How recommender systems applied in personal knowledge management environments can improve learning processes

Witold Skrzypczyk[1], Udo Bleimann[2], Christoph Wentzel[2], Nathan Clarke[1]
[1]University of Plymouth, United Kingdom
[2]University of Applied Sciences Darmstadt, Germany

Abstract

Recommender systems combine historical data on user preferences, information filtering and the application of patterns to suggest and predict items a user might be looking for. Being successful in a range of e-Business and e-Commerce applications, recommender systems can also be used in the academic area to support students and researchers at work. This paper addresses the possible inclusion of recommender systems in personal knowledge management (PKM) environments by proposing different methods and techniques.

When it comes to personal knowledge, it is hard to get a handle on the information and knowledge overflow, whether it consists of explicit or tacit one. The usage of current PKM software systems can support users in dealing with their existing knowledge and information base, but it only rarely can help them to enlarge it with relevant new aspects. By extending these tools with the recommender systems methodologies, a new intelligent information and knowledge access can be offered. Here the user's existing knowledge base can be a perfect starting point for new recommendations. Beside the common interpretation of users' behaviour, as well as by analysing the existing knowledge base with all its keywords, abstracts and relevant information, recommender systems can gain an additional advantage from the nature of many academic documents. The system can try to find the referenced documents, either internally in its own database or externally, and could so offer the user direct access to it and by doing so directly support the user's learning process.

Keywords

Personal Knowledge Management; Knowledge Management, Recommender Systems; Knowledge Base; Learning Processes

Introduction

The Internet changed the way we access and retrieve information decisively. According to the 'How much information' study the World Wide Web (WWW) grows by over 60 terabytes of accessible information every single day; to put this into perspective, in 2000 the whole WWW consisted of just 21 terabytes (Berkeley University 2003). Beside the positive aspects, the easy and fast access to such a large number of information requires users to get a handle on the resulting personal information and knowledge overflow. The use of current personal knowledge management (PKM) tools can help users dealing with their existing knowledge and information base. Therefore these tools become more and more important, especially in the educational sector, where the new generation of users (learners) need to be more self-sufficient and efficient in managing their own information and knowledge than their predecessors were (Truch 2001). But dealing with the existing knowledge is only one aspect;

extending it by accessing and acquiring new relevant knowledge is another one, at which current PKM tools only rarely support the learners.

This paper presents the use of recommender systems in PKM tools to enlarge the existing knowledge base. Being successful in a range of e-Business and e-Commerce applications, recommender systems combine historical data on user preferences, information filtering and the application of patterns to suggest and predict items a user might like and is looking for. To address this, the relations between knowledge management, personal knowledge management, and personal knowledge and information management tools are described. After that, recommender systems methodology and technologies are presented. Finally some integration possibilities of these methods in personal knowledge management tools are described.

Knowledge Management

In 1985 Peter Drucker for the first time mentioned the term *knowledge worker* while comparing the contribution of management in the 20th and the 21st century. He stated that as successful it was to increase manual worker productivity in the past, so important it will be to increase knowledge worker productivity in the future.

It is true, that by passing skills from generation to generation it can be argued that there have always been knowledge workers, but these skills mostly had to be learned once only. In general, they just changed very little during the worker's lifetime. Today's knowledge workers on the other hand are not only required to have a much wider knowledge base, but their skills also require constant renewal (Barth 2004).

From talking about knowledge economies and societies emerged the idea and necessity of managing knowledge and intellectual capital (OECD 1999, Stewart 1997) as a vital asset, as a valuable resource (Zuber-Skerritt 2005).

Tiwana (2002) describes knowledge as *actionable information*. Information on the other hand is defined by Drucker (1985) as data (a set of raw facts) endowed with relevance and purpose. Davenport & Prusak (2000) define knowledge as 'a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information'. Knowledge is generally classified into two categories, explicit knowledge and tacit knowledge. This part of knowledge that can be expressed in a systematic and formal language is called explicit knowledge (Nonaka & Takeuchi 1995). Tacit knowledge on the other hand is nearly impossible to reproduce in a document or database (Davenport & Prusak 2000). It is in the knower's head (Tiwana 2002) and is regarded as the most valuable and actionable knowledge part (Nonaka & Takeuchi 1995).

Knowledge management (KM) is a process of acquisition, sharing and utilization of knowledge. When talking about KM nowadays, most people think of 'corporate variety in which organisations try to get a handle on the vast amounts of knowledge locked inside the minds of individual employees across the organisation' (Miller 2005). The main focus lies on the organisation and the way organisations can gather a sustainable competitive advantage (Davenport & Prusak 2000) out of what they know. In this context KM has reached an established status as a management discipline during the last decade (Abecker & Völkel 2008).

Personal Knowledge Management

As Davenport (2005) underlined, the knowledge based society is no more effective than the sum of its knowledge workers' effectiveness. This demonstrates the importance of not only concentrating on groups, organisations or societies, but to put the focus on the most important one (Abecker & Völkel 2008), the individual knowledge worker. In contrast to general KM, personal knowledge management (PKM) focuses on the individual motivations and behaviour. Unfortunately, compared with organisational KM, marginal research has been done on PK until now.

Although the term *personal knowledge* has already been used in 1958 (Polanyi) the origin of *personal knowledge management* (PKM) can be found in the university environment, first in 1999 at UCLA, Los Angeles (Frand & Hixon 1999) and later (2003) at the Millkin University in Decatur. Paul Dorsey of Millikin Univeristy describes PKM as a set of skills that have a conceptual and a logical as well as a physical or a hands-on component (Avery et al. 2001). According to Frand (1999) PKM is a 'conceptual framework to organise and integrate information that we, as individuals, feel is important so that it becomes part of our personal knowledge base'. Moreover it 'provides a strategy for transforming what might be random pieces of information into something that can be systematically applied and that expands our personal knowledge'.
Higgison (2005) defines PKM as 'managing and supporting personal knowledge and information so that it is accessible, meaningful and valuable to the individual; maintaining networks, contacts and communities; making life easier and more enjoyable; and exploiting personal capital'.

Berkman (2005) says that PKM is about managing all the information that comes to your PC. He added that it is also about contextual knowledge, which means making sense of that information and what it means to you, but that demonstrates how fuzzy the line between knowledge and information management is. Gurteen (2005) believes that PKM is more about how to use this information rather than how you organise it. For him, like for many others, one of the problems with PKM is that it is interpreted differently by different people. As with knowledge and information itself, there is also no sharp distinction between personal information management (PIM) and PKM (Abecker & Völkel 2008).

Personal Knowledge Management Tools

PKM tools refer to software systems that support PKM activities. They should help the user access what he knows, make clear what he needs to know, and remember how he learned it (Clemente & Pollara 2005), but currently they are mainly used to manage electronic documents, emails, internet bookmarks and other to the individual valuable information (Frand & Hixon 1999). Therefore, according to a strong definition most of them should be categorised as PIM tools.
The KM magazine (2000) identified six categories PKM tools could be classified to: *index*, *associative links*, *organize*, *metasearch*, *collaboration services* and *web capture*. Four years later Barth (2004) developed this model further and identified the five categories: *indexing and searching tools*, *associative links and search tools*, *online meta-search tools*, *web capturing tools* and *organising and mapping tools*. Although an impression may occur, that there seems to be a tool for every need, this is not really true. Most presented tools associated with a category are not really fulfilling the category requirements. In addition, two aspects are left out of consideration: first, the users do not want to have five tools to manage their personal information and knowledge; and second, they also do not want to be isolated. This means, that an obvious step to overcome the information fragmentation (Karger 2006) must

be to integrate these functionalities into one tool, and second that these tools need to facilitate sharing information with others – directly or indirectly. It is essential to notice, that *personal* does not mean *isolated*. As Dorsey (Millkin University 2003) stated, at least two of the seven PKM skills are directly linked to collaboration with others.

To fully qualify as PKM tools, another requirement must be, that the software systems should have at least some knowledge about the information they manage, for example via semantic or ontology (Sauermann 2005).

Recommender Systems

The challenge to find relevant services and information easily and quickly is often seen as a great irony of the information revolution (Smyth et al. 2004). The enormous number of choices confuses the users and for many of them the best way to be successful and avoid mistakes is to use knowledge and experiences acquired by others (Velasquez & Palade 2007). Recommender systems are a direct response to these problems.

Recommender systems are, as first defined by Resnick and Varian (1997), systems in which users share their preferences, and obtain, in a timely fashion, recommendations for unseen objects. Sarwar (et al. 2000) define a recommender system as an electronic agent that helps users to find the most valuable products / services based on their historical preferences or tastes. They combine historical data on user preferences, information filtering and the application of patterns to suggest and predict items a user might like. By doing this, they offer users a more proactive and personalised information service.

There are two main different approaches, collaborative filtering, and content-based. The content-based recommender system suggests the user services and products by analysing the items the user liked or used in the past (Balabanovic & Shoham 1997). Based on the information which books you have bought in the past, Amazon.com for example recommends you other books from the same authors or about the same topics. However, there are several limitations of content-based recommender systems; not least knowing the user's preferences in advance. This means in the example of Amazon.com, that the predictions become better the more the customers buy, and nearly no recommendation are at all possible for new customers (Ehrlich & Malz 1995).

The collaborative filtering techniques approach on the other hand concentrates on recommending items other users, you have something in common with, have liked (Balabanovic & Shoham 1997). For example, when you have bought a book about travelling Vietnam, and some other customers who bought the same book also selected a book about travelling Cambodia, the system would suggest you the Cambodia travel guide as well.

There also exist hybrid recommendations techniques (Smyth et al. 2005) where both approaches are combined together. Depending on the first words you enter, search engines like Google and Yahoo for example suggest you relevant search string combinations based on the search string other users have been looking for in the past (Ansari et al. 2000).

Recommender Systems in PKM tools

Being successful in a range of e-Business and e-Commerce applications, recommender systems can also be used in the academic area to support students and researchers at work.

Current PKM tools are doing a good job in dealing with the learner's existing knowledge and information base, but only rarely help them to enlarge it with relevant new aspects. By extending these tools with recommender systems methodologies, a new intelligent information and knowledge access can be offered.

Using the content-based recommender system approach in PKM tools seems nearly perfect. The common problem of having too little information about user's preferences does nearly not exist, because the knowledge base of the PKM tool is a perfect and substantial starting point for good recommendations (Davies et al. 2006). It is possible to rate the information stored in the systems by matching the content to the user's behaviour. For example, if a learner has 100 academic papers in his knowledge base, and he uses ten of them frequently, their content and their keywords should be weighted more heavily than others'. Current PKM tools like *Knowledge Workshop* from *Learning Management Solutions* (LMS 2009) or *Personal Knowledge System* from *Knowledge Based Solutions* (KBS 2009) offer also possibilities to work with the stored documents. For example, learners may highlight some sentences in their documents; they may add key words, descriptions, tags or some other additional personal information. A document with several marked passages, where the user bothered him to highlight words, where he added some keywords or notes is probably much more worth than a document which was just stored in the database and never opened again.

Beside the user's manual added information, recommender systems integrated in PKM tools can gain an additional advantage from the nature of many academic documents. Keywords, abstracts and authors' name(s), e-Mail addresses, university names, journal names – these are all highly qualified input parameters for successful recommendations. Moreover, references included in the documents may also be used to show the users possible interesting directions.

As mentioned before, current PKM tools are isolated. We have demonstrated the need to facilitate sharing information with others – directly or indirectly. Centralising PKM tools would extend the entire knowledge base of the whole system. This would allow integrating the collaborative filtering techniques in the learning environment. If you have a scientific paper stored in your own knowledge base, and another user has the same paper in his associated with several other papers and hyperlinks for example, these information might be also important and essential to you. It is important to mention the privacy aspect here, but there are ways to guarantee the users privacy and make other users the knowledge retrieving processes easier: e.g. the content in the individual knowledge bases could be categorised as private or public, and the system might be allowed to consider only the public contents. Another possibility would be not to show the user the recommended items, but only inform him, that another user has something relevant to this context.

Conclusion

Personal knowledge management tools are becoming more and more important. They are helpful, and applied in the academic sector they might already now help learners managing and working with their information and knowledge base. Nevertheless, they are not successful in effectively helping the learners to extend their knowledge. The integration of recommender system methodologies in the PKM tools environment can help learners to enlarge it with relevant new aspects. The content-based recommendation approach could be integrated in current tools, as a logical on-top application. The collaborative filtering requires the systems to become more centralised, for example as a web-based service. However, this aspect is, regarding the seven PKM skills, anyway necessary to fulfil the requirements of collaborative cooperation with others.

References

Abecker, A & Völkel, M 2008, 'Cost-Benefit analysis for the design of personal knowledge management systems', *ICEIS 2008 - International Conference on Enterprise Information Systems*.

Ansari, A, Essegaier, S & Kohli, R 2000, 'Internet recommendation systems', *Journal of Marketing Research*, vol. 37, no. 3, pp. 363–375.

Avery, S, Brooks, R, Brown, J, Dorsey, P & O'Conner, M 2001, 'Personal knowledge management: Framework for integration and partnerships', *Proceedings of ASCUE Conference.*

Balabanovic, M & Shoham, Y 1997, 'Fab: Content-based, collaborative recommendation', *Communication of the ACM*, vol. 40, no. 3, pp. 66–72.

Barth, S 2004, 'Self-Organization: Taking a Personal Approach to KM', *Knowledge Management Tools and Techniques: Practitioners and Experts Evaluate KM Solutions*, *Madanmohan Rao*, Butterworth-Heinemann.

Berkeley University 2003, *How much information? 2003*, viewed 02 Feb 2009 <http://www2.sims.berkeley.edu/research/projects/how-much-info-2003/execsum.htm>.

Berkman, R 2005, Information Advisor, citied in Miller, R 2005, 'The Evolution of Knowledge: This Time It's Personal', *EContent*, vol. 28, nr. 11, pp. 38 – 41.

Clemente, B, Pollara, V 2005, 'PKM: Mapping the Course, Marking the Trail', *IT Pro November*, December 2005.

Davenport, T & Prusak, L 2000, *Working Knowledge: How organizations manage what they know*, Harvard Business School Press, Boston, Massachusetts.

Davenport, T 2005, *Thinking for a Living: How to Get Better Performances And Results from Knowledge Workers*, Harvard Business School Press.

Davies, S, Allen, S, Raphaelson, J, Meng, E, Engleman, J, King, R & Lewis, C 2006, 'Popcorn: The Personal Knowledge Base'.

Drucker, P 1985, *Management: Tasks, responsibilities, practices*, Harper & Row.

Ehrlich, K & Maltz, D 1995, 'Pointing the way: Active collaborative filtering', *CHI 1995 Proceedings Papers*.

Frand, J & Hixon, C 1999, 'Personal knowledge management: Who, what, why, when, where, how?', Speech working paper.

Gurteen, D 2005, citied in Miller, R 2005, 'The Evolution of Knowledge: This Time It's Personal', *EContent*, vol. 28, nr. 11, pp. 38 – 41.

Higgison, S 2005, 'Your say: Personal knowledge management', *Insight Knowledge*, vol. 7.

Karger, D 2006 'It's All the Same to Me: Data Unification in Personal Information Management', *Communications of the ACM*, volume 49, nr. 1.

KMS 2009, *Knowledge Based Solutions - a software development company*, viewed 02 Feb 2009 <http://www.kwbsolutions.com>.

LMS 2009, *Learning Management Solutions - Information management, learning enhancement and knowledge management software*, viewed 02 Feb 2009 <http://www.lmsweb.com>.

Miller, R 2005, 'The Evolution of Knowledge: This Time It's Personal', *EContent*, vol. 28, nr. 11, pp. 38 – 41.

Millkin University (2003), Personal Knowledge Management at Millkin University, viewed 02 Feb 2009 <http://www.millkin.edu/pkm/>.

Nonaka, I & Takeuchi, H 1995, *The knowledge creating company*, Oxford University Press, New York.

OECD 1999, 'Measuring and Reporting Intellectual Capital: Experience, Issues and Prospects', *Programme Notes and Background to Technical Meeting and Policy and Strategy Forum*,. Paris.

Polanyi, M 1958, *Personal Knowledge: Towards a Post-Critical Philosophy*, Routledge & Kegan Paul Ltd, London.

Quintas, P 1999, cited in 'Open Eye: Head Back to the Business Cafe', *The Independent*, London, February 4, p. OE9.

Resnick, P & Varian, H 1997, 'Recommender Systems', *Special Section in Communications of the ACM*, vol. 40, no.3.

Sarwar, B, Karypis, G, Konstan, J & Riedl, J 2000, ,Analysis of Recommendation Algorithms for E-commerce', *Proceedings of the 2nd ACM Conference on Electronic Commerce*, pp. 158 – 167, ACM Press.

Sauermann L 2005, 'The Gnowsis Semantic Desktop for Information Integration', *Intelligent Office Appliances Workshop of the 3rd Conference on Professional Knowledge Management in Kaiserslautern*, Germany, WM2005.

Smyth, B, Sulliva, D & Wilson, D 2004, 'Preserving Recommender Accuracy and Diversity in Sparse Datasets', *International Journal on Artificial Intelligence Tools*, vol. 13, no. 1, pp. 219 – 235.

Smyth, B, Sulliva, D & Wilson, D 2005, 'Understanding Case Based Redommendation: A similarity Knowledge Perspective', *International Journal on Artificial Intelligence Tools*, vol. 14, nr. 1 & 2, pp. 215 – 232.

Stewart, T 1997, *Intellectual Capital: The New Wealth of Organisations*, New York: Doubleday.

Tiwana, A 2002, *The Knowledge Management Toolkit*, 2nd eds, Prentice Hall, London.

Truch, E 2001, 'Manageing personal knowledge: The key to tomorrow's employability', *Journal of Change Management*, vol. 2, no. 2, pp. 102 – 105.

Velasquez, J & Palade, V 2007, 'Building a knowledge base for implementing a web-based computerized recommendation system', *International Journal on Artificial Intelligence Tools*, vol. 16, no. 5, pp. 793 – 828.

Zuber-Skerritt, O 2005, 'A model of values and actions for personal knowledge management', *The Journal of Workplace Learning*, vol. 17 no. 1, pp. 49 – 64.