

Krassimir Markov, Vitalii Velychko,
Lius Fernando de Mingo Lopez, Juan Casellanos
(editors)

**New Trends
in
Information Technologies**

I T H E A

SOFIA

2010

Krassimir Markov, Vitalii Velychko, Lius Fernando de Mingo Lopez, Juan Casellanos (ed.)
New Trends in Information Technologies

ITHEA®

Sofia, Bulgaria, 2010

ISBN 978-954-16-0044-9

First edition

Recommended for publication by The Scientific Concil of the Institute of Information Theories and Applications FOI ITHEA

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It is represented that book articles will be interesting for experts in the field of information technologies as well as for practical users.

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Printed in Bulgaria

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ISBN 978-954-16-0044-9

C\o Jusautor, Sofia, 2010

SYSTEMOLOGICAL CLASSIFICATION ANALYSIS IN CONCEPTUAL KNOWLEDGE MODELING

Mikhail Bondarenko, Nikolay Slipchenko, Kateryna Solovyova,
Viktoriia Bobrovska, Andrey Danilov

Abstract: *It is difficult to exaggerate the importance, the urgency and complexity of “good” classifications creation, especially in knowledge management, artificial intelligence, decision making. To what extent it is possible within a short paper, the peculiarities and advantages of the new system method of the systemological classification analysis for the classifications of concepts creation were discussed. It is noted that the systemological classification analysis on the basis of the natural classification improves considerably the quality and the power of the classification knowledge models and ontologies, allows taking into account the deep knowledge of any, including ill-structured, domains. In the process of the research conduction the system models of the domain fragment of the ontologies on the basis of the parametric classification were created. Some results of the actual domain “Social Networks in Internet” analysis and modelling and the ontology fragments, realized in the ontologies engineering tool Protégé 3.2, are also considered. The systemological classification analysis application has allowed proving the obtained classifications of social networks functions, taking into account the objects essential properties. It has also successfully recommended itself for deep knowledge acquisition; the basic hierarchy of classes, “good” classifications and ontologies creation; possesses predictive power, simple logically relevant structure, ensures the possibility of the correct inference on knowledge.*

Keywords: *conceptual knowledge, knowledge systematization, natural classification, ontology, systemological classification analysis, social network, hierarchy, systemology, artificial intelligence.*

ACM Classification Keywords: *1.2 Artificial Intelligence – 1.2.6 Learning: Knowledge Acquisition*

Introduction

The development of knowledge management, artificial intelligence, decision making and many other actual scientific and practical directions is determined by knowledge and its quality. As we know, knowledge, intellectual capital is the main competitive advantage, the foundation of modern organizations, enterprises, society, human and nations' welfare and important component of decision making support systems.

In different spheres of knowledge acquisition and application conceptual models of subject domains (and of problem domains – in the terminology of E. V. Popov) play a leading role. "Historically," the species of domain models are: dictionaries, thesauri (in linguistics), conceptual models (infological, semantic models - in databases), UML diagrams (of classes, of use cases, ... - in object-oriented analysis and modeling), models of knowledge (semantic nets, frames, ... - in artificial intelligence), ontologies (from the viewpoint of the realization and application one of the most modern kind of a domain model, aimed primarily at the knowledge application in Internet).

The basis of such models is the relationships of the hierarchy between concepts (concepts classification), in the first place, the relations *genus-species* and *part-whole*, about two millennia known in formal logic. These relations in the theory of classification are called the relations of *taxonomy* and *meronomy*, in artificial intelligence – *genus-species*: *Isa* (class - class), *Instance-of* (class - element) and *part-whole*: *Part-of*; in object-oriented analysis and modeling – *generalization / specialization* and aggregation (in some cases, *composition*), respectively, etc. In

systemology to these relations corresponds one relation of the support of the functional ability of the whole, respectively, for system-classes and concrete systems (which are reflected in general and single concepts).

How effective are the methods of the concepts classification creation - the basis of modern models of knowledge of domains? The analysis shows that in most domains the classifications are subjective; many of them do not meet even the requirements of formal logic. That is why it is proposed to apply a new unique method of the systemological classification analysis based on the natural classification [E. A. Solovyova, 1999; E. A. Solovyova, 1991; E. A. Solovyova, 2000], which has successfully recommended itself for deep knowledge acquisition, the basic hierarchy of classes, "good" classifications and ontologies creation in all, including ill-structured domains.

Introduction to the Systemological Classification Analysis on the Basis of the Natural Classification

As noted, this work is not about data classification into existing classes. We work with knowledge classifications and besides with the conceptual deep knowledge, on the conceptual level, determine classes (entities), properties and relations, and besides in accordance with their position in the domain, in the reality, in accordance with the systemic of the reality. Naturalists and other scientists interested for many centuries in the problem of "good" classification creation, *the position of objects in which reflects the reality (the domain), is determined by essential properties and relations of objects* and therefore possessing predictive power. This "good" classification was called systematics, or the natural classification, the first meaningful criteria of which were introduced by the Englishman Wavell more than 150 years ago; then by A. A. Liubishchev, Y. A. Schrayder and other scientists, for example, the natural classification - *is a form of the laws of nature presentation..., expresses the law of the systems of reality relationship, allows to reach the maximum number of goals, because it takes into account the essential properties, etc.* Such criteria are useful for fundamental science, but are not constructive for computer modeling, application in knowledge models and ontologies. That is why in Knowledge Acquisition Laboratory and at the Social Informatics Department for more than 20 years the systemic research of conceptual knowledge and natural classification has been conducted. For the first time the constructive criteria of the natural classification and a new method of systemological classification analysis which allow to take into account deep knowledge, objects essential properties and relations in domain models in the most objective way, have been obtained [E. A. Solovyova, 1999; E. A. Solovyova, 1991; E. A. Solovyova et al; 2000, E. A. Solovyova, 2000, etc.]. This method for the first time synthesizes system and classification analysis. The natural classification criteria correspond completely to the formal-logical criteria and also deepen and generalize them.

These fundamental results have not only theoretical but also an important practical value. They allow creating knowledge models and ontologies which take into account essential properties and causal-investigative relations, possess predictive power, simple logically relevant structure, allow generalization and unlimited knowledge refinement without redesigning classification, ensure the possibility of the correct inference on knowledge, recommendations and decisions making support, interface with the concepts of natural language application.

It is proved mathematically and systemologically and (with the use of the category theory and the categorical-functorial model of the natural classification obtaining) that the natural classification is the parametric one (including properties of all its elements), in which the properties classification determines (isomorphic) the objects classification, the properties properties classification – deep layer properties – the properties classification, etc.). In practice, the consideration of one level of properties (their genus - species classification) allows making the classification model founded and really effective for solving on its basis the various tasks that require knowledge application.

Functional systemology - the systemic approach of the noospheric stage of science development – was created for and is aimed at complex, qualitative, ill-structured problems solving, it differs profitably from the traditional

systemic approaches and for the first time really takes into account the systemic effect. Systemology, taking into account the principles of systemic, integrity and diversity, considers all objects, processes and phenomena as systems functioning to support the supersystem functional abilities. Systemology as modern system methodology does not regard system as a set but as a functional object which function is assigned by supersystem. Systemology in particular allows overcoming problems of traditional methods of system analysis at the expense of using conceptual knowledge as well as formalizing procedures of analysis and synthesis of complex systems and creating knowledge-oriented software tools for their simulation. The development of the concrete (internal) systems systemology of G. P. Melnikov for the system of classes allows deep knowledge getting and modeling for all, including ill-structured, domains [Bondarenko et al, 1998; E. A. Solovyova, 1999].

Ontologies Analysis Fragment

Ontologies is the subject of interest in intelligence technologies, diverse research areas as there are applications of ontologies with commercial, industrial, academical and, many other focuses [N. Guarino, 1996]. They are used within a great number of domains, in this paper - in the domain "Social Networks" and accomplish many various tasks. As ontologies is the sphere of interest for numerous researchers and practitioners there are many definitions of the term "ontology" itself. The different aspects appearing in different ontologies definitions are mainly caused by the concrete ontologies applications within concrete problem domains, that is by the tasks for accomplishing of which the ontologies are created. The following ontology definition proposed by Gruber is considered as the most cited one: "ontology is a formal, explicit specification of conceptualization" [M. Auxilio, M. Nieto, 2003].

The diversity of ontologies tasks and applications causes, for its turn, the absence of a single ontology classification. This fact determines the need of the domain "Ontologies" research by means of the systemological classification analysis. The considered method usage allows, in particular, to evaluate each classification from the viewpoint of its validity, reflection of the objects essential properties in it, the possibility of the objects properties detection and prediction according to their place in the classification, from the viewpoint of the possibility of the classification application as a tool for theoretical analysis in the correspondent domain [E. A. Solovyova, 1999].

The existing ontologies classifications are numerous and various. This is explained by the fact that different researchers choose different division bases when they create their classifications. The analysis of the ontologies classifications by means of the systemological classification analysis involves the essential properties of the ontologies revelation in order to determine their place in the Natural Classification (NC) and to connect these properties with the supersystem functional query. To find the supersystem functional query it is necessary to answer the question "What ontologies are needed for?". The ontologies are used for knowledge representation in many different domains. The analysis of the mentioned above division bases used for ontologies classification shows that the division bases must take into account the ontologies functional aspect. The use of another division bases (for example, connected with the structural aspect) will not allow creating the ontologies classification corresponding to the NC criteria. The use of the systemological classification analysis allows taking into account the essential properties of the considered ontologies during the knowledge systematization about them. The ontologies classifications analysis shows that there are two main types of the division bases proposed to classify the ontologies. They are: division bases reflecting the functional aspect of the ontologies, division bases reflecting the structural aspect of the ontologies. The analysis of the ontologies classifications by the division bases reflecting the functional aspect has given the following results: 1) the division bases declared by the authors often do not coincide with the real division bases; 2) the concepts definition rules of the formal logic are often violated; 3) the ontologies essential properties often are not taken into account (it concerns some ontologies classifications by the functional aspect and all the ontologies classifications by the structural aspect).

In the process of the research conduction the system models of the ontologies structure such as ontologies parametric classification fragment, semantic nets were created. The obtained version of the ontologies ontology was realized in Protégé 3.2 in the form of a frame net.

The full results of this research have been reported on the conferences and their fragment has been included into the research work for the examination in the course Knowledge Management – Knowledge Technologies (Social Informatics Department, KhNURE and Stockholm University) in 2010.

Social Networks Functions Classification

The conceptual knowledge modelling will be accomplished on the example of the actual domain of **social networks, including the ontology creation**. Nowadays the need to solve complex problems requiring the knowledge of the domain specialists appears increasingly. To train highly qualified professionals progressive companies propose to use the conception of learning organizations. A learning organization as a tool for solving problems related to the company professional level improving. To create and acquire knowledge the company needs to be constantly in the process of self-improvement. One of the advanced methods of the organization development is the social networks use. The social networks in Internet functions research will allow understanding better the expediency of their use, to use the social networks more effectively in decision making, for further knowledge systematization in the social networks domain.

Resulting from the research the developed social networks classifications were not found. There are several articles where the social networks in Internet functions but not their classifications are mentioned. For example, the following main functions of social networks in Internet are allocated:

- profiles, communities, blogs dogear, activities [Byelenkiy, 2008];
- functions of personal profiles creation, of users interactions, of common goal achieving by means of the cooperation, of resources interaction, needs satisfaction due to the resources accumulation [Kuzmenko, 2009].

The analysis shows that in the first division base, for example, the communication (messages interchange) functions class is absent. In the second division base the search functions are absent and it is also not clear what is meant by the functions of common goal achieving by means of the cooperation. The authors of the given divisions do not exemplify the functions which refer to the classes of these divisions.

Thus, the knowledge systematization in the domain of social networks is needed. Subsequently it will allow not only to obtain the social networks ontology but also to improve the considered nets from the functional viewpoint, to expand the set of their functions, to improve the meaningful placement of the menu functions in concrete social networks. The results of the social networks systematization may be applied for a new social network creation taking into account the advantages and disadvantages of the existing social networks.

In this case we consider the classification creation by the functionality as the knowledge systematization in the given domain [Solovyova, 1999]. The advantage of the proposed classification of the social networks in Internet functions is that it includes the functions considered in popular social networks «В Контакте.ру» (<http://vkontakte.ru>), «Википедия» (<http://ru.wikipedia.org/wiki>), «Мой Мир» (<http://my.mail.ru/mail>), «Connect.ua», «МойКруг» (<http://moikrug.ru>), «Science-community.org».

For these networks the functions classifications by the relation "part - whole" were created that has given the possibility to develop the recommendations or the meaningful placement of the menu functions of the social networks according to the requirements of systemology and formal logic. As an example, in Figure 1 our recommended classification of functions of the first level of hierarchy by the relation "part-whole" for the social network of scientists «Science-community.org», implemented in a software tool Protégé 3.2, is shown.

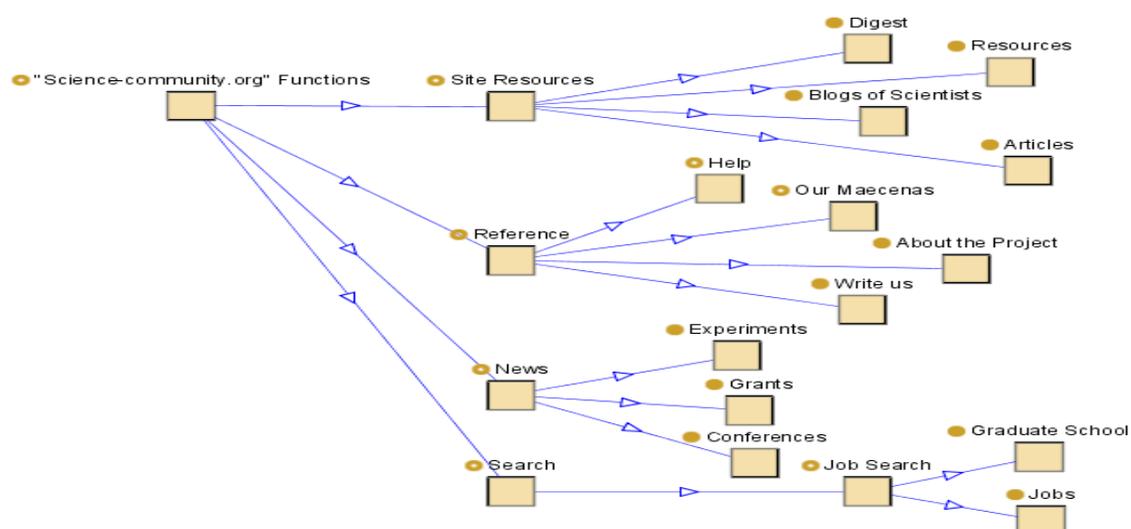


Figure 1. Recommended classification of the functions of the first level of the hierarchy for the social network «Science-community.org» by the relation «part-whole»

The systemological classification analysis application has allowed justifying the obtained classifications of social networks in Internet, to take into account the objects essential properties in them. This classification gives the possibility to detect and predict the objects properties by their position in the classification, i.e. from the viewpoint of the possibility to apply the classification not only as an effective practical tool but also as a tool of the theoretical analysis in the correspondent domain.

The use of the systemological classification analysis allows formulating recommendations for the hierarchical structure of functions implementation in the social network, for their meaningful placement in the menu in accordance with the created classification. Such natural placement will allow to reduce significantly the load on the user, will improve his work, networks and the principles of their functioning mastering.

The obtained classifications of the social networks in Internet functions allow to determine easy which class this or that concrete function of social networks refers to with which the user may meet while working with social networks in Internet. The greatest number of functions refers to the functions of "search" and "work with network resources," the functions of "communication" are also important. This classification of the social networks in Internet functions can be viewed as a parametric (including the classification of properties) one, because the classes functionality is seen from their names. Resulting from the functions of various social networks research the functions classification fragment, shown in Figure 2, was built. The created classification fragment allows determining to which class refer the functions of the first level of the hierarchy of the social networks: «В Контакте.ру» (<http://vkontakte.ru>), «Википедия» (<http://ru.wikipedia.org/wiki>), «Мой Мир» (<http://my.mail.ru/mail>), «Connect.ua», «МойКруг» (<http://moikrug.ru>), «Science-community.org». The functions search was done by means of the practical use of a concrete function to verify its functionality. First the functionality for each concrete function was determined, and then the function appurtenance to the concrete class was determined. The obtained fragment of the classification «social networks functions» was realized in the software tool Protégé 3.2. is shown in Figure 2. This software tool was chosen due to a number of advantages [Shcherbak, 2008, etc.].

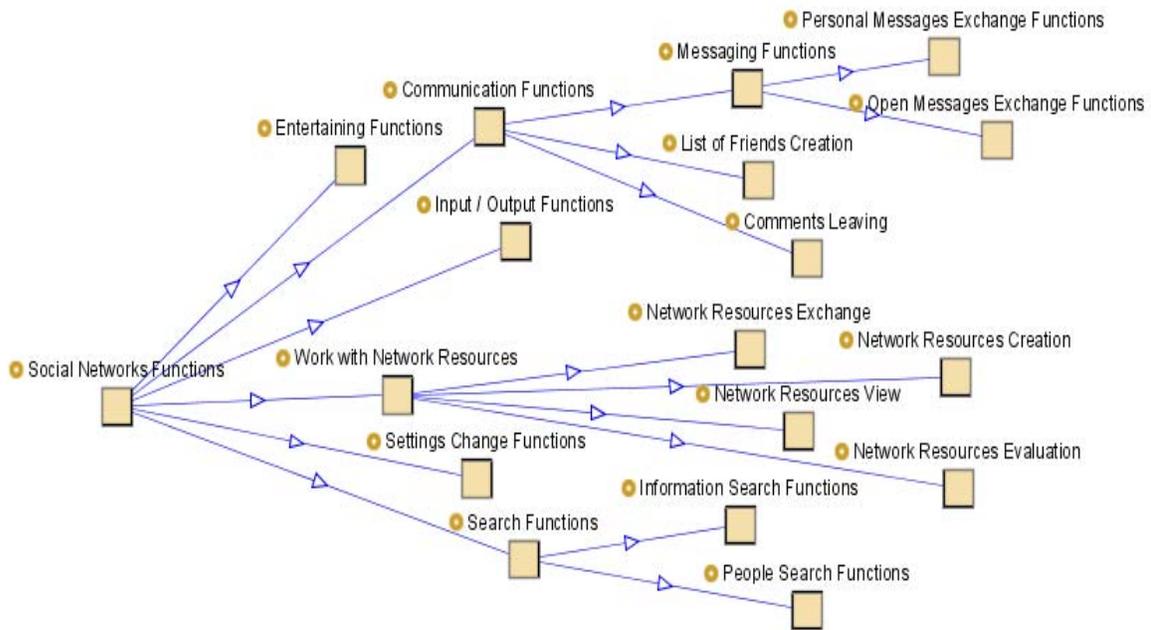


Figure 2. The fragment of the social networks in Internet functions classification by the functionality, realized in the software tool Protégé 3.2.

The obtained fragment of the social networks in Internet functions classification will allow becoming faster familiar with the functions of social networks in Internet, to choose more effectively the social network for registration, taking into account the functionality of the social network. The obtained results should be used for further knowledge systematization in the field of social networks in Internet.

Use of the Systemological Classification Analysis in the Social Networks Construction

Increase of the social networks in Internet influence of on the society has convinced many people to use social networks in business. Large corporations can afford to order a strong social network from firms of developers, but creation of such a network will require a lot of money. The enterprises (low-budget organizations) with a small income have not such a possibility, they may or attempt to use already functioning network or to attempt to create a social network by themselves. The latter variant is more advantageous, as the company itself regulates who will be the participant of the network, what tasks the social network must solve within the organization, etc. To create a social network in Internet it is necessary to use software for social networks creating.

Nowadays Internet is filled with a variety of software for the own social network creation. Many of them paid and (or) require deep knowledge in programming. There is also a number of software proposing to create a social network for free. This software proposes some free set of functions for a simple social network creating, there is also the possibility to use the supplement paid services.

The analysis of the software «Socialtext», «IBM Lotus Connections», «Jive SBS», «СвояСеть», «Connectbeam», «Ning», «Taba.ru» allows to make the conclusion that «Ning» (<http://www.ning.com/>), «Taba.ru» (<http://taba.ru/>), «СвояСеть» (<http://svoyaset.ru/getform.html#>) are the most acceptable for writing the recommendations to the social networks creation. They are conditionally free and do not require deep knowledge in programming. The disadvantage of the program service «Ning» is the absence of the interface in Russian. This

disadvantage is significant for the recommendations to the social networks creation. In connection with it the software «Табa.ru», and «СвояСеть» were chosen. While creating the social network in «Табa.ru» it is recommended to use the social networks in Internet classification fragment shown in Figure 2.

In the process of writing recommendations the alternative menu creation of the social network has been tested using the systematological classification analysis. The social networks functions alternative menu created taking into account the results mentioned above was maximally approximated to the menu corresponding to the formal logic and systemological classification analysis. Unfortunately, the considered designers have the limited functionality and do not allow applying fully the results of the conducted research. In the process of work guidelines and recommendations to social networks creation in Internet in the software «Табa.ru», «СвояСеть» have been developed, the shortcomings and benefits of a social network creation in the selected designers have been revealed, as examples the demoversions of social networks in each of the designers have been created.

The proposed results of the social networks may be used in the process of a learning organization creation, for decision making, intelligence technologies and artificial intelligence development.

Conclusion

The classifications of concepts are the basis of each science and are applied for solving various scientific-practical tasks. Now the classifications has got “the second birth” and are an integral element of ontologies, computer models of knowledge, object-oriented analysis and modeling, intelligence technologies, knowledge management, decision making and artificial intelligence, etc. That is why the role and the necessity of “good” classifications of concepts have increased even more. Systemology application has allowed synthesizing system and classification analysis, discovering new criteria of systematics (natural classification) and their applying for knowledge systematization in any domain. The results of the systemological research partially included in the paper may be used for the further knowledge systematization, creation of more effective alternative menus, etc.

Acknowledgements

The paper is partially financed by the project **ITHEA XXI** of the Institute of Information Theories and Applications FOI ITHEA and the Consortium FOI Bulgaria (www.ithea.org, www.foibq.com).

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Authors' Information

Mikhail Bondarenko – Rector of Kharkov National University of Radio Electronics, Corresponding Member of the National Academy of Sciences of Ukraine, Lenin Ave., 14, Kharkov, 61166, Ukraine; e-mail: rector@kture.kharkov.ua

Major Fields of Scientific Research: Intelligence Technologies, Information and Knowledge Management, System Analysis, Artificial Intelligence, Decision Making, Knowledge Research and Application, Natural Language Processing, Knowledge and Natural Language Modeling, Business Intelligence, Competitive Intelligence, Modern (e-) Learning, Knowledge-Based Systems and Technologies, Systemological Analysis.

Nikolay Slipchenko - Chief of Scientific Department, Kharkov National University of Radio Electronics, Professor, Doctor of Technical Sciences, Lenin Ave., 14, Kharkov, 61166, Ukraine; e-mail: slipchenko@kture.kharkov.ua

Major Fields of Scientific Research: System Analysis, Intelligence Technologies, Information and Knowledge Management, Modern (e-) Learning, Competitive Intelligence, Knowledge-Based Systems and Technologies, Artificial Intelligence, Decision Making, . Systemological Analysis.

Kateryna Solovyova - Chief of Social Informatics Department and Knowledge Management Center, Professor, Doctor of Technical Sciences, Kharkov National University of Radio Electronics, Lenin Ave., 14, Kharkov, 61166, Ukraine; e-mail: si@kture.kharkov.ua

Major Fields of Scientific Research: Knowledge Classification, Systematization, Elicitation, Acquisition and Modeling, Knowledge Management, Ontological Engineering, Systemological Analysis, Knowledge Research and Application, Decision Making, Knowledge-Based Systems and Technologies, Artificial Intelligence, Business Intelligence, Modern (e-) Learning, Competitive Intelligence, Cognitive Modeling.

Viktoriia Bobrovskia – Social Informatics Department, Kharkov National University of Radio Electronics, MA Student, Lenin Ave., 14, Kharkov, 61166, Ukraine; e-mail: si@kture.kharkov.ua

Major Fields of Scientific Research: Knowledge Modeling, Ontological Engineering, Competitive Intelligence, Decision Making Support, Artificial Intelligence, Knowledge Research and Application, Knowledge Management, Modern (e-) Learning, Intelligence Technologies, Systemological Analysis

Andrey Danilov – Social Informatics Department, Kharkov National University of Radio Electronics, MA Student, Lenin Ave., 14, Kharkov, 61166, Ukraine; e-mail: si@kture.kharkov.ua

Major Fields of Scientific Research: Social Networks, Ontological Engineering, Competitive Intelligence, Decision Making, Intelligence Technologies, Knowledge Research and Application, Knowledge Management, (e-) Learning, Artificial Intelligence, Systemological Analysis.