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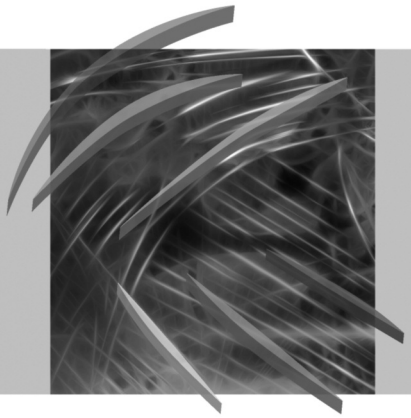

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Advanced Information Technologies for Management – AITM 2011 ISSN 1899-3192
Intelligent Technologies and Applications

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COLLECTIVE INTELLIGENCE IN FINANCIAL KNOWLEDGE MANAGEMENT: CHALLENGES IN THE INFORMATION EXPLOSION ERA

Abstract: The emerging e-finance and the explosion of financial information impacted the evolution of finance information systems. With conventional techniques, it is hard to find a way to build a self-sustainable financial knowledge-based community. In order to achieve global semantic interoperability among financial information systems, semantic concepts are applied to build financial knowledge-based communities to deliver more robust, user friendly financial information search interfaces customized based on semantics. The key challenge is the integration between collective intelligence and financial knowledge management systems. It would enable to classify the most preferable terms that shared among the financial knowledge-based community. With this system, we will easily be able to identify financial information and collect finance vocabulary.

Keywords: Collective Intelligence, Finance Semantics, Knowledge Management, Web 2.0, Web 3.0.

1. Introduction

The faster and meaningful information has been the driving aim for the evolution of financial information systems [Shakoori, Mesel 1993] and decision support system to e-finance [Banks 2001]. The effectiveness of financial information systems has been enhanced by knowledge management systems [Alavi, Leidner 1999; Feng, Xiao 2009]. One-step further, the Semantic Web, a model of semantic management and retrieval in the web environment, extended distributed financial information systems toward knowledge management systems [Fui-Hoon Nah, Siau, Tian 2005]. It has direct impact on their performance as Yangcheng Hu demonstrated [Hu 2010].

Along the development of e-finance, classification systems for financial semantics based on financial thesauri and controlled vocabularies have been created to

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cover 3 main sectors (B2B, B2C, and infrastructure). These systems have been extended to ontologies [Cheng, Lu, Sheu 2009] to represent domain knowledge in machine understandable format.

Finance-related data integration has been a key challenge for the description web financial resources. Financial Linked Data [Garcia, Gil 2010] provides the interoperability framework that allows interoperability between financial sources that also publish specific data using the same principles, wherever they come from.

In various contexts such as B2B, B2C, and intra-organizational, enabling transparency of discussions is needed to augment one's understanding and to provide more insight into the underlying financial assets that are being discussed. Such transparency has been achieved by letting people comment on and interact with the Financial Link Data that are provided on the Web (via comments related to each financial data snippet in grant proposals, budget reports, etc.). In addition, financial records and related discussions are provided in a machine-readable way, using the aforementioned Linked Data principles.

The vision of meaningful retrieval in financial knowledge management systems is related to two core aspects: user's context and financial document context. In state-of-the-art financial knowledge management, users are both consumers retrieving financial contents and contributors to the flow of financial information. This vision can be accomplished with an ontological model of user's interest areas, and the modelling of context of financial information. This makes the match of user's context with the financial document context easier at the search stage.

Due to the distributed and heterogeneous nature of sources of financial information over the web, collective intelligence became a great challenge to enhance the effectiveness of financial information search. In order to efficiently collect feedbacks, share knowledge and enable discussion for finding good answers to queries, a large community group should be considered for exchanging information as part of financial network.

As a large collaboration platform, the Internet has been successful in connecting large groups of people. Web 2.0 provides more attractive features, keeping up with a financial content even without visiting the actual financial documents. Financial knowledge management systems enforce the transition from a static financial information space to a dynamic (collaborative) financial knowledge space. Furthermore, it enables social semantic financial collaborative filtering.

As a part of the emerging Web 3.0, Internet facilitates social interaction, and collective intelligence among users. Collective intelligence is a complex adaptive system combining individual intelligence. It enables adaptive agents to collaborate together, creating accurate and reliable knowledge as a part of semantic web. In the era of information explosion, it is important to filter information. Opinions about discussion topics are usually collected from general Internet users. Furthermore, it provides some mechanisms for less controversy of the opinions and more control of information.

In this paper, we address the challenges of collective intelligence as a part of the enhanced financial knowledge management systems. One of the difficulties in constructing financial knowledge platform from financial information systems is the development of self-sustainable community. To alleviate this problem, we point out the key components and issues of the Collective Intelligence-based Financial Knowledge Management platform (named CIFKM). This platform is a core layer for setting up financial communities and collecting knowledge from financial knowledge management systems about specific financial domains. The CIFKM platform will manage not only collective intelligence-based ontologies (e.g. XBRL Ontology) but also will index financial information.

In Section 2, we overview the impacts of Web 2.0 and Web 3.0 on financial knowledge management systems. Section 3 describes the aims and key components of enhanced financial knowledge management platform according to collective intelligence features. Section 4 presents the collective intelligence challenges. A conclusion and future works are presented in Section 5.

2. Web 2.0 and Web 3.0 impacts on finance knowledge management systems

The Web 2.0 impacts the e-finance era [Banks 2001] where users easily share opinions and financial information anytime and anywhere. Consequently, users can collectively contribute to e-finance community and generate large content behind their virtual collaboration. As defined by T. Gruber, the true collective intelligence can be considered if the knowledge collected from all participants is aggregated and recombined to create new knowledge and new ways of learning that individual humans cannot do by themselves [Gruber 2008]. User-centric financial knowledge management systems [Leinweber 1988; Ping, Kebao 2010] try to be simple, scalable, and sensible. Also adapting different models of knowledge management [Mylopoulos 2009] to the financial information management has been an important issue to reach performance and reliability.

In addition, financial information management systems have been providing more and more user-friendly tools to support user participation in contribution, consumption and distribution of financial information. Also, financial applications have been enhanced by stronger financial software engineering based on Semantic Business Process Modeling Language [Weiss, Winkelmann 2011].

For a financial knowledge management system, including collective intelligence, functions and implementing scalability are challenging, but decision supports appear in various components [Zhang, Gu, Zhu 2009]. Personalization services include user feedback function, recommender function, financial search engine functions [Gomez et al. 2009], and mashup services. As part of user feedback functions, object of information's hit counters are represented by relative popularity.

The measurement of user participation is related to the assessment [Qihai, Tao, Tao 2008] of the financial knowledge management contents to which users contribute. Recommender functions are based on filtering technologies to link users to financial information of interest in their environment. Any semantic search engine function helps users find financial information [Gomez et al. 2009]. In addition, this function often utilizes a combination of content semantics, and context semantics (e.g. the OpenCalais project [*Open Calais Project* 2011]) based on ontologies [Sheu 2009]. Contextual services could include geolocation and semantic blogging following the approach of S. Rajbhandari et al. [2006].

Mashup services allow users to integrate financial information from multiple sources to provide an enriched experience as a part of the Semantic financial environment. Web 2.0 brings end-users together to a more interesting, interactive and collaborative space to access to and to share financial knowledge. Financial material from end-users can be connected. With this environment, private and personal interests do not limit knowledge exchange. Control of information is supported by Web 3.0-based functions [Yu 2009] as part of the semantic web trend. The control of sharing Semantic financial information can be improved as the decision for the opinions is more accurate. Combining altogether, the financial knowledge management systems have been moving from a social environment to an intelligent environment where computational finance field [Yingsaeree, Nuti, Treleaven 2010] has been enhanced.

3. Aims and components of the CIFKM platform

The target CIFKM platform broadly encompasses the collective intelligent component that enables collaborative financial intelligence management capitalizing on the functional semantic web architecture [Gerber, van der Merwe, Barnard 2008]. It enables the connection of various opinions about financial contents and related topics. Authorized users are members of the knowledge community.

The aims of our CIFKM platform are: (1) gathering financial information from multi-lingual distributed financial knowledge management systems on specific domains (e.g. private equity, stock market), (2) identifying latent semantic between financial information, (3) creating Uniform Semantic Locators, and (4) collecting end-users opinions and discussions.

The CFKIM functional platform architecture (shown in Figure 1) includes two collective intelligence components (information knowledge collecting and sharing, collective intelligence management) and two web service components (information and related knowledge delivery, multi-lingual search and browsing).

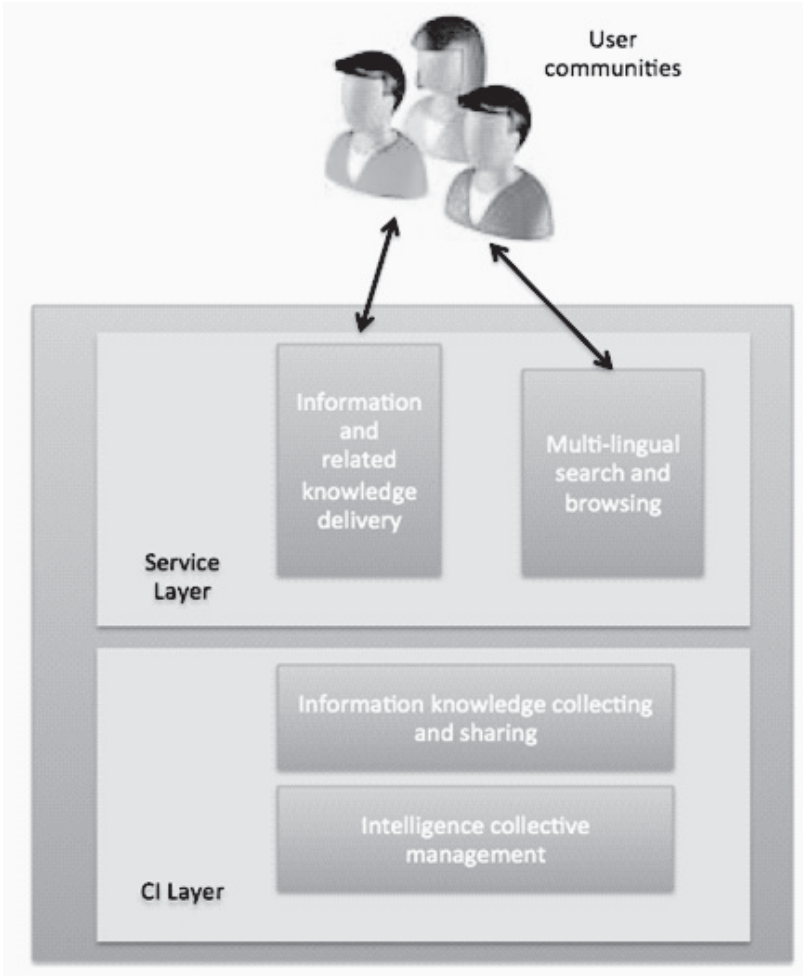

Figure 1. CFKIM functional platform architecture

For implementing the finance business logic layer, we have been using the open source Web Service Execution Environment (WSMX)[1] designed to allow dynamic discovery, invocation and composition of semantic finance web services in our CFKIM project. WSMX offers complete API support for interacting with semantic web services. In addition, WSMX supports the interaction with classical web services ensuring that a seamless interaction with existing web services (e.g. Topic Map services).

The main components of the finance logic layer as appear in Figure 2 are:

[1] http://sourceforge.net/projects/wsmx/.

(i) The Collective Intelligence (CI) Manager is responsible for the management of Collective Intelligence finance-related content to store definitions of finance web services, financial goals, finance ontologies and finance-oriented mediators.

(ii) CI Discovery and Selection. The CI Discovery service is a two-phase process. Given a requester's finance goal, capabilities of CI finance services are matched with the finance goal. A number of CI finance services satisfying the finance goal could be returned from this step, thus selection of the best or optimal CI service will be performed.

(iii) Finance data and CI Process Mediation. We introduced CI Mediators to focus on problem solving related to finance data: GG (finance Goal-finance Goal) mediators, FWFW (Financial Web Service-Financial Web Service) mediators, and WG (Financial Web Service-Finance Goal) mediators.

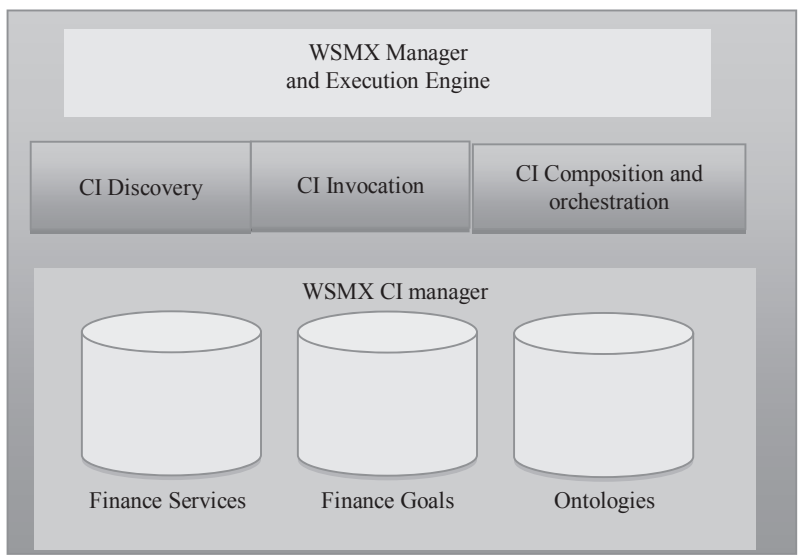

Figure 2. CFKIM Finance Logic Layer

Sharing and collecting financial information to set up collective intelligence based on opinions

Topics from the financial domain knowledge and metadata attributes (i.e., description, author, subject, title, date, and type) describing financial information are taken into account for the knowledge sharing on finance. It enables also financial semantic tracking based on previous research results of A. Kawtrakul [Kawtrakul, Yingsaeree, Andres 2007].

Each basic unit of Collective Intelligence is described by a unique semantic locator (USL) and will be classified in one of the following knowledge spheres [Andrade et al. 2006]: static knowledge, dynamic/strategic knowledge, and dynamic/tactical knowledge (see Figure 3).

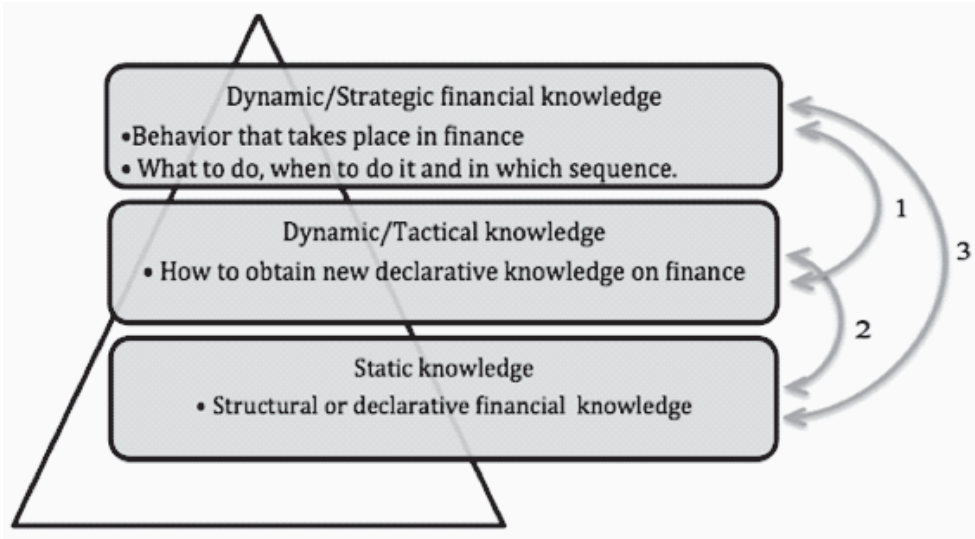

Figure 3. Knowledge spheres in finance

The strategic finance knowledge is located at the top in Figure 3, as it controls how the finance problems are dealt with. The tactical knowledge focuses on the "know-how".

On the other hand, the tactical finance knowledge needs the declarative knowledge (2), which, furthermore, is the most abundant. Tactical knowledge can be automated taking human understanding out of the loop and will enable to produce dynamic financial knowledge (1). It will help to explain reasoning to business people as it is explicitly under the control of human users enhancing their understanding.

A poll management sub-component is used to collect the different opinions and discussions on financial information. Each end-user contributor may choose to post individually his/her opinions about the target financial sub-topics. Any opinions or suggestions are committed to vote. While opinions may be different, majority votes determine the view of the communities. These features naturally realize the online collaborative works to enhance the communities on financial knowledge. The weighting polling system for each opinion can be calculated by the following formula:

$$W_{financepolling}(k) = \Sigma_{i=1,\ldots,n}\, w_{ijk}, \tag{1}$$

where: $W_{financepolling}(k)$ is defined as the total weight of $\boldsymbol{i}$ opinions related to the k-th financial topic,

w_{ijk} – the weight of the i-th opinion given by the j-th end-user about k-th financial topic.

The value w depends on the priority and agreement of the end-users. The weight from registered users, who contributes more accurate information for a long period,

will be given higher score than the new user. Each *w* is needed to update for period of time. Furthermore, if a registered member agrees with the opinion, the weight value is positive and vice versa. A set of highly weighted opinions for each topic, tends to be more believable and reliable.

Delivering financial information
In the CIFKM environment, semantic web enables a fundamental transition from pushing financial information to financial information pulling, using a new way of thinking and collaborating online.

The traditional approach has been the pulling process [Siegel 2009] based on financial information retrieval. The users can retrieve financial information when they access to the financial knowledge management system. The innovative approach is the pushing process [Siegel 2009] of financial information delivery. The CIFKM platform incorporates personalized approach to deliver new financial information to registered end-users according to their profile and topics of interest.

Searching and browsing financial information
Searching information of an object of financial information can be accomplished by two methods – i.e., simple multi-lingual keyword search and advanced search over different types of knowledge layers. It is important that a CIFKM platform provides the ability to search by multi-lingual semantic spheres. Advanced search includes faceted search to browse categories of financial information including metadata attributes and semantic features.

CIFKM statistics and personalization
Monitoring the CIFKM platform enables us to know what is happening in the ecosystem community. Two kinds of triggering are useful for this purpose. The first kind is the personal triggers that are related to information that relevant to each participant based on the number of objects of information, news and topics. The second set of triggers is related to the activities of the CIFKM community (e.g., profile updates, end-users annotations).

The personalization of services (based on inferred usage patterns) is very important for the end-users. The provision of a service personalized to the user's preferences and expected behaviour is a factor that improves user experience and therefore promotes loyalty to the user provider [Eilrich et al. 2009]. A recommendation service for Points of Interest is being implemented for the purpose of the financial CI scenario. This implementation aims at exploring the idea of using the personal and collective categories of Point of Interest as main information for user profiling.

4. The Collective Intelligence and LSI challenges

Latent Semantic Indexing (LSI) is a way to classify documents according to the latent semantics of knowledge that are present in the financial documents. The target

of LSI is not to produce an optimal representation for financial document categorization. LSI is based on the truncated Singular Value Decomposition (SVD) technique used to calculate a set of basis vectors that span the LSI space. That is, it aims to find the most representative features for document representation rather than the most discriminative ones. This means, search engines using LSI can now retrieve relevant documents – even those documents without the key phrase the searcher used. The use of LSI [Andres, Naito 2005] has proven to raise domain related search performance by up to 30 per cent. The major benefit of LSI for the end-users is the serendipity phenomenon, finding valuable financial information not sought for.

What does this mean for CI

Latent Semantic Indexing is a complement for CI. Link building, page design and keyword encrypted code will still get your rank, but not as high as it used to. With LSI, financial content will be able to be personalized according to the different types of users.

There has been a long-standing argument between various SEO copywriting providers about how important relevant content was to Page Rank. While generally agreed that good, relevant content was important on the websites themselves, there was dissension in the ranks for the pages that linked to the website.

What the creation of Latent Semantic Indexing – and its use by financial search engines [Gomez et al. 2009], what it also means is that the financial contents that are now ranked in the top five result may end up back in the middle. The effects on your ranking all depend upon what type of CI was used to boost it. However, because LSI also has the ability to tell the quality of financial content, the financial content can take a big dive. At the end, the serendipity will be optimized.

5. Conclusions

In this article, we addressed the challenges of collective intelligence management enhancing financial knowledge management system. To alleviate the challenges, we pointed out a CI-enhanced Financial Knowledge management platform named CIFKM will help to build a Financial Collective Intelligence community based on Web 2.0 and to manage the financial collective intelligence based on Web 3.0 features. For each object of financial information, its metadata are used for common access.

The CIFKM platform provides not only a mean to develop a financial collective intelligence vocabulary but is a collaborative financonomy (ontology oriented folksonomy) tool to share technical terms defined and assessed in a collaborative way. In case multiple opinions are provided, the popular vote scheme selected more preferred opinions that are used in the CI community.

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References

Alavi M., Leidner D.E. (1999), Knowledge management systems: Issues, challenges, and benefits, [in:] *Communications of the Association for Information Systems* (AIS), Vol. 1, Article 1 (February 1999).

Andrade J., Ares J., García R., Rodríguez S., Silva A. (2006), Human-centered conceptualization and natural language, [in:] C. Ghaoui (Ed.), *Encyclopedia of Human Computer Interaction*, Idea Group, Hershey 2006, pp. 280–286.

Andres F., Naito M. (2005), Dynamic topic mapping using latent semantic indexing, [in:] *Proceedings of the Third International Conference on Information Technology and Applications (ICITA'05)*, Vol. 2, IEEE Computer Society, Washington, pp. 220–225.

Banks E. (2001), *E-Finance: The Electronic Revolution in Financial Services*, John Wiley & Sons, New York.

Cheng H., Lu Y.C., Sheu C. (2009), An ontology-based business intelligence application in a financial knowledge management system, [in:] *Expert Systems Applications,* Vol. 36, No. 2, pp. 3614–3622, http://dx.doi.org/10.1016/j.eswa.2008.02.047 (accessed: 10.08.2011).

Eilrich L., Andres F., Sillaume G., and Backes M. (2009), Foresting user experience in order to improve the quality of a digital library, [in:] *Workshop on Advanced Technologies for Digital Libraries 2009*, AT4DL 2009, Trento, Italy, 8 September 2009.

Feng W., Xiao Y. (2009), A new financial management method based on knowledge management, [in:] *International Asia Symposium on Intelligent Interaction and Affective Computing* (ASIA'09), Wuhan, 8-9.12.2009, pp. 21–24.

Fui-Hoon Nah F., Siau K., Tian Y. (2005), Knowledge management mechanisms of financial service sites, [in:] *Communications of ACM*, Vol. 48, No. 6, pp. 117–123.

Garcia R., Gil R. (2010), Triplificating and linking XBRL financial data, [in:] A. Paschke, N. Henze, T. Pellegrini (Eds.), *Proceedings of the 6th International Conference on Semantic Systems* (I-SEMANTICS'10), ACM, New York, Article 3.

Gerber A., van der Merwe A., Barnard A. (2008), A functional semantic web architecture, [in:] S. Bechhofer, M. Hauswirth, J. Hoffmann, M. Koubarakis (Eds.), *Proceedings of the 5th European semantic web conference on The semantic web: research and applications* (ESWC'08), Springer-Verlag, Berlin, Heidelberg, pp. 273–287.

Gomez J.M., Garcia-Sanchez F., Valencia-Garcia R., Toma I., Moreno C.G. (2009), SONAR: A semantically empowered financial search engine, [in:] J. Mira, J.M. Ferrandez, J.R. Alvarez, F. Paz, F.J. Toledo (Eds.), *Proceedings of the 3rd International Work-Conference on The Interplay Between Natural and Artificial Computation: Part I: Methods and Models in Artificial and Natural Computation. A Homage to Professor Mira's Scientific Legacy* (IWINAC'09), Springer-Verlag, Berlin, Heidelberg, pp. 405–414.

Gruber T. (2008), Collective knowledge systems: Where the Social Web meets the Semantic Web, *Web Semantic Journal,* Vol. 6, No. 1 (February 2008), pp. 4–13, http://test.websemantics-journal.org/index.php/ps/article/viewFile/129/127 (accessed: 15.08.2011).

Hu Y. (2010), The role of marketing performance in the relationship between knowledge management and financial performance, [in:] *Third International Conference on Knowledge Discovery and Data Mining (WKKD'10)*, Phuket, pp. 436–439.

Kawtrakul A., Yingsaeree C., Andres F. (2007), Semantic tracking in peer-to-peer topic maps management, [in:] S. Bhalla (Ed.), *Proceedings of the 5th International Conference on Databases in Networked Information Systems* (DNIS'07), Springer-Verlag, Berlin, Heidelberg, pp. 54–69.

Leinweber D. (1988), Knowledge-based systems for financial applications, *IEEE Intelligent Systems*, Vol. 3, No. 3, pp. 18–31.

Mylopoulos J. (2009), Models in Knowledge Management, [in:] D. Karagiannis, Z. Jin (Eds.), *Proceedings of the 3rd International Conference on Knowledge Science, Engineering and Management* (KSEM'09), Springer-Verlag, Berlin, Heidelberg, p. 1-1.

Open Calais Project, http://www.opencalais.com/ (accessed 15.08.2011).

Ping L., Kebao W. (2010), Knowledge management in banks, [in:] *2010 International Conference on E-Business and E-Government* (ICEE'10), pp. 1819–1822.

Qihai Z., Tao H., Tao W. (2008), Analysis of Business Intelligence and its derivative – Financial Intelligence, [in:] *2008 International Symposium on Electronic Commerce and Security* (ISECS'08), pp. 997–1000.

Rajbhandari S., Andres F., Naito M., Wuwongse V. (2006), Semantic-augmented support in spatial-temporal multimedia blog management, [in:] L. Maicher, A. Sigel, L.M. Garshol (Eds.), *Proceedings of the 2nd International Conference on Topic Maps Research and Applications* (TMRA'06), Springer-Verlag, Berlin, Heidelberg, pp. 215–226.

Shakoori K.K., Mesel C. (1993), Financial information system, [in:] M. Taylor, T. Blake (Eds.), *Proceedings of the 21st annual ACM SIGUCCS conference on User services* (SIGUCCS '93), ACM, New York, pp. 93–96.

Sheu C. (2009), An ontology-based business intelligence application in a financial knowledge management system, *Expert Systems Applications,* Vol. 36, No. 2, pp. 3614–3622.

Siegel D. (2009), *Pull: The Power of the Semantic Web to Transform Your Business*, Portfolio Hardcover.

Weiss B., Winkelmann A. (2011), A metamodel based perspective on the adaptation of a Semantic Business Process Modeling Language to the financial sector, [in:] *44th Hawaii International Conference on System Sciences* (HICSS), Kauai, 4–7 January 2011, pp. 1–10.

Yingsaeree C., Nuti G., Treleaven P. (2010), Computational finance, *Computer*, Vol. 43, No. 12, pp. 36–43.

Yu Q. (2009), A new financial investment management method based on knowledge management, [in:] *Second International Symposium on Computational Intelligence and Design* (ISCID'09), IEEE Computer Society, Vol. 2, Washington, pp. 341–344.

Zhang M., Gu Y., Zhu J. (2009), Analysis of the framework for financial decision support system, [in:] *International Conference on Wireless Networks and Information Systems* (WNIS'09), Shanghai, pp. 241–244.

INTELIGENCJA SPOŁECZNOŚCI W FINANSOWYCH SYSTEMACH ZARZĄDZANIA WIEDZĄ: WYZWANIA W DOBIE EKSPLOZJI INFORMACJI

Streszczenie: Pojawienie się rozwiązań typu e-finanse oraz eksplozja informacji finansowych wpłynęły na rozwój finansowych systemów informacyjnych. Wśród tradycyjnych technik trudno znaleźć rozwiązanie pozwalające na zbudowanie samowystarczalnych społeczności, opartych na wiedzy finansowej. W celu osiągnięcia globalnej interoperacyjności semantycznej wśród systemów informacji finansowych stosuje się pojęcia semantyczne do budowania społeczności opartej na wiedzy finansowej, aby zapewnić bardziej niezawodne, przyjazne dla użytkownika interfejsy wyszukiwania i przeglądania informacji finansowych, opierając się na semantyce. Głównym wyzwaniem jest integracja inteligencji społeczności z finansowymi systemami zarządzania wiedzą. Taki system pozwoli nam m.in. łatwo zidentyfikować informacje finansowe oraz gromadzić słownictwo z zakresu finansów.

Słowa kluczowe: inteligencja społeczności, semantyka finansów, zarządzanie wiedzą, Web 2.0, Web 3.0.