Data Mining, Text Data mining and Personal Knowledge Management [3]

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1.1 Introduction

The last decade the amount of accessible information did grow at an incredible speed. Adding to it that nowadays regularly either the content of a job changes or people change job and it is obvious that there is a continuous challenge in selecting the appropriate information resources to maintain and extend people's personal knowledge.

This article explores the impact of data mining and *text data mining* for personal Knowledge Management in the next decade. Starting from a description and analysis of the use of Intelligent Tutoring Systems, current Knowledge Management practice and the theory of Knowledge Trees, as well as a theory for life long competence building from the French philosopher Serres, a synthesis is outlined which shows the challenging opportunities that (text) data mining offers to foster knowledge management and competence building from a personal perspective.

Knowledge and competence building is definitely not a linear convergent process. The importance of a holistic and cross-disciplinary view is recognised to tackle problems and challenges. A creative attitude to innovation and problem solving is a competitive prerequisite. Therefore in the second part of this paper special emphasis is given how to deal with the use of loosely structured and tacit knowledge and how to support creative processes.

1.2 Intelligent Tutoring Systems

Now already three decades ago, at the beginning of the seventies, the use of computers to capture and transfer knowledge started to emerge. From a relatively small but influential research area, Artificial Intelligence, the first knowledge based tutoring applications emerged. In contrast to the first generation of Computer Assisted Instruction programs, which offered simple automated instruction, Intelligent Tutoring Systems [Wenger, 1987] did use Artificial Intelligence approaches to capture and deal with aspects of knowledge. Micro-worlds were shaped. Built in various ways but in general containing at least a detailed domain or expert model, a personal

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or student model and a knowledge transfer or instructional model. Persons involved in such a micro-world can actively or in a guided way gain new knowledge. They can immerse in a device simulation or a programming world and practise their skills as well as receive feedback and guidance depending of their progress. Alternatively, they are guided through the domain of study awaiting the chunks of information that according to their knowledge and the instructional methods applied are fitting best. The Intelligent Tutoring Systems (ITS) built are qualitatively strong and proved to be highly effective. However, what they offer are small chunks of information and knowledge of small-scale worlds and is therefore of limited applicability on a real world scale. Also because they are in general each built from scratch little to no effort is being paid to productivity concerns. Starting in the beginning of the 90's steps have been made to design and develop authoring systems for ITS [Murray, 1999] and to deal with generic approaches, e.g. how to use task and domain ontology [Mizoguchi, Sinitsa and Ikeda, 1996] to support reusable components and how to use agent architectures by which agents (e.g. a learner modelling agent [Paiva,1996]) can be reused in different settings and by several types of applications.

With the emerging of the Web, research did also focus on adaptive and intelligent technologies for Web-based education [Brusilovsky, 1999]. Part of these focus on problem solving, i.e. exploring micro-worlds. However, the most applied examples - for our case also the most important ones - are hyper-spaces of educational material. The goal here is to guide the students through the material and show them the optimal path or the optimal content. This can be achieved in different ways. The most popular use direct guidance, i.e. they offer the best page given the student's current knowledge and learning goal or adaptive link annotation and hiding (i.e. annotating the most suitable links and disabling a link if a page is not yet ready to be learned). Additionally, based on the characteristics of the Web, student modelling extended with the option of comparing the models of different students. This gives rise to two options. One is finding a competent peer to share and discuss issues. One is to identify students that progress through their learning different from their peer group members.

1.3 Knowledge Management

In the 90's the availability and the dependence of information and communication technology drastically increases, the economy globalises and in line with these developments the importance of Knowledge Management was 'reinvented'. People, their knowledge and skills are again the main capital of a company. Like in the Middle Ages, in the master- model, it is the knowledge and skills of the people - the masters and apprentices - that are recognised to contribute most to a successful future. This started in the early 90's. First focussing on 'The Learning Organisation', i.e. an organisation that qualifies by taking learning and

experience into the daily practice, later emerging to Knowledge Management as a corporate goal.

The importance of preserving and disclosing corporate memory in order to assist in surviving in an increasingly competitive environment became widely recognised and among others workflow, document management systems and Group-ware tools have been introduced to capture and exchange knowledge. This has been supplemented with practical techniques for building Knowledge Management systems that focus both at organisational and technical concerns [Tiwana, 2000].

However, whereas the objective of an ITS is concerned with learning and the learner becomes first actively engaged at the time of learning, Knowledge Management is different. In contrast to the micro-worlds the information preserved and disclosed is in general abundant and not very well on measure. The users themselves have to a large extent to sort between relevant and not relevant and are also responsible for maintaining and filling the Knowledge Management System. In both activities, finding relevant information in a growing knowledge-base and capturing knowledge (that otherwise would remain tacit) in order to make this available to others is a tedious job.

Different solutions have been implemented or are being developed [Bair and O'Connor, 1998; Merlyn and Valikangas, 1998]. They range from better structuring and clustering the information, improving information retrieval by offering one integrated architecture to a number of independent resources [Schmitz, in preparation] or by automatically adjusting to a (pre-defined) user profile, automatically searching for relevant information, to a more intuitive graphical user interface (figure 1). For each type of interaction, i.e. gathering, organising, elaborating and communicating information, there are tools available to facilitate the process. However, it must be realised that they have to work in the complexity of organisations somewhere balancing between order and chaos [Syed, 1998]. So it is crucial to employ technologies that minimise the time to be used by the knowledge worker. At this point two areas of tools and research are of particular importance. They are research and tools for personalisation and for automatically capturing information to build knowledge bases.

Personalisation

Probably the best-known example of personalisation is the (www.amazon.com) Amazon bookshop [Albert, 2000]. It is based on a data mining technique called nearest neighbourhood or affinity grouping or clustering. For customers, once registered, a profile is kept of their interest and books ordered. The profiles are compared and clustered. The purpose of this is to give an individual advice to customers, i.e. an advice to have a look at books that have been ordered by people with similar interest. This approach uses little knowledge about the topic involved; it merely concentrates on similarities in interest. As a result there are some potential

drawbacks. New information items can only be recommended after they have been "recognised" by a sufficient number of users before the nearest neighbourhood method can start to work. Moreover, it will only work if you are a user whose profile has sufficient overlap with other users. If not, you will be literally lost in your own private space.
Another approach, content based profiling, relies on the representation of content by a suitable set of attributes. The user profile is represented in a similar way. It builds up in line with the items a user likes. The content based filtering methods select content items that have a high degree of similarity to the user's profile. In this case the problem is to build the representation and for first time users the fact that their profile at start will be small. Subsequently, a user will receive relatively few suggestions to have a look at.
In [Smith and Cotter, 2000] an application, a television listing service, is described that successfully combined both approaches.

Content creation

Supporting the creation of content can be done in various ways. They range from offering templates or predefined structures to add information to, to fully automatic content 'creation' based on a combination of searching and clustering at the level of keywords, to automatically analysing, clustering and summarising e-mails or documents using text data mining tools (cf. also paragraph 2.2 "Transforming data into meaningful knowledge"). Text data mining uncovers relationships in unstructured collections of text documents. Applications of text data mining include clustering, visualisation, information extraction and summarisation. It can be applied to e.g. analysing incoming e-mails for customer support or to analyse large quantities of documents for domain specific knowledge [Lawson, 1999; Stoner, 2000].
Here one point deserves extra emphasis. It is important to assure transparency of access. Therefore the output of the analysis should be transparent if information is required by more persons. This can be achieved by using an ontology [Gruber, 2000; Jasper and Uschold, 1999], i.e. a vocabulary of terms and their relations including a specification of their meaning.

1.4 Knowledge Trees

Also in the early 90's the French philosopher Michel Serres [Pouts-Lajus, 1993] was given the responsibility to consider the conditions in which France could found an Open University. He proposed a system in which for each individual their knowledge and know-how was represented in a set of badges, a blazon. A blazon of an individual would depend on the community to which the individual belonged. In other words, it would be relative to the role within and the level of the community. Moreover a notion of time, i.e. when in time specific knowledge was acquired, was

taken into account. Here a Knowledge Tree is the whole of the knowledge of the individual members of a community. A community and their members can use their Knowledge Tree to formulate their demands in terms of their ideal profiles for a given situation. The approach clarifies the conditions why knowledge and which knowledge has to be transferred and enables a highly individual approach.

1.5 Triangle model - a Synthesis

At first sight the progress made in the two areas discussed, i.e. ITS and (group) Knowledge Management and the theory of Knowledge Trees, is interesting but they remain independent areas focussing on various aspects of knowledge. However, once looking at personal Knowledge Management things are starting to get intertwined. The goal of personal knowledge management is to enhance our personal and business life through life long learning. This may be achieved by formally accredited courses. However, far more important is learning by doing, learning from peers and relations, and learning by having access to all kind of digital or printed resources (figure 2). It is exactly here where ITS, Knowledge Management and Knowledge Trees interact.

March 2012, Ann just entered her new job at the micro-electronics department. The first two months her task was to get acquainted with the company and to get her aware of all issues and knowledge involved in running the company. Her first task today was to instruct her personal knowledge agent to merge her personal knowledge profile with the company's knowledge tree and her function requirements. Next she had to negotiate the access rights to the various parts of her knowledge profile. After this she left for a break. At this time her personal knowledge agent had invoked a knowledge transfer process. Her personal knowledge agent entered into a dialogue with the user model agent, the domain model agent and the knowledge transfer model agent to prepare her personal internet with items of interest she could browse through and select for study if she decided so. When Ann returned her computer showed a map of items of interest to study, of people she could contact and a visualisation tool pad to structure her thoughts as she goes through her knowledge space. In line with her background and her role some of the items cover topics in detail, other give just a superficial overview. Also in line with Ann's cognitive style her information space contains a large amount of documents and a rich amount of topics. So she can really explore. Stepwise as she explores, her user model is updated and as a result of the continuous interaction between her personal knowledge agent and the three other agents her personal knowledge web extends and renews.

Figure 2. An example of a personal knowledge agent at work in interaction with an agent for the domain model, the user model and the knowledge transfer model.

The power of ITSs lies in the fact that they are built on articulated models not only of what but also of how to transfer knowledge. They are based on a model of the domain, the student and on a model on how to transfer knowledge. The weak side, however, is that the knowledge contained has to be prepared in advance and that the domain and user model contained cover only arbitrarily small samples of what is worthwhile or necessary knowing. Knowledge Management applications on the other hand and the techniques and tools used can offer access to an unlimited amount of information. Internal business resources and access to the Internet

infrastructure offers a theoretically unlimited access to the knowledge resources in a world without physical borders and can in principle precisely be adjusted to everyone's personal situation. The Knowledge Trees discussed offer a life long, student or personal model that can be carried as a *personal knowledge passport* through life. At each time and at each situation indicating what is known, at which level and from which role perspective and what are the new knowledge targets to be achieved.
And at the same time offering possible links to persons into the same interest position. This paves the way for collaboration and collaborative support and is as such an important add-on that differentiates knowledge support systems from information systems.

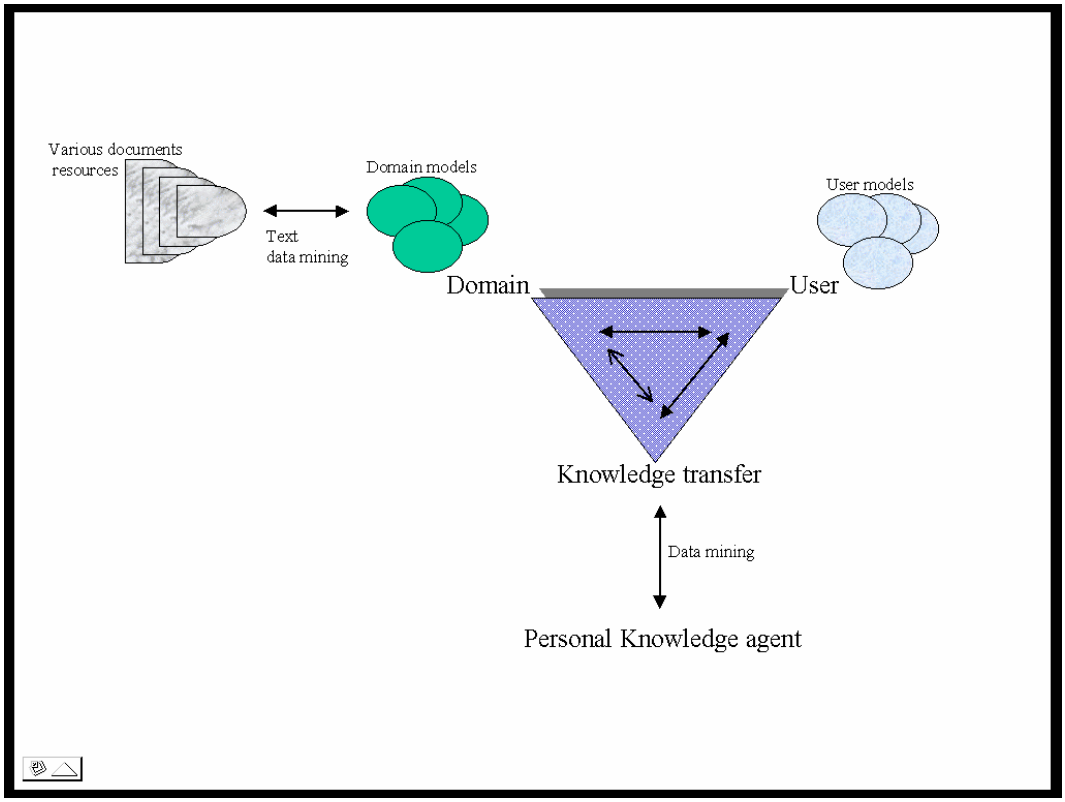

Figure 3. The knowledge triangle for personal knowledge management.

Resulting, based on the structure of ITS, we propose a synthesis integrating the strength of ITS, Knowledge Management and the theory of Knowledge Trees. This implies a domain model and content (or content references) based on Knowledge Management techniques and tools, a user model based on the theory of Knowledge Trees and a knowledge transfer model based on ITS.

Data mining and text data mining techniques and applications will play an important role to support the domain, user and knowledge transfer agents to maintain their models. Their role in the implementation of the triangle for personal Knowledge Management is crucial. This will enable systems to

move from a craftsmen phase to industrial production both from a personalization perspective as well as from a content perspective.
Data mining techniques can be used to extend and maintain the user model. Text data mining can contribute to the content of the knowledge base and support with creating *semantic maps for navigation* (see e.g. fig. 7). The latter helps to structure even loosely structured content and to visualise relations the user has not been aware of previously. Thus helping to transfer loosely structured and implicit (or tacit) knowledge into explicit knowledge which is the topic of the next paragraphs.

2 CREATIVE PROCESSES, LOOSELY STRUCTURED AND TACIT KNOWLEDGE

The starting point of the analysis is again the triangle model:

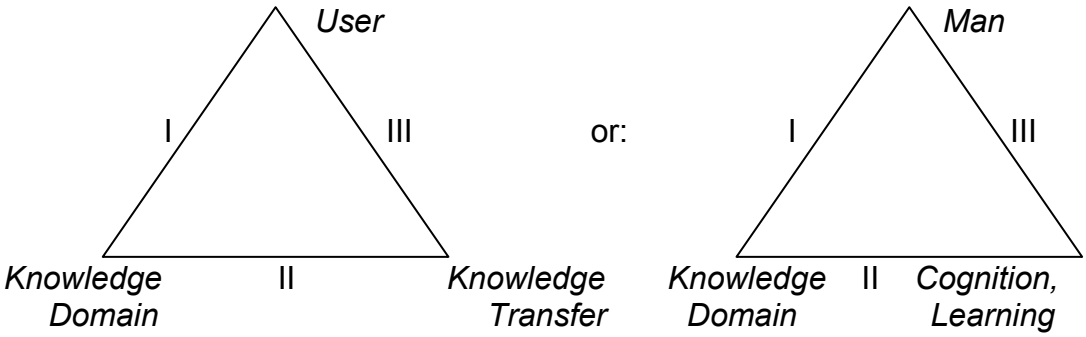

Figure 4: the "knowledge triangle"

When transforming information into knowledge the 'user' (which could be a person, group or even an organisation) inherently uses the knowledge profiles as acquired thus far in his/her knowledge domain as a starting point:
the acquired knowledge profiles are combined and complemented with the (new) knowledge he/she is looking for, and which adds value in his/her personal Knowledge Management or in an organisational context.
In figure 4 this relation is represented by I; relation II deals with the methodologies which can be used to translate knowledge concepts into knowledge which can be learned by the user (line III).

2.1 Explicit and implicit or tacit knowledge; the concept of meaningful knowledge

Now it is important to distinguish between explicit and implicit (or tacit) knowledge.

Explicit knowledge is knowledge that has been codified or described in such a way that it can be transferred to a person in for instance a learning process.
Implicit or tacit knowledge is built out of a mix of personal experiences, skills and attitudes.
All knowledge used by a person is either tacit or rooted in tacit knowledge, which is illustrated by the 'iceberg' image:

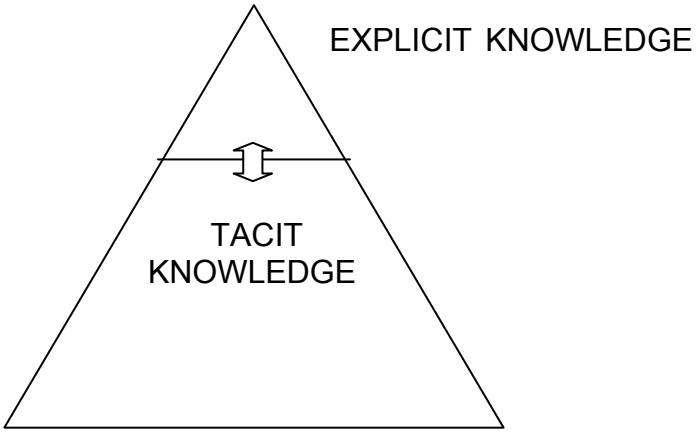

Figure 5: Explicit and tacit knowledge in relation to each other: explicit is rooted in tacit

The tacit dimension of knowledge underlines that knowledge is connected to a personal and social context: the act of knowing includes an appraisal and accordingly bridges the transition between subjectivity and objectivity.

The transition between explicit and tacit knowledge is subtle in the sense that it is a continuous one. This is illustrated in the following matrix [Tissen et al., 1998]:

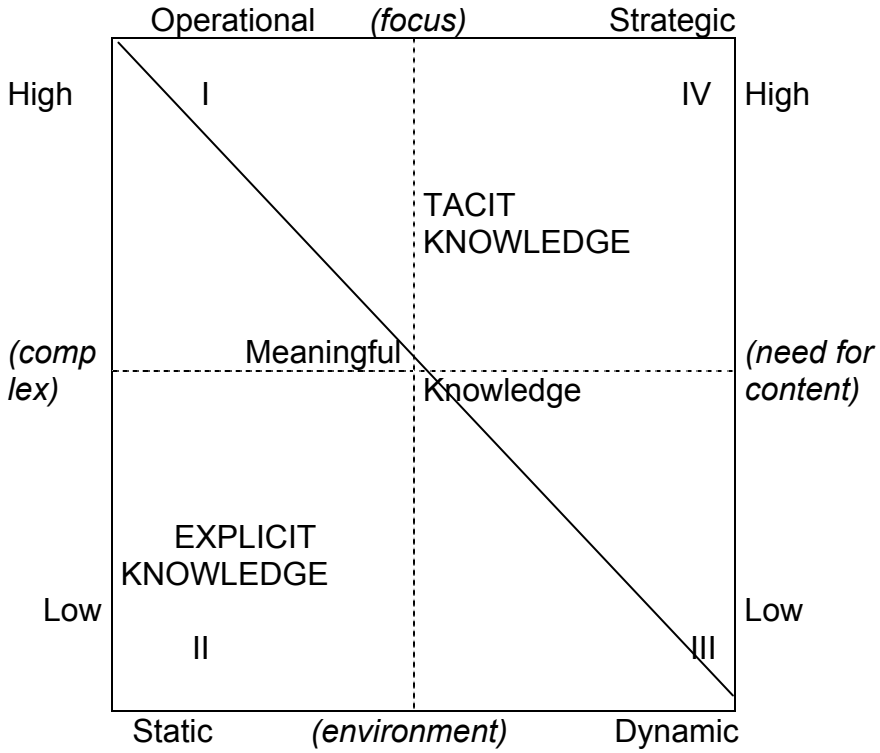

Figure 6: A matrix representation of the different types of knowledge

An example of knowledge in quadrant I is knowledge used by legal persons; knowledge in quadrant II is fully operational information requiring less contextual information to understand, examples of which can be found in industrial production.
Type III knowledge is used in a turbulent environment with a more strategic focus, e.g. in stock exchange.
Quadrant IV represents implicit knowledge that is always meaningful to a person (or group), that is to say that has a specific meaning in a personal context, thereby adding value for the individual in his/her life. Well-known examples are riding on horseback or knowing how to pour tea in a Japanese tea ceremony.
This publication is not the place to describe in detail how implicit knowledge is being made explicit or vice versa. However, some basics have to be touched upon here and in the next paragraph.
First of all the lesson that everybody has learned in his/her life: physical exercises provide a deeper understanding than intellectual exercises, or – in other words – learning by doing is to be preferred.
What is behind this almost trivial notion is that knowledge creation that is meaningful to a person liberates (psychological) energy, it creates a positive emotional state. Think for instance of a “Eureka experience” or the emotion coupled to grasping a complex relationship between knowledge concepts.

A second aspect of knowledge creation is the use of intuition. The intuitive capabilities of the human mind complement the rational way of thinking and are essential in solving problems or taking decisions in complex and strategic situations.

When returning to figure 6 it is apparent that tacit knowledge is extremely important in strategic situations with a high need for content in a dynamic environment. This is essentially the working ground for the (future) knowledge worker. In order to take decisions or reach conclusions the knowledge worker not only relies on facts, but also on intuition.
Working by using meaningful knowledge implies thinking in scenarios ("what if ……", or "how could I ….."). And scenario-thinking is what people normally (should) do in all divergent complex situations which they encounter in their personal life or in their professional activities.

One of the interesting things about scenario-thinking is that it is essentially based on 'both/and' logic. The implication is that you accept that a potential solution is not formulated in terms of X *or* Y but in terms of X *and* Y. For instance, a new industrial product to be developed should not only have the required functional properties, but also comply with environmental standards and current legislation.
Scenario-thinking is about accepting creative, even in itself *paradoxical* approaches.
The consequence of all this for the transformation of data into meaningful knowledge is discussed in the next paragraph.

2.2 TRANSFORMING DATA INTO MEANINGFUL KNOWLEDGE

Transforming data into meaningful, implicit knowledge and also making this knowledge explicit – which is a prerequisite for effective knowledge transfer – will be **the** great challenge for persons, groups, as well as for professional organisations, especially with a view to developing personal competencies and to life long learning.

Now, first of all, it is necessary to have a short view at the mechanisms and techniques that govern the transformation between explicit and tacit knowledge (in both directions).
In practice, three key factors support a successful conversion process [see also Ikujiro Nonaka, 1999]:

1) **Expression and recognition**
Text data should be expressed as clearly identifiable concepts or figurative language (such as analogies or metaphors) in order to be suitable for conversion into tacit knowledge. A person is only able to 'grasp' the idea, to reach a real understanding, if he/she can visualise conceptual information by making the proper links to already existing tacit knowledge in his/her mind.

Figurative language and the use of symbols are especially important since a prominent part of the development of (personally) meaningful knowledge is taking place in an intuitive way in the subconscious domain of the mind.

2) **Combination**
Depending on the complexity of the data that are offered to a person, he/she will combine these data in the form of associated concepts (associations between the external data or with concepts already existing in the person's knowledge profile), which will build a concept network in the person's mind. Such concept networks generally have a unique individual character since the association of concepts is a process that is to a large extent is determined by personal experiences and fostered by their attached emotional value.
This directly implies that the emotional value that a person attaches to an association can spread in a continuum between low and high.
In the process of learning and of interaction between individuals in general, associative links may easily change to other concepts, together with the personal value attached.

3) **Integration**
As we have seen in the last paragraph real understanding is promoted in learning by doing situations. Often this requires interaction with another person (a colleague or teacher) or in a group. In this way knowledge is literally **embodied in action and practice**, and an integration process - as a consequence - takes place in the person's mind. The acquired knowledge then really becomes meaningful.

We will now proceed with a state-of-the-art overview describing developments and tools dealing with the conversion of text data into meaningful knowledge, wherever possible referring to the key factors and mechanisms described above.

As we have seen the first step to be taken in order to achieve a successful transformation of text data into knowledge is expression and recognition: text data should be expressed as recognisable concepts. Our mind *associates* a concept that is recognised in external text data with one or more concepts already present (as tacit knowledge) in the mind.
A *semantic association* in the form of a *mental hyperlink* is being constructed.
In this context a number of developments and IT-based tools are important. We will focus on:

a) Algorithms for the self-organisation of linking concept patterns in the Web to the patterns of an individual user, and self-organising learning webs for knowledge structuring.
b) Knowledge management systems enabling automatic categorising, linking and delivering unstructured information from multiple input sources in such a way that users can efficiently locate and analyse the information they need.
c) Tools for structuring knowledge, making visible links and associations between concepts.

a) Algorithms that will enable linking patterns of concepts in the Web to the patterns of an individual user are studied in cybernetics and Artificial Intelligence studies [see e.g. ref. 22]. The basic idea behind several of the algorithms studied is that Web links are similar to associations in the human brain, as supported by synapses connecting neurons. The strength of a link, like the connection strength of synapses, can change depending on the frequency of use of the link. This allows the network to "learn" automatically from the way it is used. Such associative networks are more flexible than semantic networks (as used in AI); they allow the expression of *"fuzzy" or "intuitive" relations between concepts* and have been regularly suggested as models of how the brain works. Algorithms for associative hypertext networks allowing "self-organisation" into simpler, more meaningful and more easily manageable networks have already been developed [Heylighen F., 1999]. They almost allow us to think in terms of the "Global Brain" metaphor, the development of the (currently static) World Wide Web into a self-organising, thinking and dynamic Web. And even when a global brain cannot be reached, semantic Web and search technologies will govern the future of the knowledge worker when he/she needs access to information.
   We expect that such developments will be of growing importance for text data mining and personal knowledge management.

b) Already working examples of adaptive pattern-making algorithms are being used in knowledge management practice [see e.g. ref. 23]. They categorise and link unstructured or loosely structured information from multiple input sources (the Web, intra-net sites, digital documents, e-mail), identifying the areas of expertise of individuals within an organisation.
   Future developments in this field include the widespread use of *adaptive probabilistic concept models* (APCM), as originally developed from research into neural networks. Here pattern-matching algorithms based on APCM are used to analyse documents and identify key concepts, which can be recognised by concept agents that automatically monitor the documents selected by users to view. Knowledge management systems developed as in ref. 23 enable to use a person's reviewing behaviours to build a personalised profile of interests, which can then be used to achieve key knowledge management objectives.

c) As soon as (text) information has been drawn from input data a person should keep track of his/her acquired knowledge in a personal knowledge management system. Most knowledge workers start with representing their ideas and knowledge in the form of a concept diagram or concept map. Nowadays, a growing number of professionals is using IT-based tools to make mind maps, fishbone diagrams (like in fig. 1), decision trees and concept maps or ontologies (specifications of concepts and tasks that define the knowledge and the system in which the knowledge base is described).

When making a *visual representation* of your own ideas you can recall the details better and you can better recognise where your gaps in understanding are. Since many people mainly think and learn visually, visual tools like for instance used in figure 1 and 7 are being increasingly adopted [see ref. 25]. Moreover, visual representation of associated concepts “opens the gateway” to our creative and intuitive abilities and thus facilitates the transformation of explicit knowledge into implicit, meaningful knowledge.
Web-enabled tools visualising associative networks (as in ref. 26) undoubtedly will be the starting point of a number of developments directed at building personalised knowledge management systems based on associative networks of concepts (including all relevant hyperlinks).

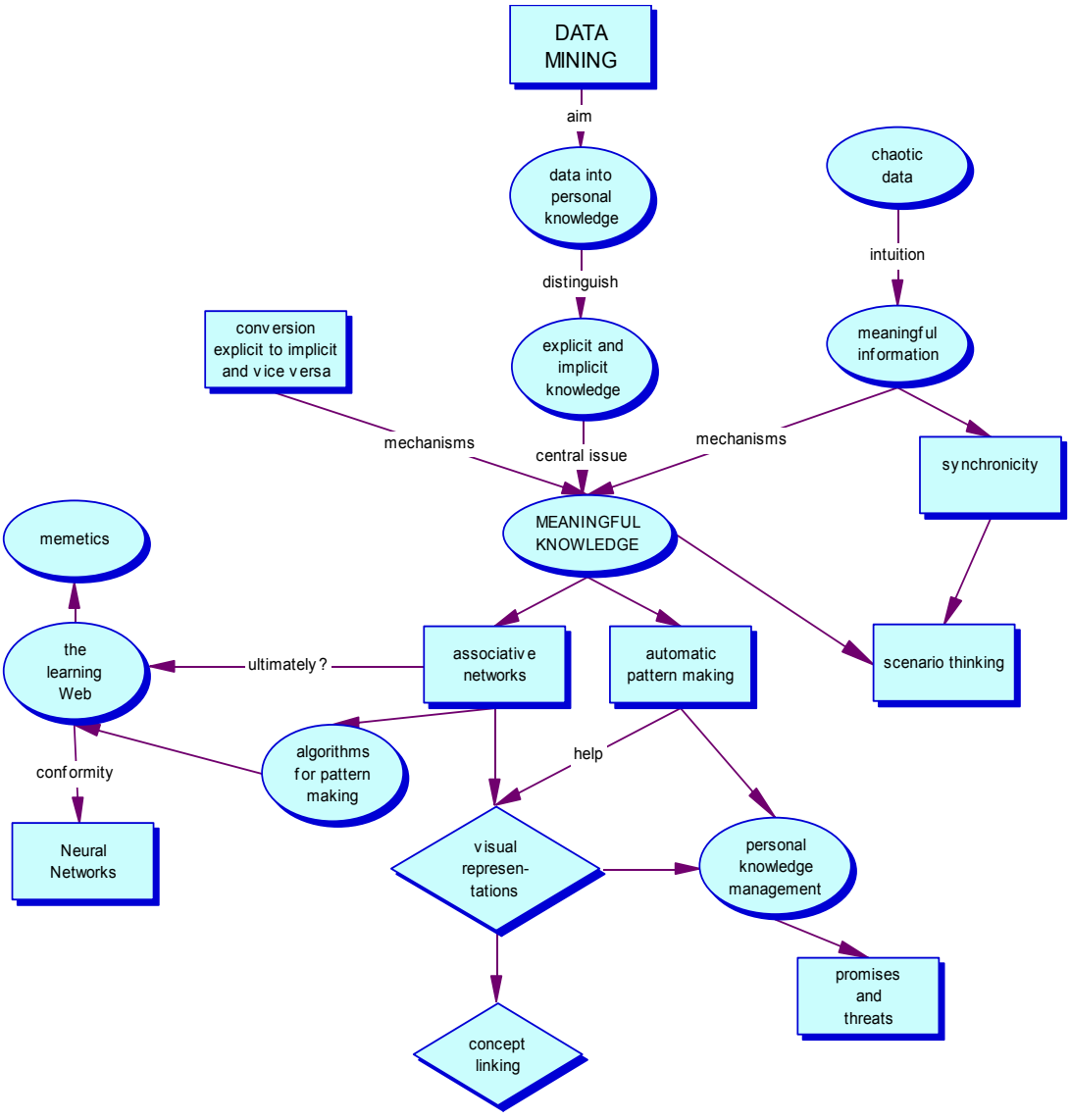

Figure 7: example of a representation of an associative concept network (the gross structure of the 2nd part of this publication in a two-dimensional image)

2.3 VISIONS ON THE FUTURE

Managing 'chaotic' data: thriving on chaos

A lot of information is coming to us in a 'chaotic', unorganised way: we receive information we did not ask for, we find Web sites or references we did not specifically look for. Nevertheless, often we find very useful – even future determining – information in this 'chaotic' way. Moreover, the use of multi-reality scenarios in e.g. business situations includes the conscious search for meaningful information that comes to us seemingly by coincidence. We intuitively feel when new information is important, since only we can grasp the context. That is the reason why it is very unwise only to rely on IT-based tools for filtering of information: in our attempts to filter out the 'noise' we filter out the music as well. We have to use our human brain computer in a parallel, intuitive way.
On the other hand as stated in the beginning of this article the world globalises and the amount of accessible information grows at a dazzling speed. Therefore tied to our triangle model we foresee ICT and (text) data mining to have an important supportive role. Enabling us, only being involved in a fraction of what could be of interest, to identify in the world of structured chaos topics of interest outside our personal neighbourhoods.

The model we do propose will enable knowledge workers to identify colleagues around the world that deal with similar or related topics. Their profiles will be similar or overlap and can (after consent) be used to identify peers. Once the contacts are made interactions may lead to sharing and discussing new ideas or old ideas with new viewpoints.

Information only works when the two other building blocks of knowledge are present: Intellect and Interaction. The ancient Chinese have already recognised this in their famous Book of Change [Wilhelm R.,1950]. The basic idea behind their philosophy is that (emotionally loaded) thoughts and events (e.g. information one is provided with) are linked in a non-causal, but meaningful way. A micro-world event reflects the whole of nature and society and includes, within it, the observer. Or, in other words, within each process of nature the whole is enfolded. The information that a person is looking for and which is meaningful to him/her significantly relates to patterns of change. The concept of *synchronicity* that summarises this philosophy in one word was introduced by C.G. Jung [see e.g. Peat, F. David, 1987]. Next decades will show a growing number of knowledge workers who recognise the importance of their creative and intuitive powers in retrieving meaningful knowledge from external data and who will not exclusively rely on information technology for the transformation of data into knowledge, and for taking important decisions based on them [Agor, Weston A., 1986].

The management of implicit, meaningful knowledge

As we have seen implicit, meaningful knowledge is playing a central role in the transformation of data into knowledge. In the last decade a lot of attention has been given to Knowledge Management, especially in those organisations where knowledge workers have a prominent position. It is expected that managing implicit knowledge, both on a personal and on a group level, will gain primary attention in the next decades in relation to organisational learning and competence building. Models coming from the domains of change management and innovation diffusion will be applied to the management of implicit knowledge. These models address the psychological, social as well as cultural dimensions of acquiring knowledge [Nabeth T., 2001]. Another area of potential importance is the study of memetics. A meme is defined as an information pattern, retained in an individual's memory, which is capable of being copied to another individual's memory. The most powerful medium for meme transition is the computer network [see ref. 31].

Promises and threats

The use of personalised knowledge profiles which describe "gaps" in the knowledge domain of an individual is evidently an important step forward in the life long learning perspective of the knowledge worker. But it also imposes a threat that this personalised information is being studied and used without explicit consent: autonomous user profiling of knowledge should be out of the question. Also, the past reviewing behaviour of a person should not be taken as a basis for decisions to filter out information and data which apparently do not fit into the personal knowledge domain. This also raises the possibility of multiple and 'marketed' identities of persons (with regard to information searching). A way should be found to determine the potentialities of both competencies and interests of a person, and based on that to assist him/her in data mining.
Moreover, technology should ensure people's (and organisations) rights to privacy and anonymity in this respect [Cingil, Dogac and Azgin, 2000; Pisa, 2001]. Private accessibility could be ensured by e.g. relevant combinations of biometrics and digital signature. But even then, ample room should be left for individual choices enabling self-tuition. Growth and development of an individual are to a large extent self-organising since the acquisition of meaningful knowledge takes place in a chaotic, self-organising way.
The possibility of complete self-tuition will have an ethical side as well: making children out of adults by stressing 'wish technology' and getting lost in fantasy worlds, developing hide and seek behaviours for fun, etcetera.

Another obvious threat is manipulating the news. The higher the degree of automation the more sensitive the user will become for deliberate manipulation by hiding, inserting or promoting specific knowledge items.

Finally, we would like to stress the risk of exclusion. While the techniques proposed can, once implemented, be duplicated at relatively low costs, practice may be different. Personalised Knowledge Management should not lead to a situation where the already existing gap between rich and poor is enlarged, since only a small group of privileged is assisted in finding or has access to the techniques and tools described in this publication.

References

1. Wenger, E., *Artificial Intelligence and Tutoring Systems*, Morgan Kaufman Publishers, California (1987)
2. Murray, T., *Authoring Intelligent Tutoring Systems: An analysis of the state of the art* , International J. of Artificial Intelligence in Education, Vol. 10, pp. 98-129 (or http://www.cs.umass.edu/%7Etmurray/papers/ATSummary/AuthTools.html) (1999)
3. Mizoguchi, R., K. Sinitsa and M. Ikeda, *Task Ontology Design for Intelligent Educational/Training Systems*, Position Paper for ITS'96 Workshop on Architectures and Methods for Designing Cost-Effective and Reusable ITSs, Montreal, June 10th (1996) (http://advlearn.lrdc.pitt.edu/its-arch/papers/mizoguchi.html)
4. Paiva, A., *Communicating with Learner Modeling Agents*, Position Paper for ITS'96 Workshop on Architectures and Methods for Designing Cost-Effective and Reusable ITSs, Montreal, June 10th (1996)
5. Brusilovsky, P*., Adaptive and Intelligent Technologies for Web-based Education*, In: C. Rollinger and C. Peylo (eds.) Künstliche Intelligenz, Special Issue on Intelligent Systems and Teleteaching, 4, 19-25 (1999) (http://www.contrib.andrew.cmu.edu/%7Eplb/papers/KI-review.html).
6. Tiwana, A., *The Knowledge Management Toolkit*, Prentice Hall, US, (2000)
7. Bair, J., E. O'Connor*, The state of the product in Knowledge Management*, Journal of Knowledge Management Volume 2 Number 2, December (1998)
8. Merlyn, P., L. Valikangas, *From information technology to knowledge technology: taking the user into consideration*, Journal of Knowledge Management Volume 2 Number 2, December (1998)
9. Schmitz, M., *Final Thesis*, School of Engineering - University of Maastricht (in preparation)
10. Syed, J., *An adaptive framework for knowledge work*, Journal of Knowledge Management Volume 2 Number. 2, December (1998)
11. Albert, G., Mining Methods II, http://www.hindubusinessline.com/2000/07/26/stories/242639b6.htm
12. Smith, B., P. Cotter, *A Personalized Television Listings Service* in Communications of the ACM - Personalization -, Volume 43, Number 8, August (2000)
13. Lawson, J., *Text Data Mining Introduction*, http://allen.comm.virginia.edu/jtl5t/index.htm (1999)

14. Stoner, A., *Knowledge discovery and data mining*, http://www.biermans.com/culminating/datamining.htm (2000)
15. Gruber, T., *What is an ontology*, http://www-ksl-svc.stanford.edu:5915/doc/frame-editor/what-is-an-ontology.html
16. Jasper, R., M. Uschold, *A Framework for Understanding and Classifying Ontology Applications* (1999)
17. Pouts-Lajus, S., *Knowledge Trees, A Global System* in Tribune European Learning Technology Collection (1993)
18. Cingil, A. Dogac and A. Azgin, *A broader Approach to Personalization* in Communications of the ACM - Personalization -, Volume 43, Number 8, August (2000)
19. PISA - Privacy Incorporate Software Agent, Building a privacy guardian for the electronic age, http://www.tno.nl/instit/fel/pisa/ (2001)
20. Tissen R. et al., Addison Wesley Longman Nederland BV (1998)
21. Ikujiro Nonaka and Noburo Konno, *The Concept of "Ba": Building a foundation for knowledge creation*, The Knowledge Management Yearbook 1999-2000, Butterworth Heinemann (1999)
22. *Learning Webs*, In: Principia Cybernetica Web http://pcp.lanl.gov/LEARNWEB.html
23. *Functional review of Autonomy*, In: www.doculabs.com or algorithms and methods described in www.inxight.com
24. Heylighen. F, *Bootstrapping knowledge representations: from entailment meshes via semantic nets to learning webs*, Int. Journal of Human-Computer Studies (1999)
25. www.mindmanager.com
26. www.thebrain.com
27. Wilhelm R., *The I Ching Book of Changes*, Princeton University Press (1950)
28. Peat F.David, *Synchronicity: the bridge between matter and mind*, Bantam Books (1987)
29. Agor Weston A., *The logic of intuitive decision-making; a research-based approach for top management* Quorum Books (1986)
30. Nabeth T. and Roda C., K-InCA: *An organisational learning system which exploits and supports social processes* Publication INSEAD/CALT (2001)
31. *Memetics*, In: Principia Cybernetica Web http://pcp.lanl.gov/MEMES.html
32. *Scenarios for Ambient Intelligence*, ISTAG report, IPTS Seville (2001) see www.cordis.lu/ist/istag.htm