CONCEPTUAL KNOWLEDGE MODELING ON THE BASIS OF NATURAL CLASSIFICATION

Mikhail Bondarenko, Kateryna Solovyova, 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 extend 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 applying of the natural classification criteria 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 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 functional ability of the whole support*, 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 Natural Classification as the Conceptual Knowledge Systematics

As noted, this work is not about data classification into existing classes. We work with deep 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, at the Social Informatics Department and Scientific-Educational Knowledge Management Center 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 poperties – 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].

Social Networks Functions Classifications

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 developped 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 functions research was conducted through the practical use of the network with identifying semantics the functions during the direct work with the network. Due to the weak structuring of the domain and the distinguished functions names in different networks, which in practice often have the same functional destination in most networks, it was necessary to undergo the registration process (or just to come into the network workspace) and to use practically the social network functions to determine their real functional destination. Also during the analysis process, the difficulties have appeared due to not clearly defined functions names, which haw required the additional research and the functions comparative analysis conduction [Danilov, 2010].

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].

Let us consider the comparative analysis of the existing classification functions and the proposed network supposed systematics.

As an example of the hierarcy first level of the social network "В Контакте.ru" functions classification, implemented in the software tool Protégé 3.2. (see Figure 1) is presented.

The created classifcations are implemented in the software tool Protégé 3.2. The choice of this software tool is grounded by the fact that it is a free, open-source ontology editor. Protégé has an open, easy spread architecture at the expense of the functionality extension modules support which are freely available on the Protégé official site. The knowledge model is an OKBC-compatible (Open Knowledge Base Connectivity – it is the application programming interface for the access to knowledge bases), this allows applying in Protégé the one customized interface for different semantic markup languages processing. An example of such language is OWL (Web Ontology Language). All the listed above possibilities of Protégé, as well as the visibility of the obtained classifications was the reason for using namely this software tool.

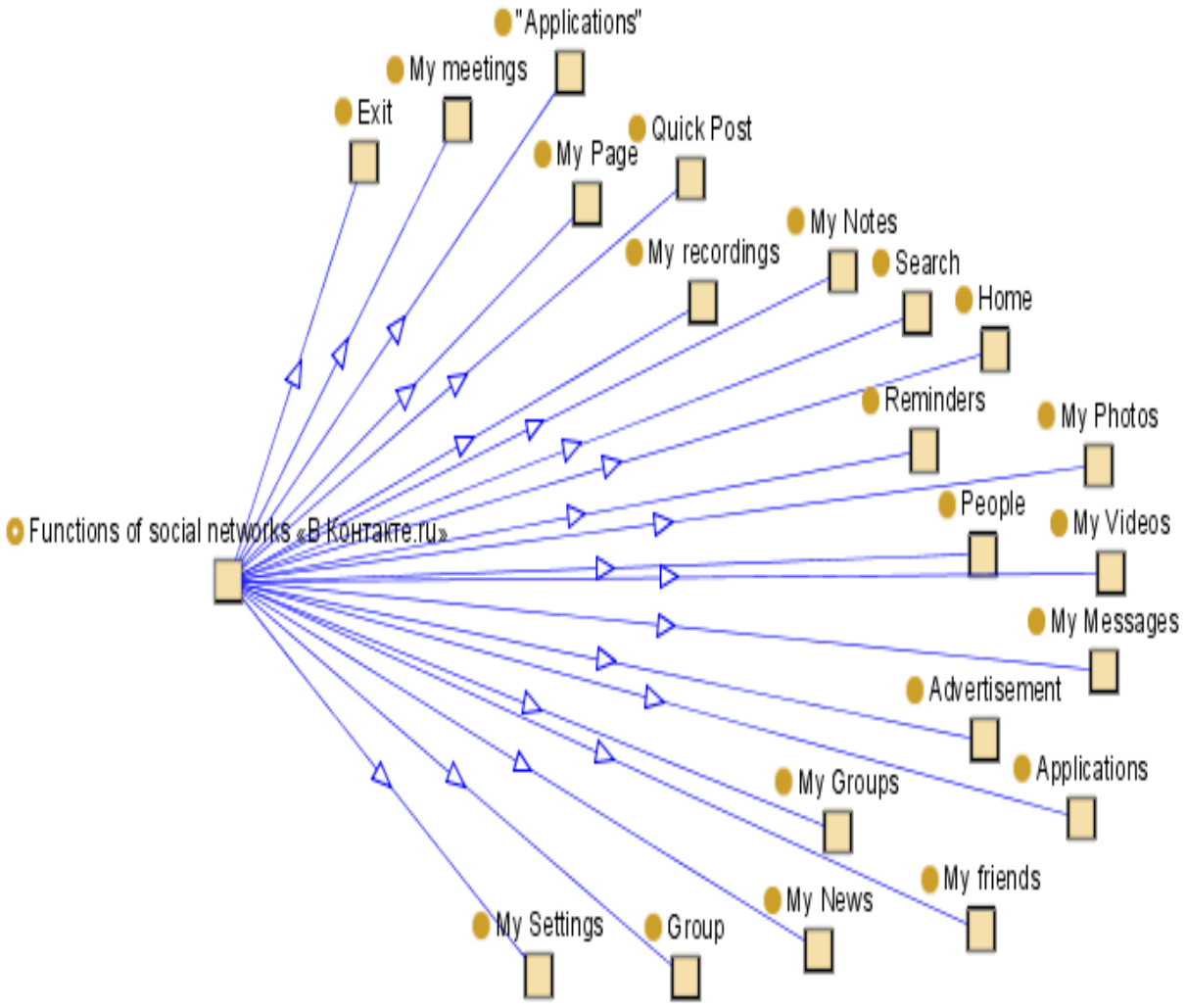

Figure 1. The social network «В Контакте.ru» functions of the first classification level.

The recommended informative placement of the functions of the first level of the hierarchy, taking into account the systemological classification analysis use and the natural classification criteria, is shown in Figure 2. The functions placement is understood as their placement in the networks workspace. The informative placement is understood as the functions structure their hierarchy in the social network menu. Our informative placement displays the functions relationship taking into account the knowledge systematization and the relations semantics between them in the best possible way.

Resulting from the analysis it was proposed to divide all the functions of the first level of the hierarchy on such groups: user information, my data, my messages, search and the function of input/output from the network workspace. Such functions placement will allow reducing the load on the user and speeding up the process of the needed function search, as it reflects the functioning of the whole support ability relation. The substantial functions placement in the social networks proposed, as the result of the conducted functions system analysis, will facilitate the functions search for the social network new users, will reduce the sense loading on the user when working with the network, by reducing the number of functions on the same level of the hierarchy.

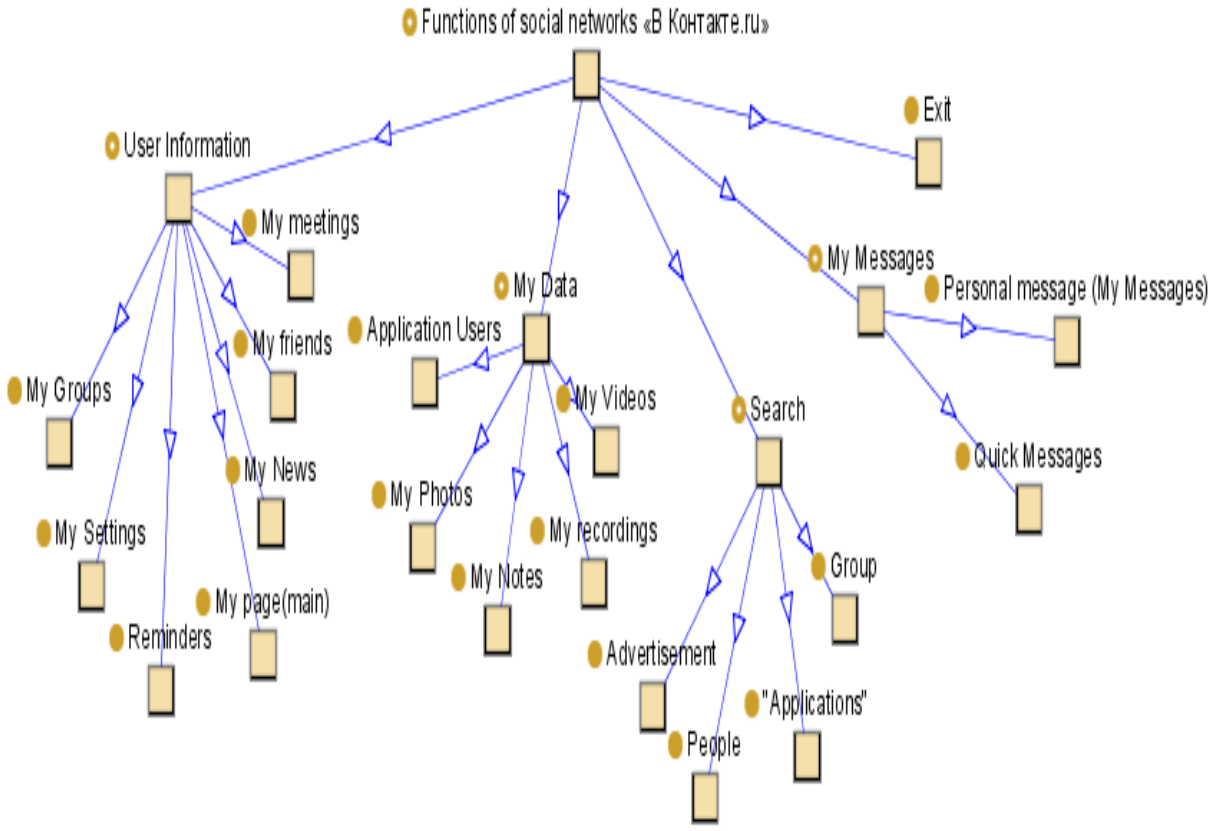

Figure 2. The social network "В Контакте.ru" systemological informative functions placement.

Also the knowledge systematization in the social networks specific functions will help to systematize the knowledge in the domain of the considered social networks in the Internet. After analyzing the social networks functions classification, created in the process of work, it was found that most social networks have a number of similar functions. In most cases, the functional destination coincided fully, and the functions differed significantly, for example, the function "Work with groups" appeared under the name "Groups", "Communities", "Groups and discussions".

The created functions classification reflects the semantics of the functions and of the relations between them, as well as the results of the knowledge systematization in the social networks in the Internet domain. Increasing the levels of the hierarchy in the functions classification, shown in Figure 2, allows finding the needed function faster, increasing the user convenience, accelerating the further functions menu development. Such analysis of the considered social networks functions allows creating the recommended functions classifications for each of them.

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.ru» (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 of the functional ability of the whole support* 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 3 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.

The systemological classification analysis application has allowed justifying the obtained classifications of social networks in Internet, to take into account the objects essential properties of 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 are seen from their names. Resulting from the functions of various social networks research the functions classification fragment, shown in Figure 4 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.ru» (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 4. This software tool was chosen due to a number of advantages [Shcherbak, 2008, etc.].

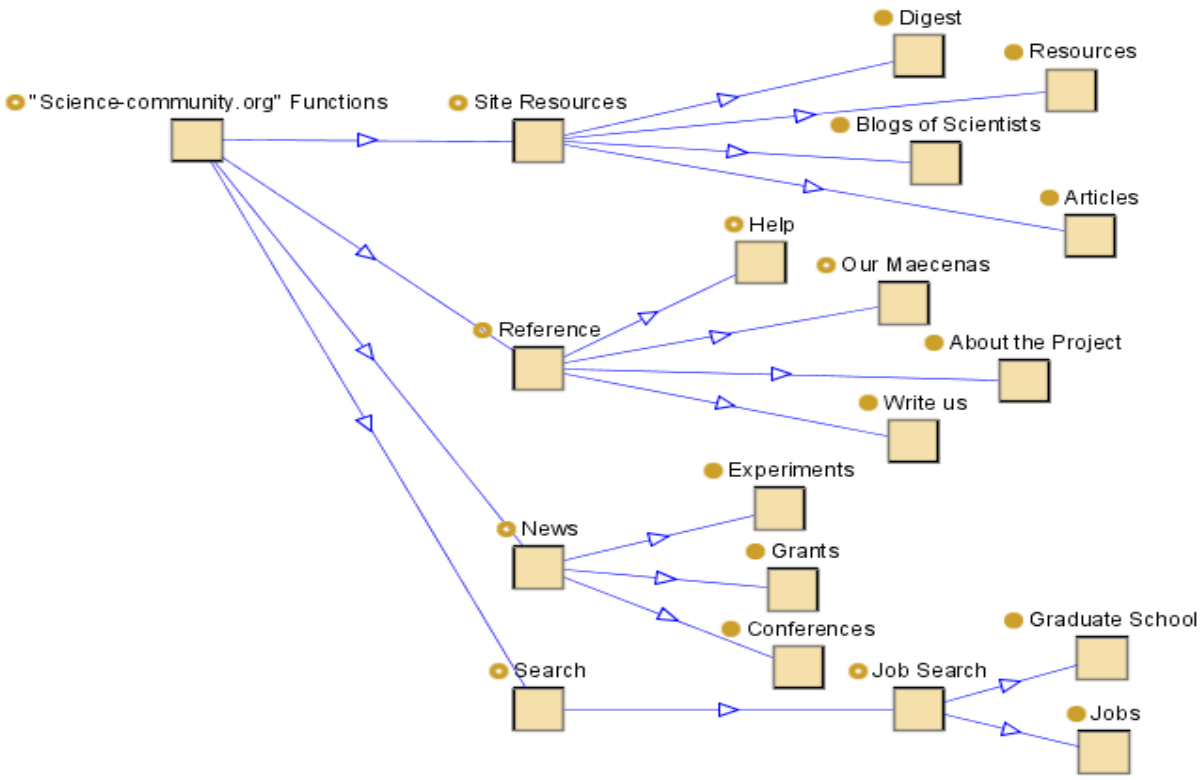

Figure 3. Recommended placement of the functions for the social network «Science-community.org»

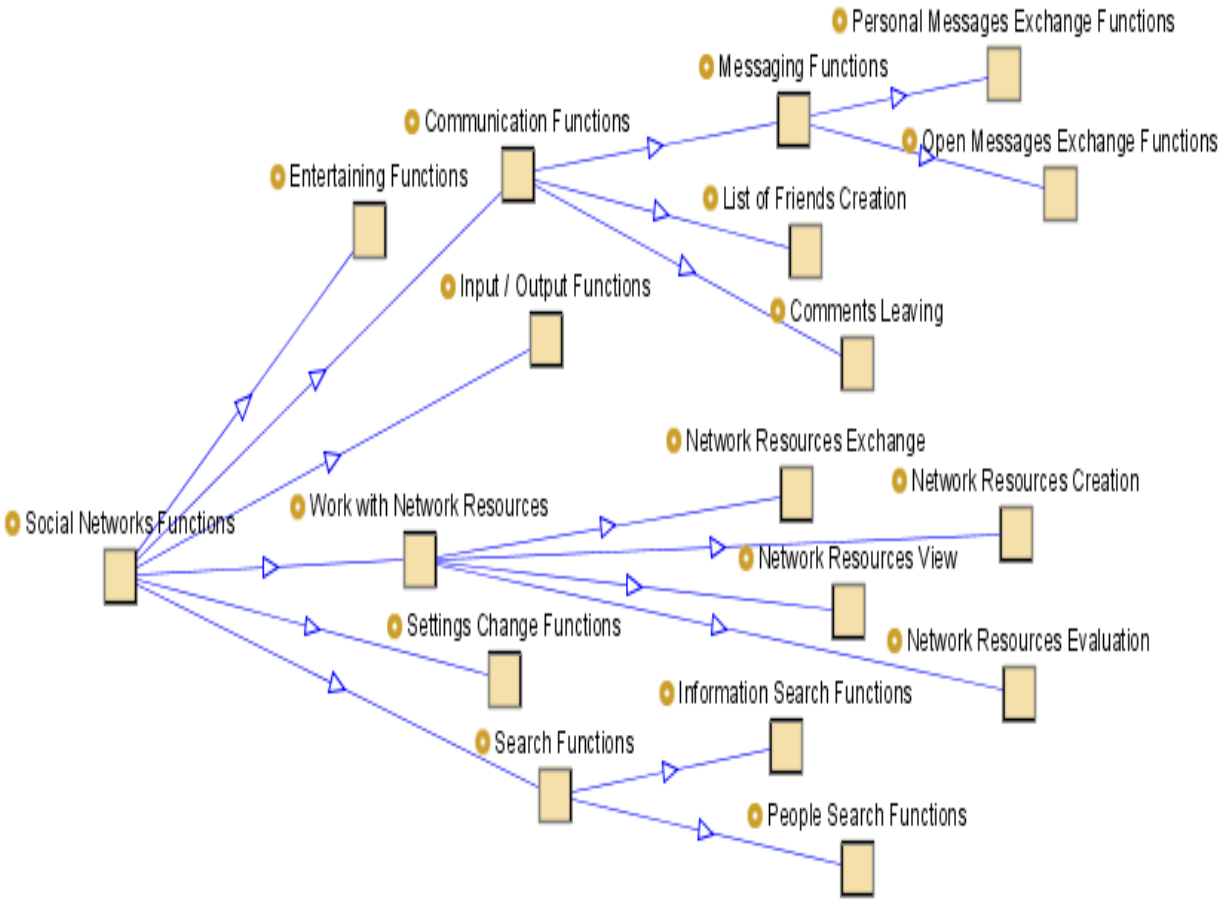

Figure 4. The social networks functions fragment classification by the relation of the functional ability of the whole support.

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.

The use of the method of systemological classification analysis allows obtaining new deep knowledge and systematizing knowledge in any domain in the most adequate and objective way taking into account the substantial properties and relations. The use of the systemological classification analysis allows evaluating the validity of any knowledge classification, the objects essential properties reflection in it; predicting new objects based on their properties.

Systemological research of social networks will allow systematizing knowledge in the social netwoks in the Internet domain and defining the appropriateness of various functions use in this or that social network, in a concrete organization.

Systemological Classification Analysis Application 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 «Taba.ru», and «СвояСеть» were chosen. While creating the social network in «Taba.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 «Taba.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.

Model Creation of Knowledge Dissemination in an Organization with a Help of a Social Network

Despite the widespread of social networks in Internet, the models of knowledge dissemination in an organization by means of social networks sites have not been found. There is a number of articles describing the use of social networks for the social capital creating and using but there are no models of social networks implementation in an organization for knowledge dissemination and the employees' intellectual capital enhancing. The model creation of knowledge implementation and dissemination in an organization will allow increasing the organization competitiveness and solving such important practical tasks as the social networks implementation process acceleration, improving their functioning effectiveness and facilitating the process of knowledge acquisition and dissemination in the social network space by the employees.

When choosing a social network it is necessary to take into account several factors, such as the creation goals, the project budget, the tasks which will be solved by means of the social network, the expected users' range. The informational business model of a social network choice, aimed at the concrete organization problems solving, will help to facilitate the process of choosing a social network.

Systemology and the systemological classification analysis on the basis of Natural Classificaton application in social networks will allow increasing the functioning effectiveness of the fuctional menu and the functioning effectiveness of social networks, the networks implementation, facilitating the new functions implementation. Using the knowledge obtained during the social networks functions classification creation, the informational business model(Figure 5) describing the process of a social network in the Internet choice and development for increasing the organization competitiveness. This model realised in BPWin and describes the main processes in the organization when choosing and creating a social network (the definition of the goals and tasks solved by the social network; the means and the software tool for creating the social network choice; a brief description of the processes associated with the immediate introduction of a social network in operation, of the ways of promoting the social network use by the employees).

In the future it is planned to develop the business model of social networks application in the Internet for knowledge management. The model will include the methods of exchanging both explicit and tacit knowledge of knowledge that will allow to increase the effectiveness of the social networks sites application in the organization for knowledge management.

The use of the created informational business model will allow facilitating and accelerating the Internet social networks choice and implementation process in the company and minimizing changes necessary for the effective functioning of the social network in the Internet; will allow reducing costs during the social network in the Internet creation and use.

The results of the work can be used as recommendations for the construction or choice of a social network by the organization for increasing its competitiveness, strengthening the relationships between the employees

(increasing the social capital), increasing the intellectual capital of the employees and of the company on the whole.

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.

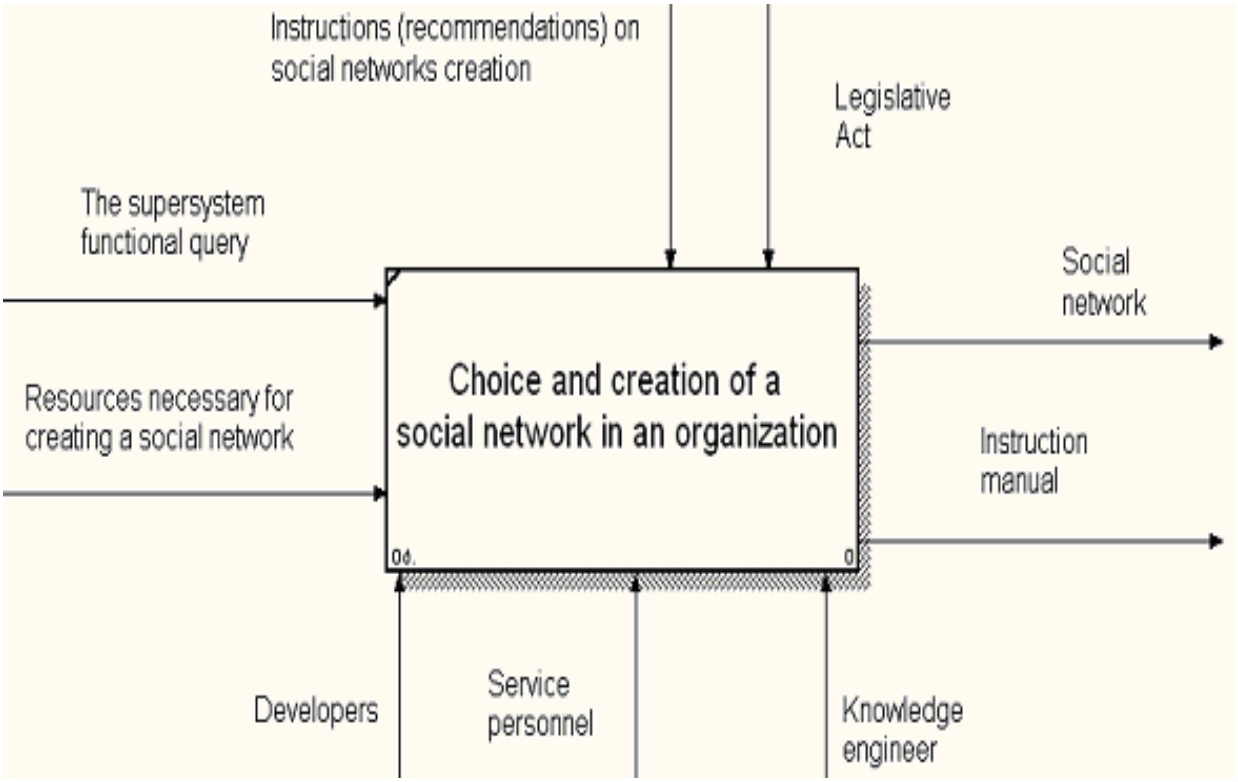

Figure 5. Context diagram of the informational model of the social network selection and creation in the organization.

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 main element of ontologies, computer models of knowledge, object-oriented analysis and modeling, intelligence technologies, knowledge management, decision making support and artificial intelligence, etc. That is why the role and the necessity of "good" classifications of concepts have increased now 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 Natural Classification criterion has been successfully used during the new method of the systemological classification analysis application. 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, natural language processing, etc.

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