[Witten and Frank, 2000] I. Witten and E. Frank. Data Mining: Practical Machine Learning Tools and Techniques with Java Implementation. Morgan Kaufmann.

[Zadrozny and Elkan, 2001] B. Zadrozny en C. Elkan. Obtaining calibrated probability estimates from decision trees and naive Bayesian classifiers. Department of computer science and engineering, University of California.

Authors' Information

Prof. Dr. Koen Vanhoof – Universiteit Hasselt, Campus Diepenbeek, Departement BEDR/VEBI; Agoralaan gebouw D, B3590 Diepenbeek, Belgium; e-mail: koen.vanhoof@uhasselt.be

Sabrina Noblesse – Universiteit Hasselt, Campus Diepenbeek, Departement BEDR/VEBI; Agoralaan gebouw D, B3590 Diepenbeek, Belgium

THE STAPLE COMMODITIES OF THE KNOWLEDGE MARKET

Krassimir Markov, Krassimira Ivanova, Ilia Mitov

Abstract: In this paper, the "Information Market" is introduced as a payable information exchange and based on it information interaction. In addition, special kind of Information Markets - the Knowledge Markets are outlined. The main focus of the paper is concentrated on the investigation of the staple commodities of the knowledge markets. They are introduced as kind of information objects, called "knowledge information objects". The main theirs distinctive characteristic is that they contain information models, which concern sets of information models and interconnections between them.

Keywords: Information Market, Knowledge Market, Knowledge Information Objects, General Information Theory

ACM Classification Keywords: K.4 Computers and Society – K.4.0 General; K.4.4 Electronic Commerce

> "The speaker doesn't deliver his thought to the listener, but his sounds and performances provoke the thought of the listener. Between them performs a process like lighting the candle, where the flame of the first candle is not transmitted to another flame, but only cause it."
>
> *Pencho Slaveikov, Bulgarian poet,*
> *the beginning of the XX-th century*

Introduction

The main characteristic of the Information Markets is payable information exchange and based on it information interaction. Special kinds of Information Markets are the Knowledge Markets. The main goal of this paper is to continue the investigation of the Knowledge Markets started in [Ivanova et al, 2001], [Markov et al, 2002]. Now, our attention will be paid to the staple commodities of the Knowledge Markets. The usual talk is that at the Knowledge Market one can buy knowledge. But, from our point of view, this is not so correct.

The investigation presented in this paper is based on the *Theory of Information Interaction*, which is one of the main parts of the *General Information Theory* [Markov, 1984], [Markov, 1988], [Markov et al, 1993], [Markov et al, 2003].

Firstly, let remember some basic concepts of the Theory of Information Interaction.

At the first place, we need to remember the concept "INFOS". Its genesis started from the understanding that the concept *"Information Subject"* is perceived as a single human characteristic. It is clear that in the nature there exist many creatures, which may be classified to this category, especially groups of persons and societies. To exclude the misunderstandings we decide to introduce new word to denote all possessors of the characteristics of the Information Subject. This word is "*INFOS*" [Markov et al, 2003], [Markov et al, 2004].

On given level of complexity of the entities, a new quality becomes - the possibility of self-reflection and internal activity appears. One special kind of activity is the secondary (information) one. The secondary activity need to be resolved by relevant possibilities of the entities from the environment. So, not every entity may be used for resolving the secondary activity. This way, the entity needs a special kind of (information) contacts and (information) interaction for resolving the information activity.

The entity, which has:

− *(primary) activity* for external interaction;

− possibility for *reflection*, i.e. possibility for collecting the information;

− possibility for *self-reflection*, i.e. possibility for generating secondary (information) activity;

− *information expectation* i.e. available (secondary) information activity for internal or external contact for resolving it

is called *Infos*.

The resolving of the information activity is *the goal* of the Infos. This goal may be achieved by the establishment and providing (information) contacts and (information) interaction, which are remembered below.

Information Objects

When the Infos interact with the entities around in the environment, there exist at least two cases of reverberation:

− the contacts and interaction are casual and all reflections in the Infos as well as in the entities have casual origin;

− the contacts and interactions are determined by the information activity of the Infos.

In the both cases, the contacted entity may reflect any information model from Infos. The concept "information model" has been defined in [Markov et al, 2001]. In general, the information model is a set of reflections, which are structured by Infos and, from his point of view, represents any entity.

An entity, in which one or more information models are reflected, is called *"information object"*.

The information objects can have different properties depending on:

− the kind of influence over the entities - by ordering in space and time, by partial or full modifying, etc.,

− the way of influence over the entities - by direct or by indirect influence of the Infos on the object,

− the way of development in time - static or dynamic,

etc.

Information Operations

The information is reflected relationship, i.e. it is a kind of reflection [Markov, 1988]. Therefore, the only way Infos to operate with information is to operate with the entity that contains it. Every influence on the entity may cause any internal changes in it and this way may change the information already reflected. Another type of influence is to change the location of entity or to provoke any contact between given entity and any other.

The influence over the information object is called "*information operation*" if it is determined by any Infos information activity.

The information operations may be of two main types:

− the Infos internal operations with the sub-entities that contain information,

− external operations with the information objects that contain information.

The internal operations with the sub-entities closely depend of the Infos' possibilities for self-reflection and internal interaction of its sub-entities.

The self-reflection (self-change) of the Infos leads to the creating of new relationships (and corresponding entities) in it. These are *subjectively* defined relationships, or shortly - *subjective relationships*. When they are reflected in the memory of the Infos they may initiate any new information model on a higher level. In such case, a relation between reflected relationships appears. The high-level information models may have not real relationships and real entities that correspond to them.

For instance, the possibility for creating the information models of similarity is a basis for realising such very high level operations as "comparing elements or substructures of the information models", "searching given substructure or element pattern in the part or in the whole structure of the information model", etc.

It is clear, the Infos is built by entities some of which may be also Infoses, but on the lowest levels. For instance the society and single human who belongs to it. So, the internal operations are determined by the concrete internal level and from the point of view of these low levels, they may be assumed as external operations. Because of this, we will concentrate out attention on the second type of operations.

The external operations with information objects may be differed in two main subtypes:
− basic information operations;
− service information operations.

There are two basic information operations which are called I-operations:
✓ I-reflection (reflecting the information object by the Infos, i.e. the origination of a relevant information model in the memory of the Infos);
✓ I-realisation (creating the information object by the Infos).

In the process of its activity, the Infos S reflects (perceives) information from the environment (entities O_i, i=1,2...) by proper sub-entities (sensitive to video, acoustic, tactile, etc. influences) called "*receptors*" R_i (i=1,2...). Consequently, the Infos may receive some information models.

The Infos subjective reflection is called "*I-reflection*".

When necessary, the Infos can realise in its environment (entities O'_j, i=1,2...) some of the information models, which are in his memory, using some sub-entities called "*effectors*" E_j (j=1,2...). Consequently, new or modified already existing entities may reflect the information, relevant to these information models.

The Infos subjective realisation is called *"I-realisation"*.

There are several operations, which can be realised with the information objects: transfer in space and time, destroying, copying, composition, decomposition, etc. Because of the activity of the Infoses, these operations are different from other events in reality. In this case, such Infos determined operations with information objects are called "service information operations".

For example, some of the very high-level service operations are based on the external influence on the information object to change any existing reflection:
✓ Including and removing an element in and from the object's structure;
✓ Copying or moving object's substructures from one place to another;

✓ Building new object's structure using as a basis one or several others;

✓ Composing or decomposing of object's elements or substructures;

Etc.

Information Processes

Let "O" is a set of real information objects i.e. $O = \{O_{ij} \mid i = 1,..,n; j=1,..,m\}$.

Let "I_s" is a set of information models in Infos S, i.e. $I_s = \{i_p \mid p=1,..,q\}$.

If the opposite is not stated, we will consider:

- every set of information objects is an information object,

- every set of information models is an information model.

Every information operation "t" can be treated as a function between two sets of information objects, which may be coincidental, i.e. $t: O_d \rightarrow O_r$.

I-realisation can be considered as a function $m: I_s \rightarrow O$.

I-reflection - in the opposite - as a function $r: O \rightarrow I_s$.

Let $t_1, t_2,..,t_n$ are information operations. The consequence of information operations P created by any composition, i.e.

$$P = t_1 \circ t_2 \circ \ldots \circ t_n$$

is called "*information process*".

It is possible that some of t_i, i=1,..,n may be I-realisation or I-reflection.

In particularly an information process can include only one operation.

Information Contact

If an information model from the Infos is reflected in another entity, there exist possibility, during the "a posterior" interactions of the given entity with another Infos, to transfer this reflection in it. This way an information model may be transferred from the Infos to another.

If the second Infos has already established information expectation, the incoming reflection will be perceptible for him. The information expectation will be resolved in some degree and the incoming information model and information in it will be received by the second Infos.

Let S_1 and S_2 are Infoses and O is an arbitrary entity.

The composition of two real contacts Θ_1 and Θ_2 :

$$S_1 \xrightarrow{\Theta_1} O \xrightarrow{\Theta_2} S_2$$

is called "*information contact*" between Infos S_1 and Infos S_2 iff during the contacts any information model from I_{S1} is reflected in the I_{S2} through the entity O.

The Infos S_1 is called "*information donor*", the Infos S_2 is called "*information recipient*", and, of course, the entity O is called "*information object*".

In this case, when the donor and the recipient are different Infoses the information contacts between them consist of the composition of at least two information operations - I-realisation and I-reflection. For the realisation of any direct information contact between two different Infoses is necessary the execution of the composition of these two "basic" operations. All the rest information operations are necessary for supporting the basic ones i.e. they are auxiliary (service) operations.

This way the elementary communicative action will be provided.

In general, every information process "c", having as a start domain the set I_{Sd} of information models of the Infos S_d and as a final domain the set I_{Sr} of information models of the Infos S_r, (I_{Sd} and I_{Sr} may be coincidental)l,

$$c: I_{Sd} \rightarrow I_{Sr}$$

is called *"information contact"* between S_d and S_r:

Note that for the realisation of one information contact at least one information object is necessary.

Information Interaction

The set "R" of all information contacts between two Infoses S_a and S_b

$$R = \{c_i \mid i=1,2..; c_i:I_{Sa} \rightarrow I_{Sb}\}$$

is called "*information interaction*".

When S_a and S_b are coincident, we call it Information interaction of the Infos with itself (through the space and time).

The set "B" of all information objects, used in the information interaction between given Infoses is called "*information base*".

Information Society

The "*Information Group*" (IG) is a set of Infoses, with common Information base of the information interactions between them.

In the small IG the service information operations may be provided by the every Infos. In the large IG this is impossible or not optimal. In such case, some Infoses became as "*information mediators*" between the others. They start to provide the service information operations. They realise "*Information Service*".

The "Information Society" is an IG with internal Information Service.

Information Market

Now we are ready to continue with introducing the basic ideas of the Information Markets.

Up to this moment, the discussion about essence of the information society has not resulted in uniform definition. Everyone from his point of view defines this stage of development of a society.

It is clear, at the stage of social growth, called "information society", for existence of the separate individuals or social teams the information and information activity get decisive value. Certainly, at earlier stages of development of mankind, the information had the important value too. But never, in all known history, the other means for the existence have been so dominated by the information means as it is in the information society.

So, the direct conclusion is the understanding that *the information society differs from the other levels of the human been growth by the domination of the information interests above all others.*

From the origin, the human society has been the "information" one, but the levels of the information service differ in the different periods of the existence of the societies. So, it is possible to allocate the following levels:

✓ **Primiti**ve **information society** (people having knowledge, letters on stones etc.);

✓ **Pap**er **information society** (books, libraries, post pigeons, usual mail etc.);

✓ **Te**chnology **information society** (telephone, telegraph, radio, TV, audio- and video-libraries etc.);

✓ **High-Te**chnology **information society** (automated systems of information service, local computer information networks etc.);

✓ Global information society (global systems for information service, opportunity for every body to use the information service with help of some global network etc.).

The information society does not assume compulsory usage of the information services by the part or all inhabitants of given territory. One very important feature thus is emphasized: for everyone will be necessary diverse and qualitative (from his point of view) information, but also everyone can not receive all necessary information. The enterprising experts will accumulate certain kinds of the information and will provide the existence through favourable to them information exchange with the members of the society. Thus, in one or other form, they will carry out payable information service (granting of information services for some income) [Ivanova et al, 2001]. This is the background of the Information Market.

The payable information exchange and services regulated by the corresponded laws and norms as well as by the government protection of the rights of the participants (members) of this kind of social interactions form the *Information Market*.

So, at the centre of discussion, we have discovered a simple true: *in the information society the payable information exchange and services will dominate above all other market activities.* In other words, the Information Market dominates over all other type of markets of the information society.

Knowledge Information Objects

V.P. Gladun correctly remarks that the concept "knowledge" does not have common meaning, especially after beginning of it's using in the technical lexicon in 70-ies years of the last century. Usually, when we talk about the human knowledge we envisage all information one has in his mind. Another understanding sets the "knowledge" against the "data". We talk about data when we are solving any problem or are making logical inference. Usually the concrete values of the given quantities are used as a data as well as the descriptions of the objects and interconnections between objects, situations, events, etc. During decision making or logical inference we operate with data involving some other information like descriptions of the solving methods, rules for inference of the corollaries, models of the actions from which the decision plan is formed, strategies for creating decision plans, and general characteristics of the objects, situations, and events. In accordance with this understanding, the "knowledge" is information about processes of decision making, logical inference, regularities, etc., which applying to the data creates any new information. [Gladun, 1994].

The usual understanding of the verb "to know" is: "to have in the mind as the result of experience or of being informed, or because one has learned"; "to have personal experience of smt." etc. The concept "knowledge" usually is connected to concepts "understanding" and "familiarity gained by experience; range of information" [Hornby et al, 1987] or "organized body of information" [Hawkins, 1982].

In other words, the knowledge is a structured or organised body of information models, i.e. the knowledge is information model, which concerns a set of information models and interconnections between them.

In accordance with this the information objects, which contain such information models are called *"knowledge information objects"*.

This definition corresponds to everyday understanding of the concept "knowledge". For instance, during the process of education the presented above operations I-realization and I-reflection correspond to creating and perceiving the *"knowledge information objects"*.

Knowledge Market

The growth of the societies shows that the knowledge information objects become important and necessary articles of trade. The open social environment and the market attitudes of the society lead to arising of the knowledge customers and knowledge sellers, which step-by-step form the "Knowledge Markets" [Markov et al, 2002].

As the other markets, the **Knowledge Market** is the organised aggregate of participants, who operate following common rules and principles. The knowledge market structure is formed by a combination of mutually-connected elements with simultaneously shared joint resources.

The staple commodities of the knowledge market are the knowledge information objects.

The knowledge information bases and tools for processing the knowledge information objects, such as tools for collecting, storing, distributing, etc., form the **knowledge environment**.

The network information technologies enable to construct uniform *global knowledge environment*.

It is very important, that it will be friendly for all knowledge market participants and open for all layers of the population without dependence from a nationality, social status, language of dialogue, place of residing. The decision of this task can become the important step of humanization of all world commonwealths.

In the global information society, on the basis of modern electronics, the construction of the global knowledge market, adapted to the purposes, tasks and individual needs of the knowledge market participants is quite feasible, but the achievement of this purpose is connected to the decision of a number of scientific, organizational and financial problems.

For more clear explanation let consider an example about the correspondence between concepts "information object" and "knowledge information object". When an architect develops any constructive plan for future building, he creates a concrete "information object". Of course, he will sell this plan. This is a transaction in the area of the Information Market. Another question is from where the architect has received the skills to prepare such plans. It is easy to answer – he has studied hardly for many years and received knowledge is the base for his business. So, we see that the textbooks are not concrete information for building concrete house, but they contain the information needed for creating such plans. The textbooks written by the lecturer in the architectural academy are special kind of "information objects" which contain special generalized information models. They are "knowledge information objects" and these textbooks have been sold to the students. It is clear; here we have a kind of transactions at the "Knowledge Market".

At the end, we need to take into consideration the difference between responsibility of the architect and the lecturer. If the building collapses the first who will be responsible is the architect, but never the lecturer!

Conclusion

In this paper, we introduced the "Information Market" as a payable information exchange and based on it information interaction. In addition, special kind of Information Markets - the Knowledge Markets were outlined.

The identifying of the staple commodities of the knowledge markets was a step of the process of investigation of contemporary situation in the global knowledge environment.

The investigation of the staple commodities of the knowledge markets is very difficult but useful task. In this paper we introduced them as kind of information objects, called "knowledge information objects". The main theirs distinctive characteristic is that they contain information models, which concerns sets of information models and interconnections between them.

This way, we have seen the usual talk that at the Knowledge Market one can buy knowledge is not so correct. But in everyday language in is accepted to say "knowledge" with the meaning of the "knowledge information object". We need specially to say that there exists another meaning of knowledge, which points to the information models into the Infos memory. Usually we do not distinct these two meanings. When we say "receiving of knowledge" we assume the I-reflection operation; when we say "generating the knowledge" we assume the I-realization operation; and at the end, when we say simply "knowledge" it is context depended to understand what is the meaning – knowledge information models into the Infos memory or those which the knowledge information objects contain. However, if we remember that the Infoses are built by entities some of which may be also

Infoses, but on the lowest levels, the internal memory of given level of the organisation of the Infos may be considered as external set of information objects on the lower levels.

This has important role for future research of this social and information phenomenon.

Acknowledgements

Bibliography

[Gladun, 1994] Гладун В.П. Процессы формирования знаний. София, Педагог 6, 1994.

[Hawkins, 1982] Hawkins J.M., *The Oxford Paperback Dictionary*. Oxford University Press, 1982, ISBN 0-19-281209-2.

[Hornby et al, 1987] Hornby A.S., A.P. Cowie, A.C. Gimson, *Oxford Advanced Learner's Dictionary.* Oxford University Press. 1987, ISBN 0-19-431106-6.

[Ivanova et al, 2001] N. Ivanova, K. Ivanova, K. Markov, A. Danilov, K. Boikatchev. *The Open Education Environment on the Threshold of the Global Information Society*. IJ ITA, 2001, V.8, No.1 pp.3-12. (Presented at Int. Conf. KDS 2001 Sankt Petersburg, 2001, pp.272-280, in Russian, Presented at Int. Conf. ICT&P 2001, Sofia, pp.193-203)

[Ivanova et al, 2003] Кр.Иванова, Н.Иванова, А.Данилов, И.Митов, Кр.Марков. *Обучение взрослых на рынке профессиональных знаний*. Сборник доклади на Национална научна конференция "Информационни изследвания, приложения и обучение" (i.TECH-2003), Варна, България, 2003. Стр. 35-41.

[Markov, 1984] K.Markov. *A Multi-domain Access Method.* Proceedings of the International Conference on Computer Based Scientific Research. PLOVDIV, 1984, pp.558-563.

[Markov, 1988] Кр.Марков. *От миналото към бъдещето на определението на понятието "информация".* Сборник "Програмиране '88". БАН, Варна, Дружба, 1988, стр.150.

[Markov et al, 1993] K.Markov, K.Ivanova, I.Mitov. *Basic Concepts of* a *General Information Theory.* IJ ITA {International Journal "Information Theories & Applications"}; 1993; v.1, n.10; pp.3-10.

[Markov et al, 2000] Kr. Markov, Kr. Ivanova, I. Mitov, N. Ivanova, K. Bojkachev, A. Danilov. *Co-operative Distance and Long-Live Learning*. ITA-2000, Bulgaria, Varna, 2000.

[Markov et al, 2001] K. Markov, P. Mateev, K. Ivanova, I. Mitov, S. Poryazov. *The Information Model.* IJ ITA, 2001, V.8, No.2 pp.59-69 (Presented at Int. Conf. KDS 2001 Sankt Petersburg, 2001, pp.465-472)

[Markov et al, 2002] K. Markov, K. Ivanova, I. Mitov, N. Ivanova, A. Danilov, K. Boikatchev. *Basic Structure of the Knowledge Marke*t. IJ ITA, 2002, V.9, No.4, pp.123-134 (Presented at Int. Conf. ICT&P, 2002, Приморско)

[Markov et al, 2003] Kr.Markov, Kr.Ivanova, I.Mitov. *General Information Theory. Basic Formulations.* FOI-COMMERCE, Sofia, 2003. ISBN 954-16-0024-1.

[Markov et al, 2004] K. Markov, K. Ivanova, I. Mitov, E. Velikova-Bandova. *Formal Definition of the Concept "INFOS".* Int. Journal "Information Theories and Applications", 2004, ISSN 1310-0513. V.11, N.1, pp.16-19. (Presented at i.TECH 2004, Varna, Bulgaria. pp. 71-74)

Authors' Information

Krassimir Markov – Institute of Mathematics and Informatics, Bulgarian Academy of Sciences, Institute of Information Theories and Applications FOI ITHEA, foi@nlcv.net

Krassimira Ivanova – Institute of Mathematics and Informatics, Bulgarian Academy of Sciences, foi@nlcv.net

Ilia Mitov – Institute of Information Theories and Applications FOI ITHEA, foi@nlcv.net