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Guest editors' introduction to the special issue on knowledge maps and information retrieval (KMIR)

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The use of visual elements to enhance information seeking and discovery is a recurring research issue in the area of interactive information retrieval. Studies in interactive information seeking behavior have confirmed that the ability to browse an information space and observe similarities and dissimilarities between information objects is crucial for accidental encountering and the creative use of information [16,26]. Some kind of guided searching, enhanced by visualization techniques, therefore becomes more and more important to precisely discover information without knowing the right search terms. So far, this seems to remain the weakest point of interactive information systems [8,9,23].

In the area of information systems, the use of information visualization techniques has been discussed since decades [2]. Hearst [11] provides a collection of attempts to improve search interfaces by information visualization. More recent examples, just to name a few, are Wei et al. [25] who visualize the evolution of themes in a collection over time, Fowler et al. [10] who propose multi-tiered visualizations to support the exploration of search results, and Dörk et al. [7] who display relationships between documents in an interactive map to enhance navigation through a document space. Santucci [18] discusses practical examples on how to apply visual analytics to information retrieval. Sarrafzadeh [19] studies use cases of knowledge graphs and hierarchy trees from the perspective of information behavior and—by this—opens up the perspective to user-centered aspects of interaction with visual representations of information.

Knowledge mapping, on the other hand, encompasses all attempts to use visualizations to gain insights into the structure and evolution of large-scale information spaces. Knowledge maps can take very different forms of visualizing the structure of information spaces, such as network visualizations, treemaps or geographic map like arrangements of knowledge structures [3,4,6,12,17,21,22]. As an activity performed in very different disciplines—and often independently from each other—it stands in line with the dominance of the visual in our culture [13]. Figure 1 shows an example of a map displaying the topical structure of a research field using a geographic metaphor [22].

However, the established research domain information retrieval and the interdisciplinary domain of knowledge mapping have mainly been independent from each other. Both strands are driven by quite different epistemic perspectives. The use of information visualization in the area of information retrieval is predominantly focused on the support of information seeking activities by visualizations, whereas the knowledge mapping domain is motivated by the question of how knowledge structures and bodies of knowledge can be visualized best. Both domains have certainly the potential to

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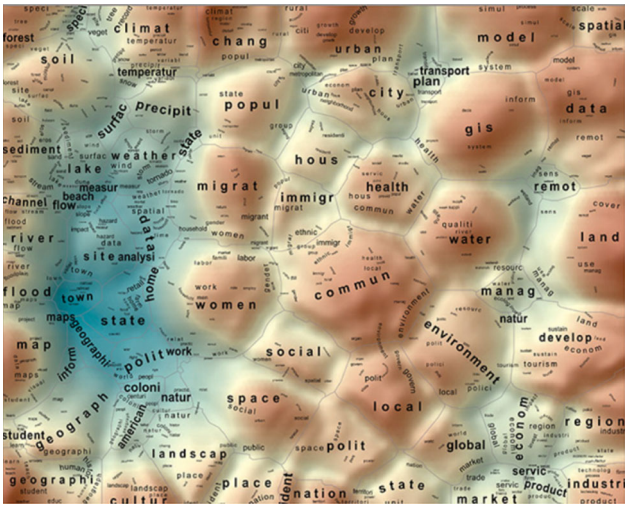

Fig. 1 Knowledge map of the topical structure of a geography research field using a self-organizing map[3]

be mutually beneficial [20]. This special issue undertakes to build a bridge between them.

The example from Fig. 1 demonstrates that, by visualizing the knowledge structure of a digital library in its entirety, knowledge maps inhere in a great potential as navigation tools through knowledge spaces. However, to the best of our knowledge, knowledge maps are still far away from being applicable as search interfaces for digital libraries. Most maps are made for special purposes, are static, and usually not interactive [1].

This special issue is a collection of attempts demonstrating exceptional achievements on combining knowledge maps and information retrieval. It focuses on one leading research question: How can knowledge maps be utilized for information seeking in large information spaces? The special issue has evolved from the first international workshop on "Knowledge Maps and Information Retrieval (KMIR)" which was held as part of the International Conference on Digital Libraries 2014 in London. Following the workshop, an open call for papers was published. The issue presents four papers on both conceptual aspects as well as technical implementations of knowledge maps as search interfaces for digital libraries. The emphasis of the papers is not so much on high-dimensional models of knowledge maps interacting with information systems but on the search for useful ways to incorporate map-like visualizations of the underlying information space, or relevant fractions of it, in an information seeking process. The issue contains three extended versions of papers from the workshop proceedings[4] and one further paper:

"**Font Attributes Enrich Knowledge Maps and Information Retrieval**" by Richard Brath & Ebad Banissi (London South Bank University, UK) highlights the value of font-based information visualization techniques. Inspired by the use of fonts in typography and cartography the paper demonstrates how font attributes can increase the readability of search results and discusses the usefulness of font-attribute-focused visualization techniques for text skimming, fact finding and other lookup strategies.

"**Mapping Metadata to DDC Classification Structures for Searching and Browsing**" by Xia Lin (Drexel University, USA) et al. focuses on visual exploration of Dewey Decimal Classification (DDC) structures in a given result set. The approach automatically classifies retrieved documents using DDC classes and provides network visualizations of related DDC classes as well as tree views of hierarchical structures among DDC classes to be used as interactive views to a result set.

"**Creating knowledge maps using Memory Islands**" by Bin Yang & Jean-Gabriel Ganascia (University Pierre and Marie Curie, France) describes the idea of Memory Islands which are cartographic representations of a given hierarchical knowledge structure (such as an ontology). The paper discusses the island metaphor as well as different shape and layout variations and provides a number of interactive functions which help users to navigate through the artificial landscape.

"**Supporting Academic Search Tasks through Citation Visualization and Exploration**" by Taraneh Khazaei (University of Newfoundland, Canada) & Orland Hoeber (University of Regina, Canada) proposes an intuitive and easy to understand bow tie visualization of citation characteristics of papers in a result set. The approach aims at decreasing the cognitive load of skimming citation structures by allowing users to capture at a glance how a paper is embedded in the wider scientific discourse.

The four papers give a glimpse of recent attempts of implementing novel navigation and search strategies based on insights of the complex nature of knowledge spaces as well as visualization principles for knowledge maps. However, the papers also show that we are still far away from the vision outlined in the beginning of this introduction: the implementation of interactive knowledge maps that show at a glance what is in a library, and at the same time, help users to better locate their individual information need on a libraries' knowledge map. Making progress here would have a great potential in overcoming one of the major points of failure of current information systems: the vagueness between user search terms and the knowledge orders of the information space in question [14,15].

[3] http://www.scimaps.org/detailMap/index/in_terms_of_geograph_92.

[4] http://ceur-ws.org/Vol-1311.

Therefore, we see this issue as a kick-off to motivate further discussions on how to incorporate knowledge maps into information retrieval models at the level of the user interface. However, this requires a continuous knowledge exchange between the "map makers" on the one hand, and information retrieval specialists on the other hand to develop models that properly combine insights of the two strands. A helpful direction for future research could be seen in the metaphor of a *macroscope* which was coined by Katy Börner. She writes: "Macroscopes provide a 'vision of the whole', helping us 'synthesize' the related elements and detect patterns, trends, and outliers while granting access to myriad details. Rather than making things larger or smaller, macroscopes let us observe what is at once too great, slow, or complex for the human eye and mind to notice and comprehend." [5]. Some recent attempts can be found where knowledge maps and the idea of *macroscopes* have been embraced from the perspective of digital humanities scholars [24] and artists [27]. More research, testbeds and user studies are certainly needed. Thus, we see as a major challenge the development and evaluation of visual means providing an overview of *where we are*, *where we came from*, and *where we might go* when interacting with a digital library.

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References

1. Akdag Salah, A.A., Scharnhorst, A., Ten Bosch, O., Doorn, P., Manovich, L., Salah, A.A., Chow, J.: Significance of Visual Interfaces in Institutional and User-Generated Databases with Category Structures. In: Proceedings of the second international ACM workshop on "Personalized access to cultural heritage (PATCH)". ACM Multimedia Conference, Nara, Japan, pp. 7–10 (2012)
2. Börner, K., Chen, C.: Visual interfaces to digital libraries - its past, present, and future. JCDL Workshop. In: Proceedings of the 1st ACM/IEEE-CS joint conference on Digital libraries (JCDL'01), 482 (2001)
3. Börner, K., Chen, C., Boyack, K.W.: Visualizing knowledge domains. Annu. Rev. Inform. Sci. **37**, 179–255 (2003)
4. Börner, K.: The atlas of science. MIT Press, Cambridge (2010)
5. Börner, K.: Plug-and-play macroscopes. Commun. ACM **54**(3), 60–69 (2011)
6. Boyack, K.W., Klavans, R.: Creation of a highly detailed, dynamic, global model and map of science. J. Am. Soc. Inf. Sci. Technol. **65**(4), 670–685 (2014)
7. Dörk, M., Riche, N.H., Ramos, G., Dumais, S.: Pivotpaths. Strolling through faceted information spaces. IEEE T. Vis. Comput. Gr. **18**(12), 2709–2718 (2012)
8. Ford, N.: Cognitive styles and virtual environments. J. Am. Soc. Inform. Sci. **51**(6), 543–557 (2000)
9. Foster, A.E.: A nonlinear model of information seeking behaviour. J. Am. Soc. Inf. Sci. Technol. **55**(3), 228–237 (2004)
10. Fowler, M., Bellis, C., Perry, C., Kim, B.: Exploring web-based visual interfaces for searching research articles on digital library systems. Proceedings of the 27th Modern Artificial Intelligence and Cognitive Science Conference 2016. http://ceur-ws.org/Vol-1584/ (2016)
11. Hearst, M.: Search User Interfaces. Cambridge University Press, Cambridge (2009)
12. Klavans, R., Boyack, K.W.: Toward an objective, reliable, and accurate method for measuring research leadership. Scientometrics **82**(3), 539–553 (2010)
13. Manovich, L.: How to Follow Global Digital Cultures, or Cultural Analytics for Beginners". In: Deep Search: The Politics of Search Beyond Google, edited by Felix Stalder and Konrad Becker, Wien: Studien Verlag, pp. 198–211 (2009)
14. Mayr, P., Mutschke, P., Petras, V.: Reducing semantic complexity in distributed digital libraries: treatment of term vagueness and document re-ranking. Libr. Rev. **57**(3), 213–224 (2008)
15. Mutschke, P., Mayr, P., Schaer, P., Sure, Y.: Science models as value-added services for scholarly information systems. Scientometrics **89**(1), 349–364 (2011)
16. Nicholas, D., Huntington, P., Dobrowolski, T., Williams, P.: Reappraising information seeking behaviour in a digital environment: bouncers, checkers, returners, and the like. J. Doc. **60**(1), 24–43 (2004)
17. Sahal, A.A., Wyatt, S., Passi, S., Scharnhorst, A.: Mapping EINS—an exercise in mapping the Network of Excellence in Internet Science. Conference Proceedings of the First International Conference on Internet Science, Brussels, pp. 75–78 (2013)
18. Santucci, G.: Visual Analytics and Information Retrieval. In Agosti, M. et al. (Eds.): Information Retrieval Meets Information Visualization. Springer, pp. 116–131 (2013)
19. Sarrafzadeh, B., Vtyurina, A., Lank, E., Vechtomova, O.: Knowledge graphs versus hierarchies: An analysis of user behaviours and perspectives in information seeking. In: Proceedings of the 2016 ACM on Conference on Human Information Interaction and Retrieval, pp. 91–100 (2016)
20. Scharnhorst, A.: Walking through a library remotely. Why we need maps for collections and how KnoweScape can help us to make them. Les Cahiers Du Numérique **11**(1), 103–127 (2015)
21. Shiffrin, R., Börner, Katy: Mapping knowledge domains. P. Natl. Acad. Sci. USA **101**(1), 5183–5185 (2004)
22. Skupin, A.: The world of geography: visualizing a knowledge domain with cartographic means. P. Natl. Acad. Sci. USA **101**(1), 5274–5278 (2004)
23. Tang, M.: Browsing and searching in a faceted information space: a naturalistic study of pubmed users' interaction with a display tool. J. Am. Soc. Inf. Sci. Tec. **58**(13), 1998–2006 (2007)
24. Tangherlini, T.R.: The Folklore Macroscope: Challenges for a Computational Folkloristics. The 34th Archer Taylor Memorial Lecture. Western Folklore **72**(1), 7–27 (2013)
25. Wei, F., Liu, S., Song, Y., Pan, S., Zhou, M.X., Qian, W., Shi, L., Tan, L., Zhang, Q.: TIARA: a visual exploratory text analytic system. In: Proceedings of the 16th ACM SIGKDD international conference on Knowledge discovery and data mining (KDD '10), pp. 153–162 (2010)
26. Westerman, S.J., Collins, J., Cribbin, T.: Browsing a document collection represented in two- and three-dimensional virtual information space. Int. J. Hum. Comput. St. **62**(6), 713–736 (2005)
27. Whitelaw, M.: Generous Interfaces for digital cultural collections. Digit. Humanit. Quart. **9**(1), 1–16 (2015)