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3 Collaborative Knowledge Acquisition and Explorationin Technology Search

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Abstract.
This article is about technology search as an example of a knowledge acquisition task in industry. Technology search is about finding technology related information in structured as well as unstructured sources. This information is needed to support optimal decision making in business processes. There are new opptortunities for technology search and challenges that need to be addressed. This article outlines some of these challenges and presents two concepts to address them in a search system.

1 Introduction

The success of companies across many industries is dependent on leveraging advances in research and development to generate successful, strategic advantages in a market. One of the foundations of this success is to always be aware of available technologies and their possible applications (e.g. in a manufacturing process or integrated into a product).

Technological development is progressing rapidly. Companies find it harder to maintain an overview about the technological repertoire of an industry and how disruptive developments may shape their businesses. For example, groundbreaking developments in one area influence the development or the application of technologies inanother. Such developments sometimes render earlier evaluations of a technology invalid, so that re-evaluations are required, taking into account the new facts that are available.

Here, **systematictechnology search** is a process in which such information is collected, stored and maintained over time. Technology search is part of a company's technology intelligence strategy [1] and aims at identifying all necessary information concerning the technologies that are used by the company. The idea is to support optimal decision making in a company by providing the management with required information. Inpractice, some of the reasons for technology search are: to expand the company's product portfolio, to increase the efficiency of production processes, new legal regulations, or cost reductions.

Aneffective implementation of the technology search process, today, has to utilize advances in information technology (like search technologies, tools for text mining or patent analysis) to improve quality and richness of the collected information. Methods and tools from knowledge acquistion or management are also valuable, for instance,to make retrieved information more understandable for a computer to employ more elaborate methods to leverage the data.

This article's contributionis to outline an approach of collaborative technology search and knowledge acquistion that addresses challenges that specifically arise in technology scouting. Our focus is in (active) computer-supported collaboration rather than collaboration via crowd-sourcing or open innovation. The paper is structured as follows. Section 2 gives a brief overview of related work for technology search. Section 3 describes a general framework of technology search and outlines some of the challenges that arise from it. Finally, Section 4 describes our collaborative approach to technology search in which we allow a company's various technology experts to engage in a search task together, acquire information together, and create a shared knowledge base of collected technology data that can be explored later.

2 Related Work

Approaches for technology search can be distinguished according to whether there sources in which technology information is sought are (semi-) structured or unstructured. An example for (semi-) structured data is patent data. The field that is interested in such data is called patent mining or patent analysis. The idea behind patent analysis is to get a better understanding of the patent situation in a particular domain. Analyzing patents, e.g., by creating meaningful visualizations of the patent landscape, is a means to infer about the underlying technologies and R&D activities of other companies. An example of such a visualization can be found in [2].

When it comes to unstructured data (e.g.,inwritten reports, projects ummaries, or emails), researchers in the field of textmining and information retrieval are interested in supporting a user's search process when trying to find relevant information. For example, there are (semi-) automated web-spiders that crawl the web for previously targeted technology data and retrieve them for further evaluation by a human. Such a web mining technique is described in [3]. Other approaches include search engines that focus on technology related resources or faceted search engines that help accessing the right information by providing special facets for technologies during search.

When it comes to storing technology-related information, another area of research that should be mentioned is competetive intelligence. Competitive intelligence is about gaining strategic insights into a company's business environment including its

competitors and suppliers. Tools that support competitive intelligence are useful for technology search, as well. Some tools are described in [4]. For example, a knowledge repository system can be used to store and explore information about competitors and suppliers in an industry.

Our contribution to the approaches above is that we try to improve the (active) acquisition phase for technology information from unstructured data by enabling a company's technology experts to work together as a team. There is currently little help when it comes to actively performing a search task together in a team of experts. Research in this area is called collaborative information seeking,collaborative information behaviour, social search,or collaborative search. A brief overview of this research can be found in [5]. Our specific focus is on supporting a team of experts in finding and collecting technology-related information and storing this information in a central knowledge repository that can be explored.

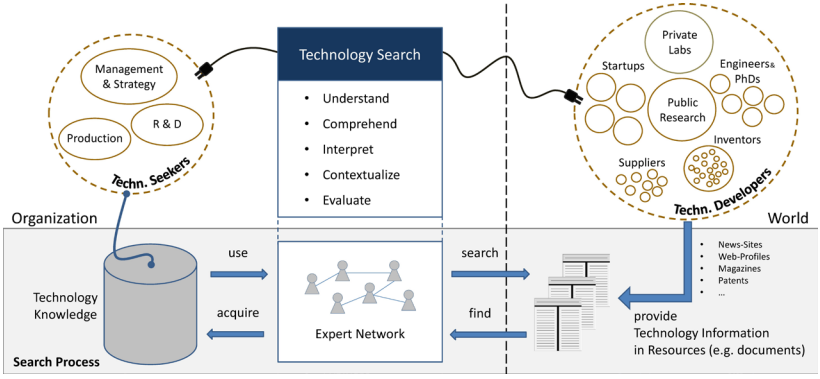

Fig.1: Overview of stake holders in technologysearch and how the process of technology search bridges the information gap between technology seekers and technology developers. The bottom part of the figure outline show technology experts find and acquire technology information with the help of resources provided by developers or third-parties.

3 Challenges in Technology Search

In this section we describe our general, conceptual framework of technology search. We will use this framework to outline some of the challenges of technology search. The framework is illustrated in Figure 1.

The top part of the figure shows two stakeholders of technologies (or innovations in general): the ones that seek technologies on the left and the ones that develop them on the right. Examples for each group are given within the respective, dotted circles. Both circles are taken from a diagramin [6]. We connect both circles with each other via technology search to emphasize that it bridges the gap between them for a company. The bottom part of the figure describes the process of technology search. On the right-hand-side developers or third-parties provide technology-related information via documents like news articles. The left-hand-side shows a network of experts of an organization that seek information they are interested in. The goal of the search task is to acquire information, extend the organization's technology knowledge and use the latter in decision making. An important aspect of the search task is to understand and comprehend the newly acquired information and relate them to what is known already.

This includes an evaluation of the technology with respect to a possible business application. These activities are some times subsumed under the term *sensemaking* in a search task. Next, we describe some challenges of technology search that we think make the information acquisition and use particularly difficult.

Technologies evolve over time which means that information about them can quickly become outdated. Search tasks have to be repeated and gradually extended for updates and news. Repeated search tasks are part of a company's technology monitoring strategy and laborious and time consuming, especially inheavily evolving technology fields. Especially cutting-edge technologies or so called disruptive innovations have to be identified.

Furthermore, changes in technologies or their applications have to be tracked systematically so that a later (re-)evaluation is easy to produce. An evaluation process often requires an etwork of experts from different domains to work to-gether where each expert contributes her assessment about a technology. For example, assessing a new type of robotics technology in a manufacturing application may involve experts from automation, human-machine-interaction, engineering, and psychology. Experts typically need to share the information they collect during a search task. Often times, they create (intermediate) reports to further condense the information content.

Another challenge is that the process of searching for technology-related information is rather complex because the relationships between a technology, its alternatives, and the business applications it can be used in have to be examined carefully to provide rich information for decision makers.This also requires an excellent background knowledge of the domain inquestion.

4 Collaborative Knowledge Acquisition

Harnessing a network of experts in the information acquisition process is very important. Therefore, this section describes the design of a search system that supports two aspects of this process: collaboration in search and collaboration insense making. Collaboration in technology search is needed to (1)reduce individual search efforts, (2) benefit from different expert backgrounds, and (3) exchange information more efficiently *before,during and after* a search task.Collaboration in sense making with in an expert team is important when it comes to interpreting, understanding and storing meaningfulfacts about technologies or their application for future access.

The outline of our search system is shown in Figure 2. The left-hand-side shows a network of experts that collaborate in a search task. All search-related activity of the team is stored in a central database. Examples of workspaces that allow collaboration during search are Coagmento [7] and Search Maps [8]. Both tools also allow to continue previous search tasks when information updates are expected. Theright-hand-side shows the collaborative sensemaking part of the system.A team of co-searchers can create a graphical representation of what they find during search. This representation is stored in a central knowledge repository. The team creates this representation with a user interface that is designed like a mind-mapping interface with vertices representing technologies, institutes, applications, developers, projectsetc. Edges between vertices represent their relationship like ”is used by”, ”is developed by”,or ”is solution for”. The interface restricts the use of an edge between two vertices so that only meaningful expressions can be made. We use a special-tailored domain on tology to fomalize this graph and make it computer-understandable. The technical basis is as emanticn etwork.

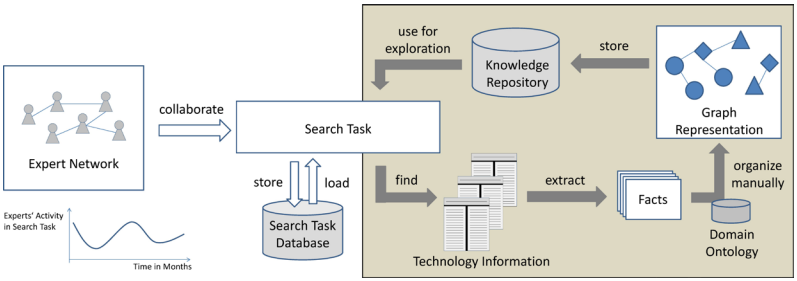

Fig.2: The concept of how we achieve computer-support in technology search: experts work together in search tasks using collaborative workspaces; past search tasks can be loaded from a search task repository; facts can be extracted from resources and fed into a knowledge repository using a mind-map-like user interface. The knowledge repository can be used as a means of exploring already collected information in the future.

Our decision to let experts create a knowledge repository manually using a graph interface is complementing other ideas in which domain knowledge is extracted from text automatically, like IBM's Watson. The underlying hypothesis for us is that experts interpretand contextualize retrieved information during search given their particular information need. They reason, draw conclusions and evaluate the information they find, maybe following additional protocols of a technology search. These thought processes are difficult to implement in an algorithm because they maybe varying for different technology search tasks. With our graphical interface we leave the reasoning for the expert but try to reduce the effort to express it using the ontology. In essence, what we achieve with the interface is that expert scan interpretand contextualize the information they collect during search given the concrete search problem they have. They can express the result of this sensemaking as a graph and feed it back to a repository. Since every expert has access to this repository they can benefit more effectively from their individual and collaborative search endeavors. Of course, they may have different opinions about a fact, thus mediating between conflicting optinions should be possible. This is, however, currently not supported by our tool. Provided a meaningful domain ontology is used, more advanced methods from artificial intelligence, collaborative filtering, or datamining can be employed. The system can be used to access valu a be information more easily, draw conclusions by noticing relationships between different technololgies or their applications, and essentially support decision making in an organization.

5 Conclusion

This article describes technology search as an area of application for knowledge acquisition in organizations and highlights some of its challenges. We describe how computer-support can be achieved that focuses on collaboration and sense-making in the search process. For this, we briefly out line the design of a search system that we have implemented as part of a larger project in a business application.

References

Schuh,G., Klappert,S.: Technologiemanagement: Handbuch Produktion Und Management 2. Handbuch Produktion und Management /Gu¨ntherSchuh. Springer(2011)

Tseng,Y.H., Lin,C.J., Lin,Y.I.: Text mining techniques for patent analysis. Information Processing & Management 43 (5) (September2007) 1216–1247

Baumgartner,R. ,Fr¨olich,O. ,Gottlob,G. ,Harz,P. ,Herzog,M.,Lehmann,P. ,Wien,T.: Webdata extraction for business intelligence: the lix to approach. In: InProc. of BTW2005. (2005) 48–65

Bose,R.: Competitive intelligence process and tools for intelligence analysis. Industrial Managementand Data Systems 108 (4) (2008) 510–528

Shah,C.: To ward collaborative information seeking (cis). CoRRabs/0908.0709 (2009)

Sloane,P.: A Guide to Open Innovation and Crowdsourcing: Advice from Leading Experts in the Field. Kogan Page (2011)

Shah,C.: Co agmen to a collaborative information seeking, synthesis and sensemaking framework (an integrated demo), New York, NY,USA, ACM (2010) 527–528

Stange,D., Nu¨rnberger,A.: Searchmaps. In de Rijke,M., Kenter, T., de Vries, A., Zhai, C., de Jong,F., Radinsky,K. ,Hofmann,K. ,eds.: Advances in Information Retrieval. Volume 8416 of LectureNotes in Computer Science. Springer International Publishing (2014) 763–766