distribution by typology (eg. by author, keywords, area of knowledge, relevance, among other examples). Even when this data is available, it is not possible to understand the pertinence and relevance of the information for the users, in other words, to visualize the structure that emerges from the interaction of users with the queried information. In this way, the problematic is related with the objects that best suit to the specific research. But, if we think that the KOs are accessed by a significant number of users with a specific interest in a subject, and in the course of their research, they handle a significant amount of KOs, it is then possible to consider the existence of a structure of evidences, as a result of the relationship between the various users and their specific interests.

The proposal to solve the problem stated, results from the conceptualization of a collaborative interface directed to the enrichment of the KOs, based on an reputation and classification tagging system, and on the visualization of the structures that result from that action. In this sense, the goal is to interpret, summarize and present dynamically and interactively the emerging relational structure of evidences, resulting from the connections concerning to user interaction with the search of the KOs. Therefore instead of the usual "object" centred approach like Well-formed Eigenfactor and Citeology, an approach based on the user experience will be established (e.g. MACE). In this sense, the interface architecture [fig. 4] is defined by the relationship established between the community and the enrichment of KOs, the user's feedback (tagging, ratings and reviews) and the interactive structures to be generated. An important aspect for future work is the study of the weight of the assigned classification that will have a direct relationship with the field and academic degree of each user. For instance, a rating from a professor will have more weight in relation to the student classification; or when users from different fields evaluate the same paper, the user who is directly related with the specific field of the paper will have more impact. Different scenarios are being equated.

It is a fact that the DAKRs solved the issues related to storage, retrieval and information search. However, given the exponential growth of information, a query based exclusively centered on the results, proves not to be efficient for the user who is looking for a specific subject. In this sense, the need to structure an interactive, efficient and functional relationship with a wide range of KOs, reveals in the current paradigm of abundance of information a large-scale problem. Thus, there is an urgent need to develop tools that allow users play a social active role. However this is an approach that contradicts the ingrained thinking in the Design discipline, that thinks and describes the user as a simple potential consumer, when in fact it is imperative to think of him as an actor (Thackara 2006, 221).

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