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Chapter 4: Cartographic Visualization of personalized Scientific Alerts

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Abstract

Different diffusion tools within collaborative networks provide to researchers more and recent information. In this paper, we focus on the scientific quality of diffused information and discuss the implications of this tendency for scientific performance. We propose a qualitative scientific watch system enriched by an alerts' personalization and cartographic visualization tools. The proposed watch system is based on scientific quality evaluation in its different parts. Scientific quality evaluation is made by the mean of scientometric indicators to select qualitative new publications to diffuse to the researchers. The integration of personalization tool helps researchers on identifying qualitative information which corresponds to their needs. Moreover, the cartographic visualization provides to the researchers the possibility of analyzing and choosing more quickly interesting and useful alerts.

Keywords: scientometrics, scientific quality, cartographic visualization, personalization, scientific watch, academic social networks;

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1. Introduction

According to Rieger, 2008 scientific communication is a process by which scientific information is produced, certified, diffused, preserved and used. Scientific communication is part of the context of scientific research. The scientific community generally shares the idea in order to improve knowledge, innovation and creativity (Belli et al., 2019). The way we access, use and analyze scientific knowledge has radically changed in the last few years due to the availability of a large amount of research databases on the Web. These databases provide us with accurate and complete information about the content of scientific papers. As more information on scientific production continues to grow, new tools are needed in order to extract and organize knowledge (Luan, 2018).

A scientific paper is considered to be the output of scientific research. The purpose of scientific publications is sharing research results to benefit from research work. The means of sharing and diffusing scientific information play an important role in the development of science and research activity. There are several means of sharing and diffusing used by researchers such as academic social networks such as: research gate, academia.edu, science work, scoop.it and watching tools such as: Google Scholar alerts, Google alerts, mention, talkwalker alerts and GigaAlert. These means aim to collect and diffuse scientific articles and promote research work to all readers.

In this context, we are interested in the quality of the information diffused by these tools. These tools follow a scientific watch process which recommends to researchers a set of scientific articles corresponding to their thematic needs. This information may not be of an expected quality. Why not integrate the quality of information into the scientific watch process to diffuse qualitative information?

The diversity of scientific diffusion tools makes the control of the information quality more difficult than before. Hence, we need a qualitative diffusion tool to inspect the quality of scientific information used by researchers. Typically, qualitative needs are different for each user. Diffusing specific information for each individual user is particularly important. Different users expect different information even given the same query. Personalizing alerts for individual users is another axis that we should focus on. Moreover, in order to assist in the proper use of diffused information, an efficient way of alerts' visualization must be proposed. Our question concerns the quality of diffused information and its adaptation to the researchers' needs. The information communication tools (academic social networks, blogs and watching tools) do they play a role in improving scientific production quality? Do these tools' users refer to researchers' based on their quality? Does it fit the researchers' needs?

We will first present several tools used for scientific information diffusion in Section 2. In Section 3, we propose an enriched qualitative scientific watch system. In Section 4, we present our personalization approach followed by a qualitative evaluation of diffused information. In Section 5, we present an adapted way of alerts visualization by the mean of cartography. We discuss our findings and conclude in Section 6.

2. Scientific Information Diffusion

Research output is diffused as written information published in different forms. Publications forms differ according to the discipline. Scientific information can be defined as all the information produced by research and necessary for scientific activity (György, 2019). The researcher-author is at the heart of the knowledge production process, he is at the origin of the research that has been conducted and he is responsible for diffusing the results of his research. This diffusion is done through scientific publications. Price, 1951 considers that the final product of the scientific research is the publication of a written text (scientific articles, contributions to symposium, reports or any other kind of literature). Science is which is published in journals, articles, papers and scientific works (Price, 1961). Scientific journals are the main vehicles for diffusing new knowledge after validation by the review committee (Tveden-Nyborg et al., 2013).

2.1. Scientific Watch

Scientific information must circulate as widely, quickly and efficiently as possible, while being of the highest possible quality, as this diffusion fully contributes to the functioning of research. Putting a watch in place is to monitor the environment in which we evolve. Establishing scientific monitoring of open access resources is therefore to monitor the latest publications of scientific articles and scientific literature in general in a given discipline.

The watch is a permanent activity whose main attribute is observation. It consists of keeping the user informed in a very up-to-date manner in an evolving information environment. It contributes to giving information a strategic dimension, particularly in terms of decision-making. Applied in scientific research, intelligence is a major documentary skill in an environment where information is highly mobile.

The watch methodology includes the selection of sources of information to exploit. The reading of the national but also international scientific publication is an essential tool for any activity of scientific watch. It also consists in being able to work on several levels of depth of the documents.

2.2. Diffusion of Scientific Information Via Academic Social Networks

Academic social networks are the new intersection between social media and scholarly publishing which are interesting online spaces that merit their own discussion (Ovadia, 2014). These spaces are added to the classical scientific resources such as journals, book chapters, books and conference proceedings. Social networking sites can seem frivolous and pointless to academics. We observe that specialized academic social networking sites are gaining popularity in certain disciplines and with certain faculty (Ovadia, 2013). Academic social networks, also known as scientific social networks, are used to accelerate the world’s research. Researchers can access millions of academic papers for free, share their research and track its impact.

Following the classic definition of a digital social network, these tools orchestrate the networking of users from their profile. A network of user is formed using semi-automated connections established from published information (CVs, lines of research, articles, etc.).

With more than 3 million registered researchers, ResearchGate (Lee et al., 2019) is in the process of building the largest graph of researchers ever made on the model of Facebook and reproduces main feature of the news feed. Its strength lies in the exploitation systematic citations and reservoirs of articles freely available or in archives. ResearchGate has its own baptized index RG Score assigned to each member, based on the contribution intake of the profile and the interactions of members with it (article downloads, questions, answers to questions).

Other academic social networks use watching systems for scientific information diffusion such as: Academia , Scoop.it and ScholarWorks .

Academia's mission (Thelwall and Kousha, 2014) is to make every scholarly and scientific paper available for free on the internet and to enhance academic discussion and collaboration. Based on a watching system, academia allows the creation of an unlimited number of alerts to receive updates on specific search preferences.

Scoop.it (Antonia and Tuffley, 2014) is a useful platform for the creation and sharing of information resources with other researchers and the wider community. Scoop.it facilitates the creation of networks for information sharing and knowledge building. Scoop.it has additional functionality that allows the user to diffuse their content via the social media platforms that are embedded within the tool and suggest content to other users.

ScholarWorks makes the intellectual output of the Walden University community publicly available to the wider world. ScholarWorks' rich repository encourages new ideas, preserves past knowledge, and fosters new connections to improve human and social conditions. ScholarWorks provide alerts tool which keep track of newly published content, tailored to the user interests. Based on keywords the user is notified via email of content fitting his/her desired criteria.

2.3. Diffusion of Scientific Information Via Bibliographic Databases

The recent development of online bibliographic databases allows us to have a quantitative description of large amount of scientific papers as well as the relations between these papers (citations). This development offers exciting new perspectives for understanding how the process of scientific production evolves over time (Lambiotte and Panzarasa, 2009).

The study by Norris et al., 2008 shows that several scientific watching systems exist and they are used by researchers to be up-todate in their researches. The widely used scientific watching systems are: Google Scholar alert system and Science Watch

Google and Google scholar are effective search tools for finding scientific publications. These two search engines have the advantage to index the articles posted on the websites of the authors and the websites of the research laboratories. It is possible to create email alerts on Google scholar. Google Scholar will send a notification each time it will meet a new reference with the terms used during searches. It is therefore important to focus search and therefore choose relevant and targeted keywords so as not to receive too many notifications with useless references, or on the contrary, not to receive enough.

ScienceWatch.com (Noruzi, 2017) provides a look at the researchers, journals, institutions, nations, and papers selected by Essential Science IndicatorsSM from Clarivate Analytics and other products of the Research Services Group. ScinceWatch is updated weekly, new papers are added with every update, and ScienceWatch.com tracks these new additions. ScienceWatch.com highlights the most-cited of these new entries.

3. Qualitative Scientific Watch

The existing free scientific content allows anyone to publish anything and make it accessible by a large number of readers who may not have the ability to select qualitative information. Niazov et al., 2016 find that a paper in a median impact factor journal uploaded to scientific social networks receives 16% more citations after one year than similar article not available online, 51% more citations after three years, and 69% after five years. This practice can orient researchers to rely on publications which are not judged on their qualities but on their number of shares. This uncontrolled content can influence the quality of scientific production. This requires studying the quality of diffused information by scientific watch systems available on academic social networks and bibliographic databases. We focus on post-publication quality which reflects the impat of informations after peer evaluation and publication.

Based on the qualitative study carried out by Ibrahim et al., 2020, we justify our need for a qualitative tool to diffuse scientific information. This tool analyzes the quality of the information before alerting the users. Scientific quality is now determined by a set of metrics measuring the quality of scientific documents (Hammarfelt and Rushforth, 2017). Our objective is therefore to present some tools that facilitate the documentary research and the establishment of a scientific watch of available scientific resources. We enriched the proposed watch system, published in (Ibrahim et al., 2020), by alerts' personalization process and cartographic visualization.

To integrate quality in scientific watch we used scientometric indicators (document citations, author h-index (Huggins-Hoyt, 2018), conference or journal class and journal impact factor) to analyse the quality of diffused papers. This analysis is based on the scientometric indicators of each paper detected. We adapt the diffusion criteria according to the preferences of researchers based on their scientometric preferences available in their profile (Ibrahim et al., 2016). In the context of the establishment of a complete platform for personalized retrieval and watch of qualitative scientific documents, we propose a qualitative scientific watch system based on scientometrics as shown in Fig. 1. The proposed approach consists on scientific watch system, alerts' personalization process and cartographic visualization tool.

The process of scientific watch includes defining the themes of the scientific documents to be monitored, the identification and selection of their sources, analysis, synthesis and diffusion of these documents. This is in order to update documentary bases that will help the researchers in the detection of new scientific documents which are relevant to their research and correspond to their qualitative needs. This process requires document access tools, processing tools, communication and visualization tools. In order to fulfill this mission, we recover the researcher qualitative preferences from his/her profile. Face with this permanent evolution, the validated scientific document is indispensable in the documentary watch process.

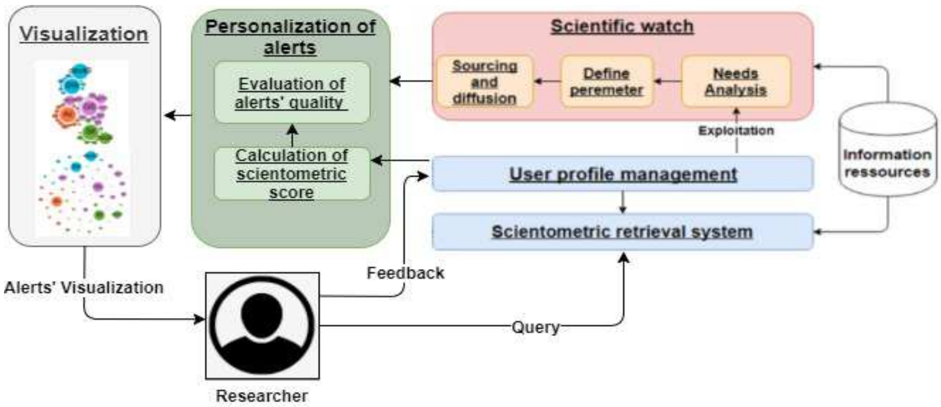

Fig. 1. Scientific watch approach

3.1. Needs Analysis

First of all, the environment in which the watch is going to be performed must be taken into consideration, precisely defining the needs to be covered. The context in which the researcher is placed is that of a so-called scientific information watch. In this perspective, it is necessary to know clearly what researcher needs to monitor in different identified domains as shown in Fig. 2. Researchers aim to contribute to the evolution of information quality. In this context, they need to be alerted regularly of the new publications in their fields. Diffused information should be adapted to researchers' qualitative preferences. Then, an efficient visualization tool enables an efficient exploitation of the diffused information.

The watcher must also take into account the objectives he sets and the orientation of the structure in which the watch is set up. The objectives of the watch can be of two different types: they can aim at a state of the art and / or the regular detection of novelties. The objectives are defined:

- Depending on the field: keep abreast of the production of knowledge in a discipline, discover the fields of research related to the field, identify the new most qualitative research and identify experts in the field.

- Depending on the problems, domain-specific constraints. Given the dynamic aspect of scientometrics domain, synchronization must be done to synchronize the different scientometric indicators considered from the different bibliographic databases.
- Depending on the products targeted: synthesis, state of the art, criticism, etc. ;
- Depending on the targeted audiences: watch for the researchers, watch for the research institution.
- Depending on the research institution: Each research institution is interested in improving the quality of its scientific production. Scientific quality requirements vary from one institution to another. Thus, the researcher's needs evolve according to these requirements.

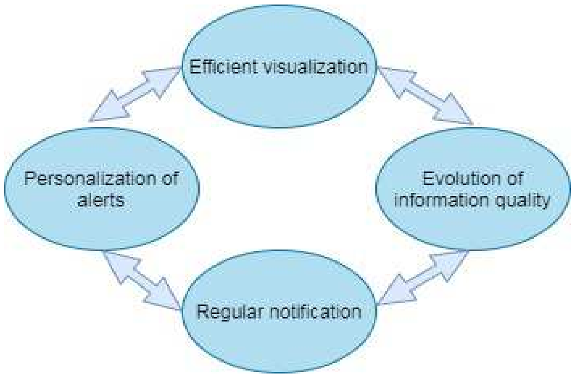

Fig. 2. Researchers' needs

3.2. Define a Perimeter for the Scientific Watch

Defining a perimeter is based on the establishment of a methodology deducted from the needs analysis and goal targeting.

- Thematic perimeter: It will be a question of defining the main themes on which to collect data, by identifying, if necessary, sub-themes and delimiting their borders and relations, to specify the subjects, to express them in questions of research and to translate them by keywords. The detection of thematic is based on the researcher preferences available on his/her profile. In our approach we consider scientific disciplines to extract information published in scientific papers.
- Linguistic perimeter: In any watching approach, we must think of defining a linguistic and geographical framework of reference: we may wish to limit ourselves to English resources.
- Qualitative perimeter: Based on the researcher preferences, we define the scientometric perimeter. We consider only publications corresponding to the preferences in the researcher profile.

3.3. Sourcing and Diffusion

Sourcing is identifying and selecting sources that can meet the needs of researchers. Sourcing is a fundamental step in any watch process. Source evaluation is particularly crucial in the current context of information overabundance and it is necessary to constantly assess the authority, relevance, quality, completeness, reliability and freshness of the information provided. Documents are automaticly annotated by our scientometric annotation system (Ibrahim et al., 2018). Our system consists on annotating scientific documents by scientometric indicators in addition to the thematic and semantic annotation (Kboubi et al., 2012). In our context, we consider the quality of the document as a core feature of the watch system.

In our approach, we opted for radar watch mode. This mode covers a broad spectrum. In our case, the watch is done on many sources through queries, alerts, to identify new qualitative papers. Our proposed solution for sourcing and diffusion is:

i. Retrieving continuous alerts from existing scientific watch systems (Google Scholar, scoop.it, Academia, Scholarworks and sciencewatch)
ii. Analyzing the quality of the information received based on the scientometric annotation of each paper in addition to the user qualitative preferences.
iii. Rediffusion of qualitative documents selected by our watch system which corresponds to the user's preferences.
iv. Personalization of selected documents.
v. Adaptation and visualization of qualitative alerts.

4. Personalization of Scientific Watch

Between all publications diffused by different scientific watch systems, it is not always easy for the researcher to choose qualitative ones. In the context of scientific watch, the difficulty for researchers to express their information quality needs is closely linked to the current state of their knowledge in the field of scientific quality. The relevance of defining needs therefore depends on the ability to explain the state of their knowledge. This explanation generally takes the form of a user profile. In this article we are interested in the preferences of researchers related to the quality of scientific information. In this context, we introduce a researcher profile that can capture and store the quality preferences corresponding to the researcher's needs.

In our approach we use the researcher profile proposed by ibrahim et al., 2016. This profile allows us to define the needs of researchers that we use in the scientific watch process. The information diffusion will be adapted to the needs of researchers in terms of scientific quality. We propose to evaluate the alerts according to the quality score while taking into account the preferences of researchers. To do this, we use the quality score proposed by ibrahim et al., 2018.

We used our personalization approach to evaluate the quality of information diffused by the existing watch systems. One way to study the quality of diffused scientific information is to observe the alerts of the different watch systems in the domain of computer science. We use the scientometric score to evaluate the quality of alerts. We study the quality of diffused information provided by the following watch systems: Google Scholar alerts (GS), Scoop.it alerts (Sit), ScholarWorks alerts (SW) and Academia alerts (Ac). We observed diffused information provided by these systems during 3 months for 10 queries and 20 researchers. Each time, we evaluate the quality of the alerts by extracting scientometric informations corresponding to each diffused paper and calculation the scientometric score. We used the qualitative preferences of 20 researchers in the laboratory RIADI. Their preferences include a threshold of citations number, the h-index of the first author, and their preferences about the conference or scientific journal class or impact factor. For scientific books researchers express their preferences in terms of citations number, author h-index and SJR of the book. These indicators have become widely accepted measures of the scientific production quality (Zainab and Wani, 2018). The results of the qualitative analysis carried out are shown in Fig. 3.

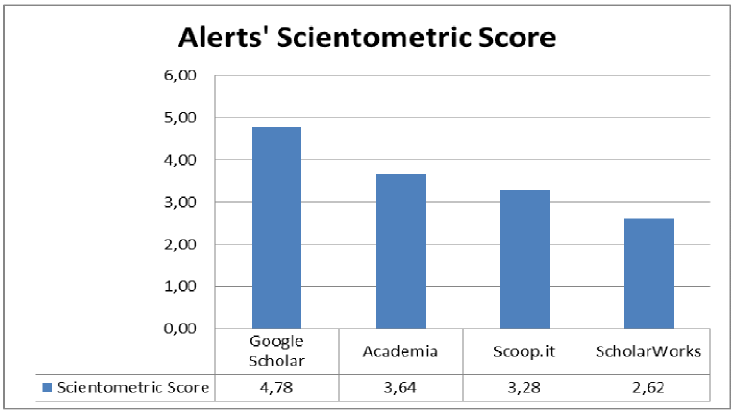

Fig. 3. Scientometric score corresponding to existing watch systems

For each watch system, we calculate the mean of scientometric scores corresponding to the diffused scientific papers to the 30 researchers. Based on the results in Fig. 3, we can remark that the information diffused by Google Scholar is more qualitative than other watch systems. This can be justified by the fact that Google Scholar is more comprehensive source than the others. Furthermore, the free uncontrolled information available in academic social networks can be of an unsupervised quality. However, the quality presented by these watch systems does not necessarily corresponds to the preferences of the user who is the researcher.

5. Alerts' visualization

With the increase of the results and the links complexity, textual results become more and more unreadable. Different visualization techniques opted for graphs or maps to present search results. Termwatch (Ibekwe-Sanjuan, 2004) is a term mapping system aimed at assisting a scientific watch task. HotMap (Hoeber and Yang, 2006) provides a compact visual representation of web search results at two levels of detail, and supports the interactive exploration of web search results. Another well-known example is the WEBSOM project (Kohonen et al., 2000). The map approach can take advantage of the cognitive aspect such as in the work of Skupin and Fabrikant, 2003.

To improve our work (Ibrahim et al., 2020), we propose a cartographic visualization tool given the special needs of researchers. Cartographic visualization would allow the user to more quickly choose the documents that are most interesting and useful. Such a graphical representation could display thousands of results in one view allowing the researcher to find relevant information more easily. The alerts are visualized as a graph connecting the different alerts to original watch systems. This view allows an intelligent exploration of alerts and facilitates the detection of the article that best meets the needs of the researcher. We used Gephi software (Heymann, 2014) to represent the cartographic view. We enrich cartographic visualization by scientometric data to provide a qualitative view of diffused alerts. The articles diffused to researchers will be presented as nodes. The size of the nodes, in Fig. 4 and 5, shows the importance of each article in terms of scientific quality. Each node is resized according to the scientometric score of the scientific document which represents.

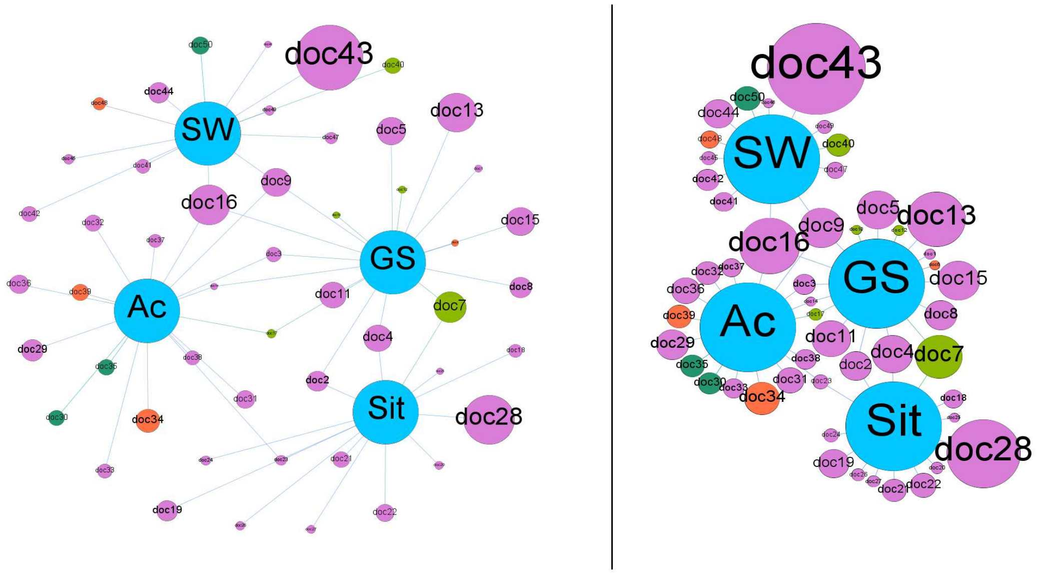

Fig. 4. Proposed cartographic views of qualitative alerts categorized by alerts' types

In Fig. 4, we present an example of the proposed cartographic view. In this example we categorized the diffused scientific papers according to their types: journal paper (purple color), conference paper (green color), book or other (red color). Watch systems are presented by blue nodes and labeled by its name. Each alert is provided by one or more watch system.

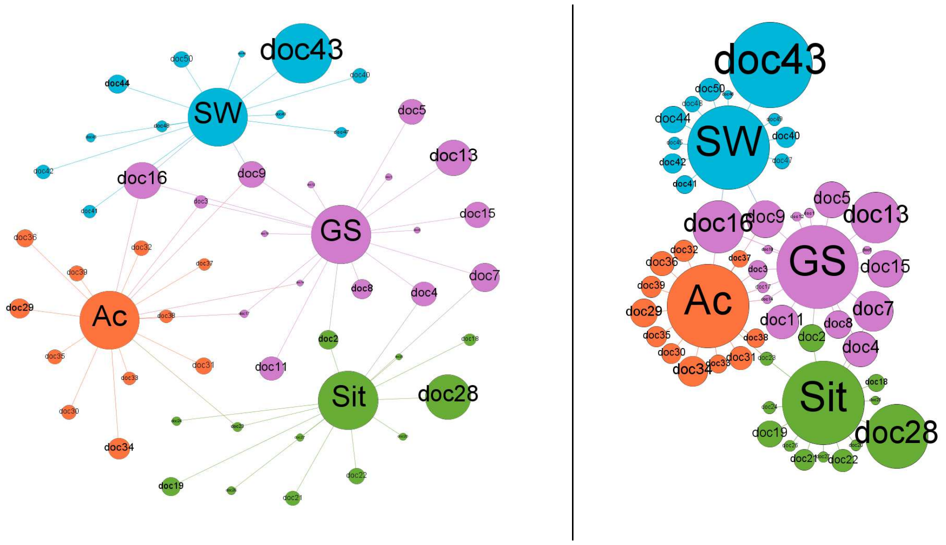

Fig. 5. Proposed cartographic views of qualitative alerts categorized by alerts' communities

In Fig. 5, we present another example of alerts' cartographic view categorized by communities. These categories ideally represent the origin of alerts from which it is possible to visualize the provenance arrangement and to follow the evolution over time. Moreover, we observe a fair distribution of alerts derived from the different watch systems. This distribution shows the concentration of qualitative alerts around Google Scholar by focusing on the size of purple nodes.

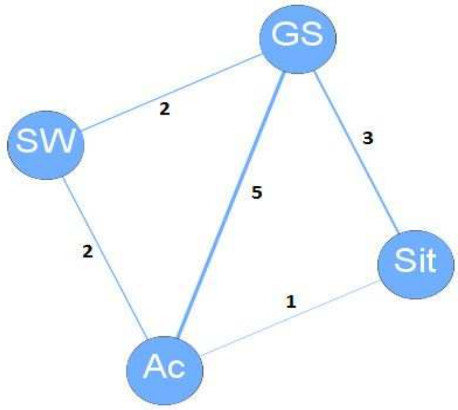

Fig. 6. Connectivity degrees between existing watch systems

We note the existing of jointed alerts provided by more than one system presented in Fig. 4 and Fig. 5. This jointure reveals connections between the different watch systems. We analyzed the possible connections between the different watch systems and we identified the degree of each one. In Fig. 6, we present the graph of connectivity between the different watch systems. We note that Google Scholar provides connections with all other watch systems. Moreover, the highest connectivity degrees are between Google Scholar and the other systems. Also, we observe a weak connectivity between Academia and Scoop.it watch systems and there is no connection between ScholarWorks and Scoop it. These results confirm the qualitative study presented in the previous section. Again Google Scholar shows that it is the more qualitative, comprehensive and complete information source.

6. Conclusion

Based on our qualitative study of available scientific watch systems, we determined our need for a qualitative scientific watch. We proposed a scientific watch approach based on scientometric indicators. In this paper we proposed an enrichment of the watch system by personalization and visualization tools. The user can receive alerts of new qualitative publisher papers which corresponds to his/her needs and preferences. Diffused alerts are presented to the researcher as a cartographic view. We collect new published papers from the collection of papers diffused by scientific watch systems previously studied (Google Scholar, Scoop.it, ScholarWorks, ScienceWatch and Academia).

Establishing an effective scientific watch is a laborious exercise. It should be noted that the preparatory stages for documentary research and the setting up of a scientific watch are essential. The choice of keywords and concepts will have a direct impact on the results of the research at first, then on the effectiveness of the scientific watch in a second time from the moment when we export the results of the research carried out in the form alerts. The multiplicity of our resources makes our watch system more efficient and comprehensive. Alerts' personalization makes the researcher more confident in the quality of received alerts when using our qualitative watch system. Moreover, our cartographic visualization tool facilitates the selection and identification of adequate alerts.

The proposed watch system is not intended, however, to replace bibliographic databases that a researcher can access to retrieve informations. Diffused scientific informations are complementary to traditional scientific resources in order to be more effective in the process of collecting scientific and technical information. Ultimately, the obtained results and interpretations remain subjective since they depend on several factors such as: the type of users and their preferences, the level of knowledge of the users, the domain and the period of watch.

References

Antonio, A., Tuffley, D., Creating educational networking opportunities with Scoop. It, Journal of Creative Communications 9(2), p. 185-197.

Belli, S., Cardenas, R., Velez, M., Rivera, A., Santoro, V., 2019. Open Science and Open Access, a Scientific Practice for Sharing Knowledge.

Fidelia, I. S., Eric, S., 2004. Mining textual data through term variant clustering: the TermWatch system, In Coupling approaches, coupling media and coupling languages for information retrieval, p. 487-502.

György, R., 2019. Scientific information and society, Walter de Gruyter GmbH & Co KG.

Hammarfelt, B., Rushforth, A. D., 2017. Indicators as judgment devices: An empirical study of citizen bibliometrics in research evaluation, Research Evaluation 26(3), p. 169-180.

Heymann, S., (2014). Gephi, In Alhajj, R., Rokne, J. (eds.) Encyclopedia of Social Network Analysis and Mining, p. 612–625. Springer, New York.

Hoeber, O., Yang, X. D., 2006. The visual exploration of web search results using HotMap, In: The Tenth International Conference on Information Visualization, IEEE, p. 157–165.

Huggins-Hoyt, Y. K., 2018. African American Faculty in Social Work Schools: A Citation Analysis of Scholarship, Research on Social Work Practice 28(3), p. 300-308.

Ibrahim, N., Habacha Chaibi A., Ben Ghézala, H., 2016. A new Scientometric Dimension for User Profile, In The 9th International Conference on Advances in Computer-Human Interactions (ACHI), Venice, Italy, p.261-267.

Ibrahim, N., Habacha Chaibi, A., Ben Ghézela, H., 2018. A Scientometric Approach for Personalizing Research Paper Retrieval, In the 20th International Conference on Enterprise Information Systems (ICEIS), Maderia, Portugal, p.419-428.

Ibrahim, N., Habacha Chaibi, A., Ben Ghézala, H., 2020. Scientific watch based on information quality, In The 8th international Multi-Conference on Organization of Knowledge and Advanced Technologies (OCTA).

Kboubi, F., Habacha Chaibi, A., Ben Ahmed, M., 2012. Semantic visualization and navigation in textual corpus. International Journal of Information Sciences and Techniques (IJIST 2, p. 53–63.

Kohonen, T., et al., 2000. Self organization of a massive document collection, IEEE Trans. Neural Network 11(3), p. 574–585.

Lambiotte, R., Panzarasa, P., 2009. Communities, knowledge creation, and information diffusion, Journal of Informetrics 3(3), p. 180-190.

Lee, J., Oh, S., Dong, H., Wang, F., Burnett, G., 2019. Motivations for self-archiving on an academic social networking site: A study on researchgate, Journal of the Association for Information Science and Technology 70(6), p. 563-574.

Luan, Y., 2018. Information extraction from scientific literature for method recommendation. arXiv preprint arXiv:1901.00401.

Niyazov, Y., Vogel, C., Price, R., Lund, B., Judd, D., Akil, A., Shron, M., 2016. Open access meets discoverability: Citations to articles posted to Academia.edu, PloS one 11(2).

Noruzi, A., 2017. Hot Papers in Library and Information Science from the Point of View of Research Methods, Webology 14(2).

Norris, M., Oppenheim, C., Rowland, F., 2008. The citation advantage of open□access articles, Journal of the American Society for Information Science and Technology 59(12), p. 1963-1972.

Ovadia, S., 2013. When social media meets scholarly publishing, Behavioral & Social Sciences Librarian 32(3), p. 194–98.

Ovadia, S., 2014. ResearchGate and Academia. edu: Academic social networks, Behavioral & social sciences librarian 33(3), p. 165-169.

Price, D. D. S., 1951. Quantitative measures of the development of science, Archives Internationals d'Histoire des Sciences 14, p. 85-93, 1951.

Price, D. D. S., 1961. Science since Babylon, New Haven: Yale University Press.

Rieger, O. Y., 2008. Understanding interdisciplinary ecosystems: social construction of scholarly communication, Corne ll University Library.

Skupin, A., Fabrikant, S.I., 2003. Spatialization methods: a cartographic research agenda for nongeographic information visualization, Cartography Geographic Information Science 30(2), p. 99–119.

Thelwall, M., Kousha, K., 2014. A cademia. edu: Social network or A cademic Network?, Journal of the Association for Information Science and Technology 65(4), p. 721-731.

Tveden-Nyborg, S., Misfeldt, M., Boelt, B., 2013. Diffusing scientific knowledge to innovative experts, Journal of Science Communication 12(1).

Zainab, T., Wani, Z. A., 2018. Encyclopedia of Information Science and Technology, chapter Advancement and Application of Scientometric Indicators for Evaluation of Research Content, p. 6739-6747, IGI Global.